Connecticut Electronic Tolling and Congestion Pricing Study

final report

prepared for

Connecticut Transportation Strategy Board
Connecticut Office of Policy and Management

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Preface

The final documentation for the Connecticut Electronic Tolling and Congestion Pricing Study is composed of three volumes:

- **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.

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Connecticut Electronic Tolling and Congestion Pricing Study

Volume 1 – Summary of Findings

April 20, 2009

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.

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.

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:

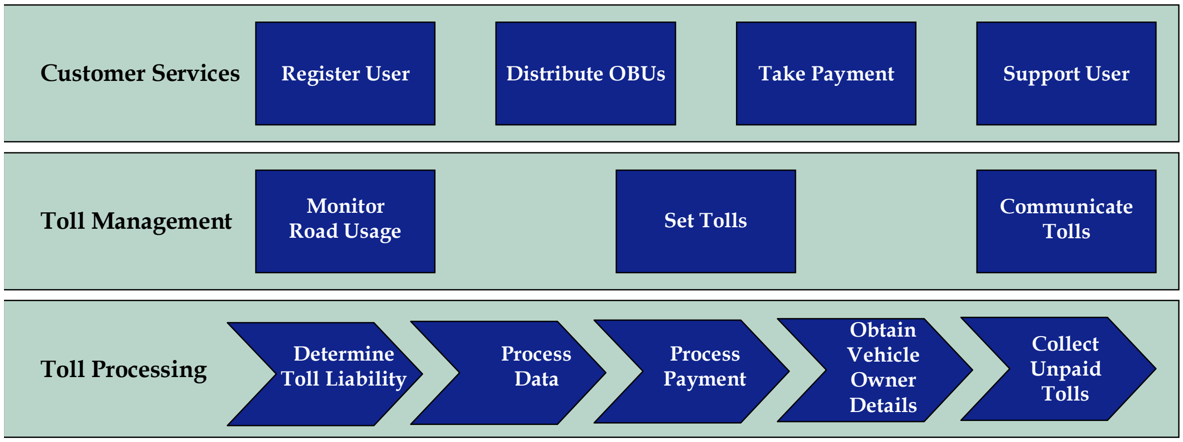
1. **License Plate**. This approach uses gantry-mounted Automatic License Plate Recognition (ALPR) cameras to identify the vehicle's license plate. No in-vehicle equipment is required.
2. **Radio Frequency ID (RFID)**. This approach uses an in-vehicle transponder (such as E-ZPass) which communicates 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.
3. **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.

Notwithstanding these advances, introducing cashless tolling on roads with a high proportion of non-Connecticut vehicles will provide challenges, particularly in the collection of revenue from out-of-state customers who do not choose to pay. These challenges are not insurmountable, but they are considerable at least until there are Federal standards that relate to toll collection; billing and enforcement; or interoperability with other agencies in the region that adopt similar policies and procedures.

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.

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.

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.

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.

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.

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.

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 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:

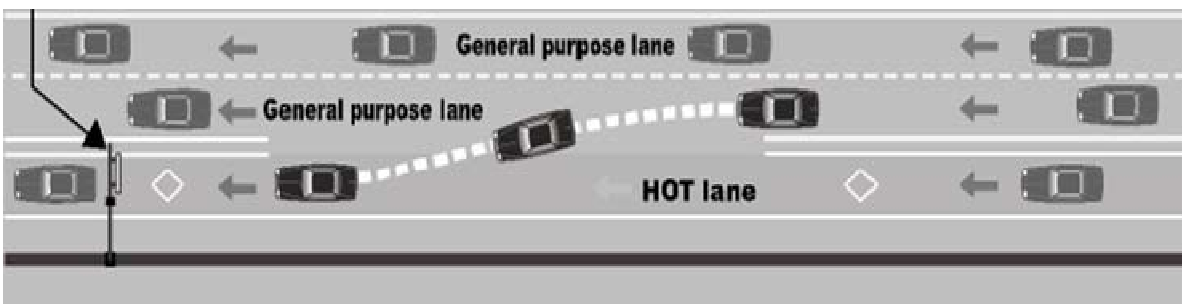
- **Static pricing** works by prepublishing toll rates to let drivers know how much tolls will be at certain times. Toll rates might vary by time of day and/or day of week, but people will know in advance what the tolls will be at any particular time, and can make their travel plans accordingly. Static pricing is technically simple and can

[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.

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 nontolled 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 $40 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	(94.0)	(34.7)
Initial Capital Cost of Toll Collection System	90.2	59.6
Total Highway Construction Costs	1,366.1	371.0
Life-Cycle Surplus/(Shortfall)	**(1,550.3)**	**(465.4)**

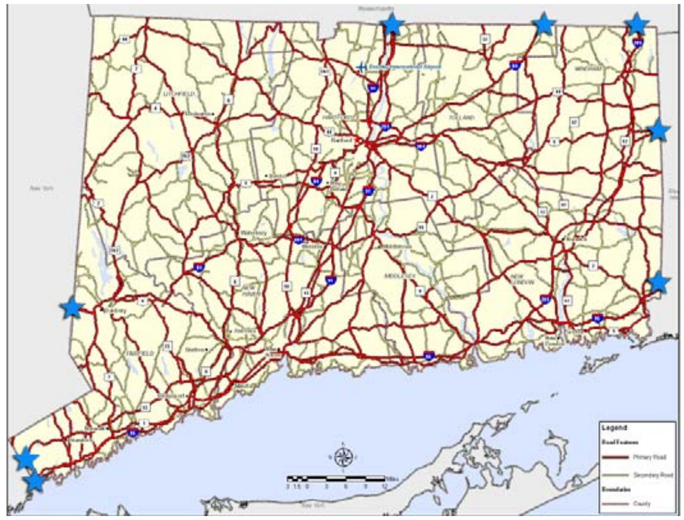
Environmental, Economic, Equity, and Safety Impacts

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	3950.6	9358.3	18,830.4
Initial Capital Cost of Toll Collection System	220.2	207.0	189.8
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,730.5**	**9,151.3**	**18,640.6**

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)	**Average Per Mile Toll Rate**		
Concept C Toll Trucks on Limited Access Highways	**$0.30**	**$0.45**	**$0.60**
Present Value of Net Toll Revenue	4,891.9	8,229.1	12,087.5
Initial Capital Cost of Toll Collection System	1,384.0	1,383.6	1,383.4
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,507.9**	**6,915.5**	**10,704.1**

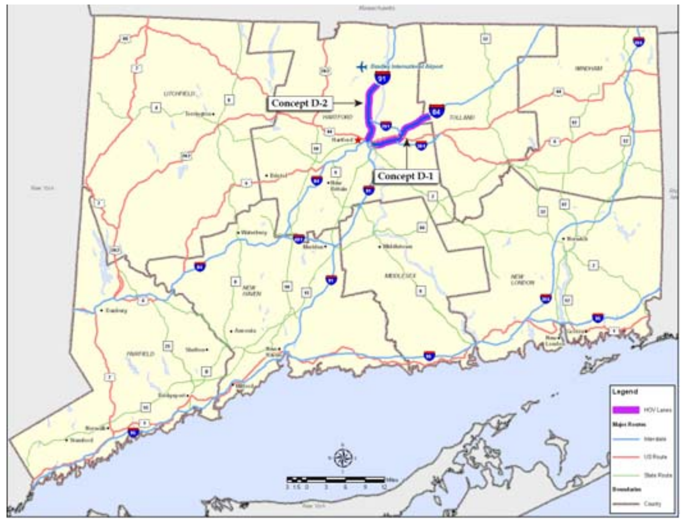
Environmental, Economic, Equity and Safety Impacts

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 $17.7 million over a 30-year period, and fall just $1.3 million shy of covering the capital cost of toll collection. This could 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	(16.9)	17.7
Initial Capital Cost of Toll Collection System	13.4	19.0
Total Highway Construction Costs	0	0
Life-Cycle Surplus/(Shortfall)	**(30.3)**	**(1.3)**

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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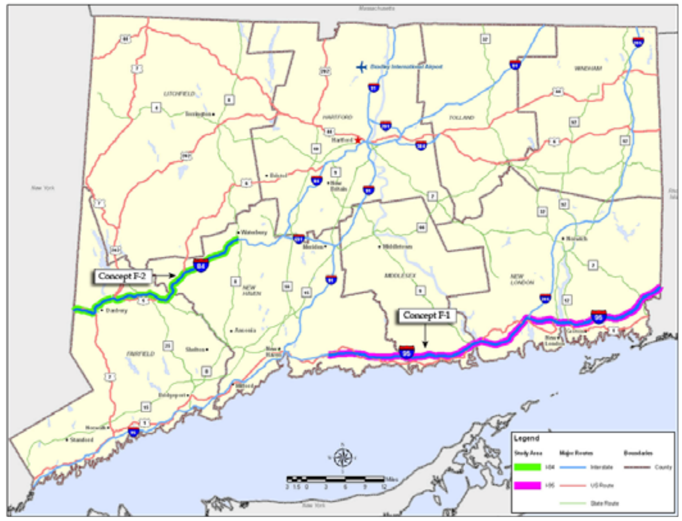
Concept F: Toll Individual Highways Needing New Capacity



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	2,939.7	6,162.4	8,490.7
Initial Capital Cost of Toll Collection System	381.1	357.8	330.3
Total Highway Construction Costs	1,468.5	1,468.5	1,468.5
Life-Cycle Surplus/(Shortfall)	**1,090.1**	**4,336.1**	**6,691.9**
Concept F-2: I-84			
Present Value of Net Toll Revenue	1,704.8	3,612.0	4,992.2
Initial Capital Cost of Toll Collection System	233.5	220.2	203.8
Total Highway Construction Costs	404.7	404.7	404.7
Life-Cycle Surplus/(Shortfall)	**1,066.5**	**2,987.1**	**4,383.7**

Environmental, Economic, Equity and Safety Impacts

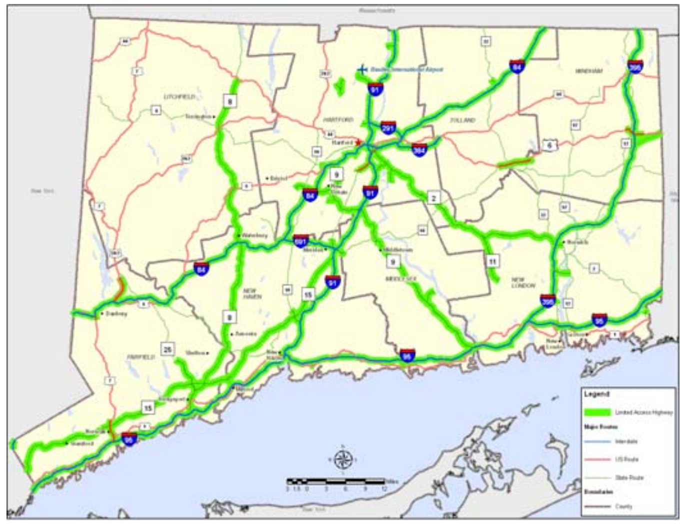
Most environmental measures would be negatively impacted to at least a small degree due to the overall degradation in corridor traffic operations resulting from the diversion of traffic to local routes. Significant community ambiance and bicycle/pedestrian impacts would be experienced in the I-95 corridor 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	11,273.8	18,255.9	25,544.4
Initial Capital Cost of Toll Collection System	1,644.4	1,643.7	1,642.03
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**9,629.4**	**16,612.3**	**23,902.4**

Environmental, Economic, Equity and Safety Impacts

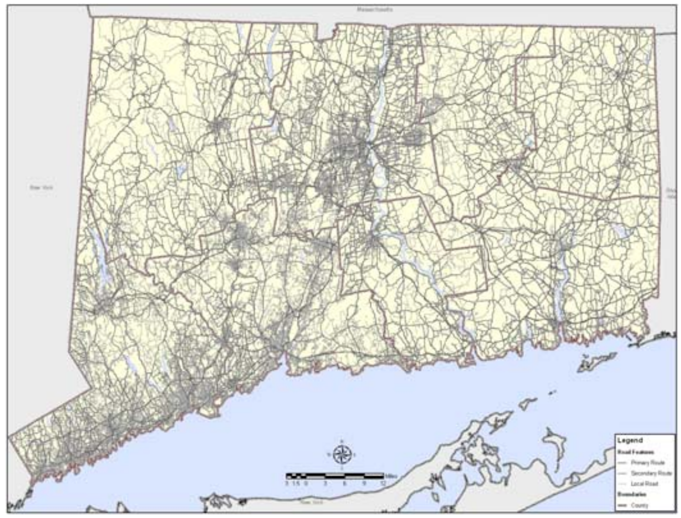
Environmental impacts resulting from the diversion would be minor to water quality, energy consumption and environmental justice, and potentially more significant to air quality, community ambiance, bicycle/pedestrian conditions, noise, and cultural/historic resources. Economic impacts would be felt 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 $40 billion in revenue in excess of the cost of tolling (there are no construction costs). Without complementary improvements, **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. However, using the considerable revenue raised from congestion pricing for improvements such as more commuter rail parking, more express bus and BRT networks supported by park-and-ride facilities and local feeder services, or other uses could mitigate these concerns and result in a beneficial project.

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 mid-day 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 almost $40 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	40,056.8
Initial Capital Cost of Toll Collection System	315.1
Total Highway Construction Costs	0
Life-Cycle Surplus/(Shortfall)	**39,741.8**

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.

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Connecticut Electronic Tolls and Congestion Pricing Study

Volume 2 – Background Report

April 20, 2009

1.0 Introduction

1.1 Background and Overview

Connecticut is at a crossroads when it comes to looking into the future of transportation finance and congestion relief. The Connecticut Department of Transportation (ConnDOT) Reform Commission has 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 U.S., 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.

Structure of this Report

This is Volume 2 of a three-volume series of reports that provides details on the analysis that is summarized in *Volume 1: Summary of Findings*. Volume 1 is an integral piece of this report, and should be read before considering the details in this Volume 2. Further methodological and computational detail is provided in Volume 3: Technical Appendices.

Section 2.0 of this Volume 2 report reviews the institutional and legal considerations of implementing congestion pricing. Section 3.0 covers the operational and deployment challenges associated with all electronic tolling. Section 4.0 focuses on the potential for public private partnership opportunities and potential contractual issues. Section 5.0 discusses the potential issues surrounding privacy for these concepts, and Section 6.0 deals with public acceptance.

This study also considered eight different concepts of electronic tolling and congestion pricing of varying degrees of complexity and coverage. Within each tolling concept, there are one or more illustrative projects that we explored, some of which involve consideration of different toll levels. The intent is to provide some basic information about the transportation system implications, dollars and cents, and other facets of these concepts. If any of these concepts were to move forward, there are countless other variations which could be analyzed, including alternative toll levels, toll variations by time of day, and ways to address equity concerns that impact certain classes of drivers, among others. Any concepts which move forward into alternatives analysis, environmental review and final design would undergo a much more thorough and varied analysis.

Sections 7.0 through 15.0 consider each of the eight concepts in detail:

- 7.0: Concept A – New Tolled Express Lanes:
  - I-95 between Branford and the Rhode Island line (A-1);
  - I-84 between Waterbury and the New York line (A-2); and
  - A-1 and A-2 combined.
- 8.0: Concept B – Border tolling at the border crossings of all limited access highways in the State, tested for three different tolling levels for four different classes of vehicles (autos, vans, single-unit trucks, and tractor trailers).
- 9.0: Concept C – Tolling all trucks on all limited access highways in the State, at three different tolling levels for three different vehicle classes (vans, single-unit trucks, and tractor trailers).

- 10.0: Concept D – Converting the existing High-Occupancy Vehicle (HOV) lanes to HOT lanes on:
  - I-84 east of Hartford (D-1);
  - I-91 north of Hartford (D-2); and
  - D-1 and D-2 combined.
- 11.0: Concept E – Converting existing shoulders on I-95 and Route 15 from the New York border to the Bridgeport area to HOT lane operation.
- 12.0: Concept F – Adding a general purpose lane in each direction, and tolling all traffic lanes at three different toll levels:
  - I-95 from Branford to the Rhode Island line (F-1);
  - I-84 from Waterbury to the New York line (F-2); and
  - F-1 and F-2 combined.
- 13.0: Concept G-1 – Tolling all limited access highways in the State.
- 14.0: Concept G-2 – Tax all vehicle miles of travel (VMT) in the State:
  - As an augmentation to the existing state motor fuel tax; and
  - As a replacement for that tax.
- 15.0: Concept H – Tolling congested corridors. We selected the I-95/Route 15 corridor from the New York border to the Bridgeport area as a demonstration.

The chapters for each concept include the following analytical sections:

- Project description;
- Institutional and legal;
- Technology and deployment;
- Potential public private partnership approaches;
- Privacy;
- Transportation impacts;
- Toll revenue estimates;
- Implementation requirements and toll collection costs;
- Implementation strategy;
- Environmental;
- Economics;

- Equity;
- Safety; and
- Financial.

In the rest of this opening section, we provide an outline of the methodology used for the topical areas.

1.2 Methodology

The first four topics described above are qualitative in nature: institutional and legal; technology and deployment; potential public private partnership approaches; and privacy. The other topics are more quantitative in nature. An overview of the methodology used for the quantitative sections is provided below, with further details in Volume 3, Technical Appendix.

Transportation Impacts and Toll Revenue

The traffic and revenue analysis methodology is unique to each alternative and is described in each concept section. In general, we made use of available data, and devised analysis methods intended to provide a feeling for how drivers would respond to tolls in the different situations, how that would impact traffic on both the tolled facility and other facilities, and how much revenue could be collected. In all cases, sketch-planning tools were used that were appropriate to the data sources. All revenue and costs (including toll rates) were assumed to increase at an annual rate of inflation of three percent.

Toll Collection and Implementation

In order to collect revenue, all concepts would involve the development, construction, and operation of toll collection facilities. These would not be toll booths in the traditional sense, but modern toll collection systems capable of collecting tolls at high speeds without the use of cash. Such systems are still in their infancy and the technology changes quickly. IBI Group took the lead on this analysis, and developed reasonable assumptions for the steps that would be needed, the kinds of technology that would be appropriate, and the costs that would be involved.

We identified the implementation requirements in terms of the technology options and scope of support functions needed to deploy the specific concept, project and toll rate option as discussed in the earlier Phase 2 report. This included identifying the specific equipment needed at each tolling point to support the functional needs of that concept. We then extended these requirements according to the size of the project in terms of length of instrumented roadway, number of tolling points, number of transactions and total revenue. A major assumption used in this analysis is the need for a tolling point on every segment of the tolled facility to ensure that even the shortest trips between adjacent exits are tolled. Further analysis might find that some segments could be left toll-free without significantly affecting revenue, or impacting perceptions of equity, thus saving the capital and operating costs associated with that tolling point.

We also made assumptions about the characteristics of the tolling program, including the potential for leveraging existing E-ZPass accounts from other states, the potential customer base in relation to account volume, the ability to require use of transponders on the facilities, and the level of customer service that would be required. We estimated the number of vehicle tags that need to be purchased over the life of the program from the number of accounts and anticipated lifetime of the tags.

We estimated back-office costs based on four factors: the number of accounts that need to be maintained, the amount of video toll processing that needs to be undertaken, the revenue volume that would be processed, and the level of customer service distribution that would be required in terms of walk-in centers and retail locations. The financial transaction costs in terms of credit card, bank, and collection agency processing fees were estimated based on the expected percentage of revenue collected via the different means.

Both minimum size of back-office operation for smaller projects and anticipated economies of scale for larger project have been taken into account to generate these conservative estimates. It is possible that improved coordination with existing services and greater efficiencies in the processing of large volumes could be achieved; however, this would require significantly more detailed analysis of the specific expected distribution of transactions and tolling points if a concept was to be pursued further.

Our estimates of overall operating costs also incorporated initial estimates for the staffing of the program to oversee the planning, procurement, design and testing of the toll collection system. We also identified costs associated with additional law enforcement and roadside assistance personnel based on the goal of the project and the length of roadways covered. Capital cost estimates take into account the estimated component lifetime and replacement costs over the 30-year project span.

Table 1.1 shows a summary of typical toll collection costs:

Table 1.1 Typical Capital Costs of Toll Installations

Typical Capital Costs	
Tag	$18
Large gantry system for a single tolling point (four to six lanes) with tag readers, bi-directional image capture	$1,100,000
Small gantry system for a single tolling point (single lane) with tag readers, bi-directional image capture	$350,000
DMS sign	$100,000
Static sign	$10,000
Vehicle detection station (per lane)	$20,000
Vehicle classification unit (per lane)	$40,000
Vehicle separation unit (per lane)	$20,000
Roadside computing unit, power connection, and fiber equipment per tolling point	$420,000
Back office mobilization cost	$1,000,000
Typical Operational Costs (Yearly)	
Small back office (17,000 tag accounts, 136,000 video annual transactions)	$1,300,000
Medium back office (624,000 tag accounts, 65m video annual transactions)	$20,400,000
Large back office (1.9m tag accounts, 360m video transactions)	$63,500,000
Walk-in center	$500,000

Environmental

The environmental impacts analysis was performed at a macro level. The conclusions regarding the potential for impacts is intended to assist in the decision-making process by identifying any potentially significant impacts which may be considered a 'fatal-flaw' for implementation of the concept, and to assist in determining what level of formal environmental documentation may be appropriate if the concept is carried forward to the next stage. If a concept is forwarded to design, a more in-depth environmental analysis will be required to comply with the National Environmental Policy Act and related state laws and regulations and determine what, if any, mitigation of impacts may be required.

A full range of natural, social, and cultural resources was considered for the collective tolling alternatives. For this final report, only those resources which would have potential for some level of impact for one or more of the concepts were documented. In the case of community resources, these are considered collectively under the heading of community disruption and refer to the potential for impacts to cohesive communities or neighborhoods.

Resources not noted in the impact summaries and tables should suffer no significant adverse impact. Where there is some potential for impact, the order of magnitude is categorized as beneficial, neutral, minor-adverse, or potentially significant-adverse. The general locations of impact are shown on maps provided in each section. The analysis provided in this report is intended to be a 'snapshot' of conditions and impacts that can be quickly and easily interpreted by the reader.

In all concepts, tolling gantries are expected to be located within the highway right-of-way. It is assumed that the footprint of the individual gantries will be limited such that the potential for construction-related impacts to environmental resources will be minimal and/or there will be an opportunity to avoid any sensitive resources.

Economics

The economic impacts of roadway pricing on local, regional, and state economies is a critical component of any public discussions about such proposals, raising issues such as:

- Is congestion perceived to be a significant economic problem that residents and businesses would like the government to address?
- Are the pricing proposals aimed at addressing these congestion problems, and publicly perceived as part of the solution to congestion problems or merely as a way of raising funds?
- Are there any funding strategies linked to the pricing proposal that would help address potential impacts of those proposals (e.g., supporting transit in the same travel markets), or funding other public investments that newly tolled travelers would support (e.g., road or bridge maintenance)?

The potential for economic impacts – positive and negative – will primarily depend on the size and nature of the pricing proposal. Modest tolls lessen the fear of negative economic impacts, but also would have fewer impacts on travel decisions and congestion levels. However, relatively high tolls may be necessary to get meaningful changes in travel patterns.

The biggest economic concerns typically relate to so-called spatial competition differences created by a congestion toll – will a congestion toll on the highway segments in a particular area of the State put residents, travelers and businesses in that area at a disadvantage? Ideally, toll costs would be balanced by somewhat faster, more reliable trips due to reduced congestion, improved freight movements, and similar benefits, along with possible toll-supported expansion of transit services.

The following factors are included in this analysis:

- The economic value of congestion and its relief;
- The coverage of the tolling program;

- Spatial competition issues;
- Existing highway travel markets and available alternative routes and modes; and
- Potential interstate economic issues.

Equity

Equity issues involve the incidence of a given form of tax – or toll in this case; i.e., who exactly would pay the toll and how would these payments be distributed among different groups, localities, industries, etc. These issues include two basic types of equity:

1. **Horizontal Equity –** How groups or individuals with similar needs or resources are treated under a given proposal – what most people mean when the phrase "fairness" is used; and

2. **Vertical Equity –** The treatment of groups that are unequal in some manner (usually income).

Key factors analyzed to assess these equity issues include:

- Geographic distribution of the travelers who would being paying the tolls;
- Distribution of travel markets involved – work trip, shopping, business travel, etc.;
- Likely truck markets involved – long-haul interstate, local service and delivery, etc.;
- Time savings in tolled versus untolled routes;
- Potential for substantial and unavoidable tolls;
- Potential impacts on low-moderate income groups;
- Availability of convenient alternate travel routes; and
- Availability of effective transit services.

Safety

The safety impacts of the concepts were assessed by analyzing the complexity of the operation of the tolled road, and any likely impacts of diversion to other routes.

Financial Analysis

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.

The financial analysis was predicated on several assumptions:

- Project open to traffic by 2015;
- Project development period based on reasonable assumptions considering the complexity of consensus building, design and construction;
- Inflation rate and construction cost escalation rates both at 3 percent, based on long term historical averages;
- Uncollectible toll revenue of 5 percent; and
- Nominal discount rate of 4.9 percent, consistent with OMB Circular A-94.[1]

Differences in any of these assumptions could change the findings of the financial analysis.

An overview and comparison of the financial implications of all of the concepts follows the concept-by-concept summaries.

[1] http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html.

2.0 Institutional and Legal Considerations

The last tolls were removed from Connecticut roadways in 1989. Any effort to bring tolls back or institute congestion pricing will be subject to existing Federal and state laws and to the requirements of the various institutions that play a role in managing Connecticut's transportation system. This section explores the legal and institutional issues that would be involved in implementing tolling and congestion pricing. A detailed concept specific review occurs in Sections 7.0 through 15.0.

2.1 Legal Implications of Past Actions

Typically roads paid for with Federal funds must be free from tolls. One notable exception was a provision in the 1978 Surface Transportation Act that allowed toll roads on the Interstate Highway System to receive Federal money earmarked for resurfacing, restoring, rehabilitating, and reconstructing. In order to qualify, the state had to remove all tolls once the costs associated with construction, debt service, and toll removal had been raised from tolls. At this point, the mileage on the former toll road would be factored into the state's apportionment formula for Federal resurfacing money. In 1983, Connecticut became one of the few states to execute this agreement, removing tolls from many of its roadways.[2] As a result, Connecticut is obliged to keep tolls removed from the portions of I-95 and I-395 that was the Connecticut Turnpike, just like any other Interstate highway. The former Connecticut Turnpike included I-95 from the New York border to near New London and I-395 from New London to near the Rhode Island border. Some of the more recent Federal demonstration programs that are discussed later allow tolling on Interstate highways under certain circumstances. The toll removal agreement states that "When freed of tolls, the Connecticut Turnpike toll road subject to this Agreement on the Interstate and Primary Systems at the date of this Agreement, shall be treated the same as any other portions of the Interstate and Primary Systems which were constructed with Federal aid." This implies that the former Connecticut Turnpike would be eligible for the new Federal demonstration programs.

[2] Agreement No. 3.07-08(83) between the State of Connecticut and the United States Department of Transportation, Federal Highway Administration., August 30, 1983.

In 2005, the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) afforded greater flexibility for states to operate toll roads while receiving Federal funds. Included in SAFETEA-LU are five programs that allow tolling on the Interstate system (detailed in Section 2.2 below). Additionally, the U.S. Department of Transportation (DOT) has sponsored an Urban Partnership Program and Congestion-Reduction Demonstration to facilitate the creative use of tolling in congested urban areas. The reauthorization of SAFETEA-LU, which expires on September 30, 2009, may include additional opportunities for tolling on Federal-aid highways. In Sections 7.0 through 15.0, these programs, as well as other legal and institutional considerations, are discussed in relation to the tolling and congestion pricing concepts identified in the Phase 1 report.

2.2 Federal Laws Related to Tolling and Congestion Pricing

Title 23 of the United States Code governs the use of tolls on Federal-aid highways. Generally, this law prohibits the collection of tolls on highways constructed with Federal funds. However, the following provisions allow for tolling on Federal-aid highways without the penalty of a reduced share of Federal funding.

Interstate System Reconstruction and Rehabilitation Toll Pilot Program

This pilot program was established under TEA-21, and continued without change under SAFETEA-LU. It allows for tolls to be collected on up to three Interstate facilities (highway, bridge, or tunnel) in order to fund needed reconstruction or rehabilitation. Under TEA-21, the Federal Highway Administration (FHWA) actively solicited pilot project applications, with limited response. After the application deadline was eliminated in favor of an open-ended, first-come first-served invitation, two of the three available spots became reserved for Virginia to toll I-81 and Missouri to toll I-70. However, as Virginia no longer plans to pursue its tolling plan, two slots remain.[3]

A state must demonstrate that the facility could not be adequately maintained or functionally improved without the collection of tolls. Federal funds allocated for maintenance may not be used for a facility on which tolls are being collected, and toll revenues must only be used for 1) debt service; 2) reasonable return on investment of any private person financing the project; and 3) any costs necessary for the improvement of and the proper operation and maintenance of the toll facility, including reconstruction, resurfacing, restoration, and rehabilitation of the toll facility.

[3] Tollroad News, *VDOT Issues Death Notice on I-81 Truck Toll Lanes Concession Proposal,* http://www.tollroadsnews.com/node/3349, January 16, 2008.

Pennsylvania recently submitted an application to FHWA so that it could toll I-80, but the application was rejected, as it violated the revenue use requirements. Although toll revenues may be used to pay annual lease payments, the lease payments must be based on an objective valuation of the asset being leased. In Pennsylvania, the annual lease payments were set by the legislature and not related to the value of the concession, which resulted in the rejection of the application.

Of the concepts and projects we are studying in Connecticut, the improvements to I-95 from Branford to Rhode Island and I-84 from Waterbury to New York could potentially qualify for this program, if the State is interested in tolling these corridors.

Express Lanes Demonstration Program

This demonstration program was created under SAFETEA-LU, and allows for tolling on any Interstate highway, bridge, or tunnel to manage high levels of congestion, reduce emissions in a nonattainment or maintenance area (as defined by the Clean Air Act), or finance added lanes for the purpose of reducing congestion.

The effects of the tolling concepts are located throughout all counties in Connecticut. An exceedance in a county would cause an area of that county, or the entire county depending upon the pollutant, to become classified as nonattainment for that pollutant. The current air quality monitor locations, exceedances, and attainment designations for the six criteria pollutants in Connecticut counties are displayed in Table 2.1:

Table 2.1 Connecticut Air Quality Status

Pollutant	Number of CT Monitors	Exceedance (2006)	Attainment Status
CO	5	None	Attainment
Ozone	11	At 10 monitors	Nonattainment in all areas of Connecticut
PM_{10}	6	None	Attainment
$PM_{2.5}$	13	At six monitors	Nonattainment in Fairfield and New Haven counties. Attainment in all other areas.
NO_2	3	None	Attainment
SO_2	7	None	Attainment
Lead	0	-	Attainment

For transportation projects, the criteria pollutants of greatest concern are CO, ozone, and PM. CO and ozone are predominantly influenced by motor vehicle activity. In addition, the entire state is listed as nonattainment for ozone. Thus, projects or programs that reduce overall vehicular pollutant emissions will have a positive effect on air quality. Projects or programs that result in increased emissions will have a negative effect on the ambient air quality.

Existing Interstate or non-Interstate lanes that are modified or constructed to create toll lanes also are eligible, as are existing Interstate or non-Interstate HOV lanes.[4] The Express Lanes Demonstration Program is authorized from 2005 to 2009, and its continuation would have to be renewed in the reauthorization of SAFETEA-LU, as discussed in a later section. The program includes slots for 15 demonstration projects; however, FHWA currently does not list any demonstration projects reserved or approved.

Under this program – in addition to debt service, reasonable rate of return on private financing, and operations and maintenance costs – revenue may be used for any other highway or transit project, carried out under Title 23 or 49 of the U.S. Code anywhere in the state, provided that the facility being tolled is adequately maintained. Automatic (electronic) toll collection is required for express lanes, to avoid congestion and delays. In addition, there is no requirement that a demonstration project should consist of only one facility. A network of facilities managed under the same oversight agency or agencies can qualify as a single demonstration project.

The Federal contribution to projects tolled under this program may not exceed 80 percent. Revenue that is not needed for operation of the facilities can be used for other eligible transportation projects, which also would give the state more freedom to set toll rates (variable by time of day, level of traffic, or number occupants) at the level needed to manage congestion or improve air quality as well as to fund alternative modes, such as transit.

Of the concepts we are studying in Connecticut, the express lanes on I-95 between Branford and the Rhode Island line and on I-84 between Waterbury and the New York line could potentially qualify for this program.

Value Pricing Pilot Program

The Value Pricing Pilot Program (VPPP) is an experimental program that develops initiatives aimed at learning more about the potential of different pricing approaches for reducing congestion. It was initially authorized in the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 as the Congestion Pricing Pilot Program, carried over into TEA-21, and renewed in SAFETEA-LU. Funds are available to support efforts by governments or public authorities to establish pilot programs that provide for implementation, monitoring, and evaluation of value pricing projects, and to report on their effects. This is the only program intended to support studies and implementation of tolling or pricing projects.

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[4] Federal Register 73(23), *Notices,* [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2008_register&docid=fr04fe08-85.pdf], February 4, 2008.

The VPPP can be used for projects that manage congestion on highways through tolling and other pricing mechanisms. In fiscal years 2006-2009, $3 million of the annual funding allocation was set aside for value pricing projects that do not involve highway tolls, and $5 million is set aside for metropolitan regionwide pricing studies. Examples of congestion pricing concepts that do not involve highway tolls include innovative parking pricing strategies and pay-as-you-go insurance. The remaining $4 million is not allocated for a specific type of study. Funding will not be awarded for congestion pricing concepts that have become mainstream, such as conversion of High-Occupancy Vehicle (HOV) lanes to High-Occupancy Tolling (HOT) lanes.

In 2006, ConnDOT and the South West Regional Planning Agency (SWRPA) independently submitted applications to the VPPP. SWRPA proposed to study electronic tolling and value pricing in southwestern Connecticut, while ConnDOT proposed to study cordon tolling and the conversion of existing HOV lanes to HOT lanes in the Greater Hartford Area.[5] The FHWA had stated that it would no longer fund HOV to HOT lane conversion under the VPPP. Thus, the ConnDOT application was rejected, in part, due to the mainstream nature of HOV to HOT conversion, and both were rejected largely due to a Federal official's statement that the FHWA was interested in funding implementation projects rather than studies.

ConnDOT reapplied to this program in 2007, citing the need to study congestion pricing to determine its feasibility in Connecticut. In this second application, ConnDOT solicited the endorsements of a half-dozen state regional planning agencies, including SWRPA, to show that the study constituted a statewide need.

With the November 7, 2008 deadline to apply for VPPP funding under SAFETEA-LU, there is no longer an opportunity for Connecticut to reapply for funding under this program. However, the VPPP has been a popular program, and it is possible that it will be continued in the reauthorization of SAFETEA-LU, in which case it, or its successor, may take on renewed significance for the implementation of any of the electronic tolling or congestion pricing concepts under study.

Urban Partnerships and Congestion-Reduction Demonstration

The U.S. Department of Transportation's (DOT) National Strategy to Reduce Congestion on America's Transportation Network, otherwise known as the Congestion Initiative, consists of Urban Partnership Agreements with model cities that make a commitment to implement "broad congestion pricing." The deadline for partnership applications was April 20, 2007 and selected cities received Federal funding to implement congestion pricing initiatives. The selected cities were New York, Miami, Minneapolis/St. Paul, San Francisco, and Seattle. Participating cities create a broad congestion pricing plan

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[5] South Western Region Metropolitan Planning Organization, Meeting Minutes. http://www.swrpa.org/pdf_files/Y2006/mpo06-0424minfinal.pdf April 24, 2006.

involving tolling, transit, telecommuting, and technology (referred to as the "four Ts"). The New York's proposal for cordon tolling did not achieve the needed legislative authority to move forward, so that project has been canceled.

As a follow-up to the Urban Partnership program, the U.S. DOT created a Congestion-Reduction Demonstration Initiative with a deadline for applications of December 31, 2007. The cities of Chicago and Los Angeles were selected for their congestion reduction plans also involving managed lanes, transit, and parking management.

Because the participants for these programs already have been selected, Connecticut is not currently eligible to apply. However, similar programs created by the reauthorization of SAFETEA-LU may be useful in managing congestion in urban areas in Connecticut.

High-Occupancy Toll (HOT) Lanes

A High-Occupancy Vehicle (HOV) lane is one in which vehicles carrying a minimum number of passengers, most often two, are permitted to enter a designated lane and bypass congestion. A High-Occupancy Toll (HOT) lane is a variation on an HOV lane, in which solo drivers who wish to use an HOV lane during periods of congestion may do so for a fixed or variable toll. HOT lanes run the risk of becoming inefficient if too many drivers choose to use it; thus varying the fee according to congestion levels at different times of the day can help to maintain free-flow conditions in the lane.

SAFETEA-LU grants states the authority to charge tolls to vehicles that do not meet the established vehicle occupancy requirements for HOV lanes, if the state produces a plan for vehicle selection, variable tolling, and violation enforcement. This forms the basis for providing authorization for states to convert HOV lanes to HOT lanes. For HOV to HOT conversion, a toll agreement must be executed between the FHWA, ConnDOT, and operating agencies but there is no limit to the number of agreements that can be approved. For the proposals in this study, conversion of HOV to HOT lanes on I-91 and I-84 would be influenced by these provisions.

Interstate System Construction Toll Pilot Program

This pilot program allows for tolling on up to three newly constructed facilities on the Interstate Highway System, by a state or a multistate group. The new construction of I-73 through South Carolina received approval through this program in 2007, and although the State of South Carolina was the applicant, other states also may construct their sections of I-73 as a toll project, using the same slot. The remaining two spots in this program are still available. Applications must be received by FHWA before August 10, 2015.

Applicants must identify the proposed facility and its age, condition, and intensity of use. Relevant MPOs must be consulted on toll placement and number of tolling points, and an agency must be selected to oversee the implementation and administration of the program. A facility management plan must be created showing an implementation plan, a schedule, and a financial plan. The applicant also must show that financing the facility with the collection of tolls is the most efficient and economical way to advance the project. Tolling can be one of a number of financing options.

Under this program, automatic (all electronic) toll collection is mandatory, and the toll revenue 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. Federal funds allocated for maintenance may not be used for facilities on which tolls are being collected. Noncompete agreements are prohibited, meaning that the state may not enter into an agreement with a private entity that prevents the state from improving or expanding capacity of adjacent roads to address conditions resulting from diverted traffic.

Since Connecticut does not envision building new Interstate highways, this program is not currently relevant.

The FHWA Tolling Application Process

States interested in submitting to any of the programs administered by FHWA need to follow a four-step application process:[6]

1. Submit an Expression of Interest that provides the rationale for funding or tolling authority and the intent of the project. An optional template is available on the FHWA web site.[7] The FHWA will respond with the appropriate tolling pilot program for the project.

2. Submit a Phase 1 Application that provides details about the roadway selected for the project, the existing operational and financial status, and the proposed rehabilitation and reconstruction plans. The FHWA will work with the applying agency to issue "provisional acceptance" of the project and assign an available program slot.

3. Prepare a Phase 2 Application that includes an environmental document prepared in accordance with the requirements of the National Environmental Policy Act (NEPA). The FHWA will review the application and decide on environmental approval and final tolling authority. The result will be a formal Federal tolling agreement.

4. The project will then proceed to implementation based on an agreed-upon implementation schedule and facility management plan included in the formal tolling

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[6] Federal Highway Administration, *Tolling and Pricing Program*, http://ops.fhwa.dot.gov/tolling_pricing/announcement/tolling_announcement.htm.

[7] Federal Highway Administration, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU); Opportunities for State and Other Qualifying Agencies to Gain Authority to Toll Facilities Constructed Using Federal Funds, http://ops.fhwa.dot.gov/tolling_pricing/announcement/tolling_announcement.htm.

agreement. Initial activities will include toll facilities, bridge and roadway reconstruction and rehabilitation, maintenance activities, and sign installation.

Speculation on Tolling and Congestion Pricing under the Reauthorization of SAFETEA-LU

In December 2007 the report entitled *Transportation for Tomorrow*: *Report of the National Surface Transportation Policy and Revenue Study Commission* was released. This report is the product of the commission mandated by SAFETEA-LU to recommend new transportation funding sources and policy. While the contents of the report are only recommendations for the content of the reauthorized legislation, it is an indication of where debate over the new legislation will begin.

Several aspects of the report are relevant to discussion of tolling and congestion pricing in Connecticut. The report specifically recommends congestion pricing to manage congestion and fund transportation in metropolitan areas of one million people or more, as defined by the U.S. Census, even where they cross state boundaries. For Connecticut, this would include the Hartford metropolitan area and the New York City metropolitan area (which includes southwest Connecticut). While the report did not provide details of how this might be legislatively or financially encouraged, it does recommend removing barriers to tolling and congestion pricing to allow state and local governments greater flexibility to implement such a program.

As there is a current general prohibition on tolling highways that are part of the Interstate system (except as part of one of the above programs), the report also recommends allowing greater flexibility to implement tolls on the Interstate system. First, it recommends the allowance of tolls for funding new Interstate capacity and flexibility to manage the congestion on that new capacity. Further, the report recommends allowing tolls on new and existing capacity within metropolitan areas of one million people or more. This could come in the form of high-occupancy toll (HOT) lanes, express toll lanes, full facility pricing, or areawide pricing. There would be strict criteria about what the revenue could be used for but it could include other nonhighway transportation projects.

Altogether, there is a strong emphasis in the report on congestion pricing as a way to meet the growing transportation budget gap and bring U.S. transportation infrastructure up to a state of good repair. It also emphasizes giving states more flexibility to plan and fund their own transportation systems. The emphasis on congestion pricing in the committee's report suggests that there may be more opportunities to use tolling and congestion pricing in future authorizations of the nation's transportation program. If so, this may create more opportunity for either statewide tolling or congested corridor tolling in Connecticut. These concepts are explained in more detail below.

2.3 Connecticut Statutes

Title 23 of the United States Code, Section 301, generally prohibits tolling on any highways that were constructed with Federal funding – including, but not limited to, the Interstate highway system. However, SAFETEA-LU has provided some exceptions. Tolling state roads that were not constructed with Federal funds generally does not require permission from the FHWA.[8] In order to reinstate tolls and congestion pricing in Connecticut, the State Legislature would need to pass legislation re-enabling their use of tolls.

The Legislature also will need to specify whether a government agency will collect and manage the toll revenue or if a public-private partnership will be used. While a private agency does not need state permission to borrow money, the State agency managing the tolling operations will need legislative permission to issue bonds for construction of tolling infrastructure. The legislature also will need to establish the terms and conditions governing use of Electronic Toll Collection (ETC) systems and requirements for account holders. This legislation needs to allow ETC operators access to motor vehicle registration data and allow the use of video technology for prosecution of toll violators.[9]

2.4 Legal and Institutional Aspects of Enforcement

Automatic toll collection would most likely be achieved through a car-mounted electronic device that is read by roadside equipment and processed off-site. One method for discouraging those without an electronic device from using a lane designated for tolling or a congestion pricing scheme is through video enforcement.

Video enforcement in the United States is relatively new and the legality surrounding it varies from state to state and municipality to municipality. In Connecticut, while cameras are used for public safety in limited ways, their use for law enforcement has historically been a political non-starter. Currently, the State Highway System is equipped with a network of over 300 cameras that can be rotated 360 degrees and can be zoomed in and out. The cameras are monitored by state DOT staff for coordination of a quick response to any incidents. If an incident occurs, staff also can activate highway message signs to provide detours for motorists. However, state law has only provided for use of these cameras for

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[8] Federal Highway Administration, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU); Opportunities for State and Other Qualifying Agencies to Gain Authority to Toll Facilities Constructed Using Federal Funds; http://ops.fhwa.dot.gov/tolling_pricing/announcement/tolling_announcement.htm.

[9] Federal Highway Administration, *Tolling and Pricing FAQs,* http://www.ops.fhwa.dot.gov/tolling_pricing/faq/index.htm.

monitoring highway safety without the recording of any footage. The State of Connecticut has not passed any laws that further allow recording of footage for law enforcement purposes.[10]

Beyond legal barriers to using the cameras for law enforcement, there also are technological and institutional barriers to using the current highway camera equipment to record images. Many of the cameras are not placed in such a way as to be able to read license plates and they do not see in the dark. In addition, Federal money used to buy the cameras did not authorize their use for law enforcement. A higher level of coordination between ConnDOT and the police also would be necessary if the cameras were to be used for law enforcement.[11]

Even if these technical and institutional barriers can be overcome, gaining political support for video enforcement may be difficult. Earlier this year, Connecticut Governor M. Jodi Rell proposed legislation that would have allowed the use of highway cameras to enforce the speed limit on a particularly dangerous stretch of I-95. [12] However, due largely to privacy concerns, the State House Public Safety and Security Committee voted against allowing the bill to proceed. [13]

In 2006, there was an earlier attempt to pass legislation that would have permitted the use of red light cameras in Connecticut to increase safety at certain intersections throughout the State. However, after opposition from the American Civil Liberties Union of Connecticut (ACLU-CT) and other groups concerned with privacy infringements, the bill was voted down in the State House Judiciary Committee.[14]

Legally, the authorization of law enforcement cameras can be granted by the State. U.S. courts have found no legal problems with law enforcement cameras – only occasionally with the specific practices of agencies or third-party vendors who manage the programs. However, due to historic opposition by the ACLU-CT and citizens concerned with privacy issues surrounding camera enforcement, any video enforcement enabling legislation may face a difficult battle for political approval. A more detailed treatment of the privacy issue is contained in Section 4.0 of this report.

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[10] Wernau, J., *State's Highway Cameras See But Don't Tell*, *TheDay.Com,* http://www.theday.com/re.aspx?re=b708c5fc-3b10-4870-a433-8c140809c9d8, November 11, 2007.

[11] Ibid.

[12] Sipe, C., *Proposal to Install Radar Cameras in Connecticut – Illusion of Solution*, *Associated Content*, http://www.associatedcontent.com/article/622177/proposal_to_install_radar_cameras_in.html?cat=17, February 28, 2008.

[13] Keating, Christopher and Tracy Gordon Fox, Panel Rejects I-95 Plan (Gov Rell CT radar cameras), http://www.freerepublic.com/focus/f-news/1982180/posts, March 7, 2008.

[14] National Campaign to Stop Red Light Running, *April 2006 Legislative Update*, http://www.stopredlightrunning.com/html/legislation.htm, April 2006.

2.5 Institutional Considerations

Various agencies could play roles in a Connecticut toll or congestion pricing implementation. This includes ConnDOT, various transit operating agencies, and Connecticut's 15 Regional Planning Organizations. Federal agencies such as the FHWA and Federal Transit Administration (FTA) also might have an interest in some implementations of tolling and congestion pricing in Connecticut.

Laws pertaining to congestion pricing are all at the Federal level, and are largely products of the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). While there are no existing laws at the State level that expressly relate to congestion pricing, the Connecticut legislature has banned all tolling in the State.[15] State laws pertaining to transportation funding and camera enforcement also would apply to a congestion pricing plan, however, and will need to be considered.

The following sections lay out the objectives of each agency, focus on an end goal of a comprehensive tolling and congestion pricing system, and then discuss methods of inter-agency coordination.

Connecticut Department of Transportation

The stated mission of ConnDOT is "to provide a safe, efficient, and cost-effective transportation system."[16] ConnDOT has statutory responsibilities for the following:

- Roads;
- Bridges;
- Bus and rail services;
- Ferry services, the State Port Complex; and
- Airports.

A congestion pricing or tolling plan in Connecticut would affect many aspects of travel in the State such as the impact that a highway tolling or pricing plan could have on the traffic volumes of adjacent free roadways. This could lead to more wear and tear on non-highway roads and greater congestion, as local roads are not designed to move large volumes of traffic as quickly as highways. A thorough analysis of the final tolling and

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[15] Connecticut General Statutes, Title 13a, Chapter 239. *Tolls*, http://www.cga.ct.gov/2005/pub/Chap239.htm, November 17, 2008.

[16] *Connecticut Department of Transportation Mission and Goals*, http://www.ct.gov/dot/cwp/view.asp?a=1380&q=259714, September 9, 2003.

congestion pricing proposal will need to account for this issue and ensure that the balance of traffic throughout the entire traffic network is studied.

Revenue collection and redistribution of tolling or pricing proceeds would either be handled through the Special Transportation Fund (STF) or a separate agency fund created for this purpose. Established by the Connecticut General Assembly, the STF provides dedicated funding for the financing of the State Transportation System, and covers all the operating costs of ConnDOT and its services. The STF is comprised of money from the following sources:

- Motor fuels tax;
- Motor vehicles receipts;
- License, permit, and fee income;
- FTA operating assistance grants;
- Interest income;
- Oil company tax;
- Department of Motor Vehicles collected vehicle sales tax; and
- General fund transfers.

The Fund currently is responsible for funding the following:

- Transportation Bond Debt Service;
- ConnDOT operations;
- Pensions and Fringe Benefits for ConnDOT and Department of Motor Vehicles employees;
- Department of Motor Vehicles operations; and
- Town Aid Road Grants.

Revenue from a state congestion pricing or tolling plan would likely be assigned to the STF. Placing the money into a dedicated transportation fund, rather than the general fund, will have the added bonus of reassuring the public that the money will be used for transportation projects. State legislation will need to be passed to dictate how this additional revenue will be spent.

Finally, a congestion pricing or tolling plan could have an impact on transit demand. This is discussed in more detail in the following section.

Transit Agencies

ConnDOT's Bureau of Public Transportation includes commuter rail, state-owned bus service (CTTRANSIT), other public bus services, and paratransit/ADA bus services.[17] The New Haven line commuter rail service is operated by Metro North, a subsidiary of New York's Metropolitan Transportation Authority (MTA), under a contract with ConnDOT and the MTA. Amtrak operates the Shore Line East Service under a contract with ConnDOT. Combined fare options allow commuters to use both Metro North and the Shore Line East systems on one fare card.

Tolling or congestion pricing concepts will encourage some drivers to shift to transit, so transit operators will be important players in the creation of any comprehensive congestion pricing or tolling plan. In order to assure the public that alternatives will be available at the outset and to actually accommodate the mode shift from the date of implementation, transit agencies must provide the necessary capacity from the day a congestion pricing system goes into place. This means that before a congestion pricing or tolling system can generate any revenue, some portion of the capital funds should be directed to transit agencies. Otherwise, most transit agencies will not likely be capable of providing additional capacity. If a congestion pricing system is adopted, a study will need to determine anticipated service needs in post-implementation phases.

Any plan that considers tolled express lanes also should engage transit authorities on whether these lanes also could accommodate express buses and other forms of public transit. Drivers along those routes, when faced with a choice of paying a toll or taking a toll-free express bus to their destination, may well be persuaded by such a visible alternative.

Transit agencies may wish to advertise themselves as a toll-free alternative to further encourage the shift to transit. This could take the form of conventional advertising mediums, or also appear on highway signs next to toll lanes, or at the bottom of monthly mailed expense statements to toll road users.

While most transit agencies that serve Connecticut operate solely out of Connecticut, MTA's Metro-North Railroad operates out of New York and serves locations in both Connecticut and New York. One of the MTA's Metro-North Railroad's lines, the New Haven line, has 49 percent of its peak-hour ridership consisting of commuters to Manhattan with 51 percent consisting of reverse commuters who live in New York City and commute to suburban employment centers in New York and Connecticut.[18] If a congestion pricing or tolling plan were adopted that affects drivers between southwestern Connecticut and New York City, the shift to certain Metro-North lines could be

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[17] Connecticut Department of Transportation, *Public Transportation*, http://www.ct.gov/dot/cwp/view.asp?a=1386&q=259356&dotPNavCtr=|.

[18] Connecticut Department of Transportation, http://www.ct.gov/dot/cwp/view.asp?A=1373&Q=332922, 2006.

significant. Specific considerations regarding how MTA would use any Connecticut state congestion pricing revenue would have to be made.

Regional Planning Organizations (RPO)

The State of Connecticut is organized into 15 Regional Planning Organizations (RPO), consisting of a number of member municipalities. These RPOs perform comprehensive planning functions and provide a forum for addressing intermunicipal concerns on issues pertaining to state and Federal programs. The 11 largest RPOs also serve as Metropolitan Planning Organizations (MPO) for Federal transportation funding purposes. Since 1962, MPOs have been required by Federal law in any urbanized area with more than 50,000 people for the distribution of Federal transportation funding. Their function is to ensure that all transportation planning is done in "a continuing, cooperative, and comprehensive ("3-C") planning process"[19] and that all Federal transportation funding is channeled through this process.[20]

One of the SAFETEA-LU programs, the Interstate System Construction Toll Pilot Program (ISCTP), has a Federally mandated stipulation to consult metropolitan planning organizations where a proposed project affects a metropolitan area. The FHWA must receive assurance that local MPOs have been consulted about toll placement and number. However, Connecticut's congestion pricing or tolling plan will not likely use this program to build new highways. In any case, RPOs could serve as an important outlet for community outreach. Aspects of the congestion pricing or tolling plan could be disseminated through the local RPO, many of which have voiced strong support for a pricing or tolling proposal. In addition, any Federal funding the State receives for implementation of a congestion pricing plan will need to be channeled through the relevant MPOs.

Interagency Coordination

The implementation of any tolling or congestion pricing program in Connecticut will require all of the agencies discussed above to be involved in the planning process. In addition, one agency or person should act as the primary facilitator and coordinator for the planning process. This will allow for program outreach, consensus building, and coordination among stakeholders to be conducted in an equitable and straightforward way. It also is important that the planning process be transparent and visible and that all information on planning and implementation is distributed to the public.

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[19] Paradis, D, *About DOT*, http://seedeater.ct.gov/dparadis32/cwp/view.asp?A=11&Q=254118, 2003.

[20] Ibid.

3.0 All Electronic Tolling – Operational and Deployment Challenges

This section has two major subsections related to deploying all-electronic tolling: an overview of all-electronic tolling functions and operations and the major deployment challenges.

■ 3.1 All Electronic Tolling – Operational Program Functions

This section describes those components and external services required to successfully run the functions required for an All Electronic Tolling (AET) operation. An AET program comprises three high-level functions (see Figure 3.1).

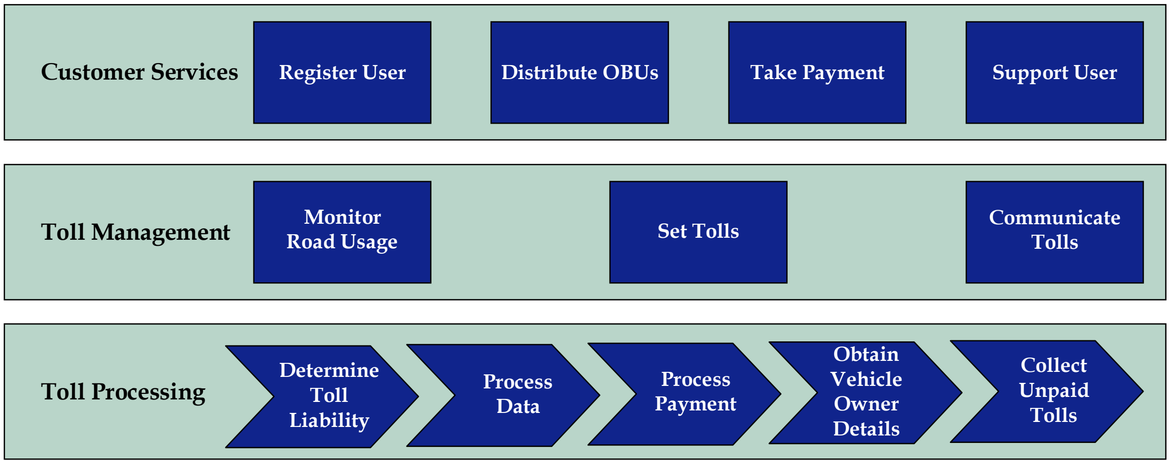
1. **Customer Services –** Registering users, distributing on-board units, taking payments and providing support where necessary;

2. **Toll Management –** Determining the usage of the road, setting appropriate tolls, and communicating those toll to drivers; and

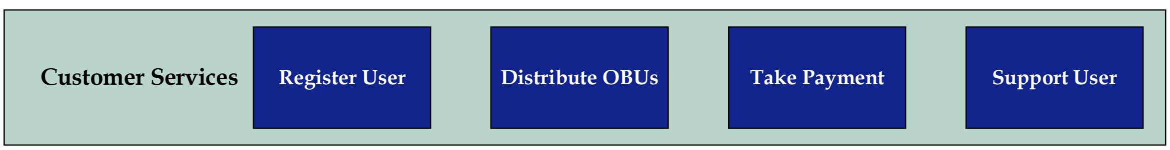
3. **Toll Processing –** Detecting the toll liability, processing roadside data, calculating charges, processing payments, obtaining vehicle owner details for nonregistered customers, and collecting unpaid tolls from nonpaying customers.

Some of these functions have a sequential order, (denoted by arrows), for some, order is unimportant.

Figure 3.1 All Electronic Tolling (AET) Operational Program Functions



Customer Services



The Customer Services functions are those necessary to deal with the driver as a customer of the toll program.

Register User

This function deals with the registration of users with tolling systems which use tag, video, or GPS technologies. This will include the creation of user accounts (which might include prepay or postpay options), and recording personal details, payment means and vehicle information.

Distribute On-Board Units

This function is needed for systems using tag or GPS technology. The toll program will need to procure, personalize, distribute, and possibly install these OBUs. This function also will need to reconcile issued devices to user accounts, as well perform audits of distributed and nondistributed stock. Depending on the device ownership policy (owned by customer or owned by authority), this function also may need to track returns to inventory or disposal.

Take Payment

This is the primary function through which users pay their tolls. An AET program can offer three main ways in which a user can pay their tolls – through establishing an account, video post billing, or "one off" payment, described below. Payment types (for all types of account) can include credit, debit, automated bank transfer, checks, and cash. Payment channels can include web, phone, kiosk, walk-in counter, or mail. The toll system may offer a text service whereby users can authorize payment from a preregistered card via SMS text message using their cell phone. Such a service currently is offered by the London Congestion Charge, which allows the registration of credit and debit cards that users can authorize for toll payment using SMS text message. Kiosk and SMS payments have not been implemented in the U.S. to date. However, partnerships with retail chains have been implemented to provide a broader number of locations for toll account payments.

Establish Accounts

Currently, all U.S. toll systems require electronic toll users to establish an account in advance of using the facility. Accounts can be prepay or postpay depending on policies, but most U.S. toll tag-based systems have prepay policies to avoid extensive collections operations. Most current postpay tag accounts are restricted to commercial accounts that establish a surety to guarantee payment. Both prepay and postpay can be used with tag, video, and GPS technologies.

With a prepay account, the user can add credit to it when they want, or the toll system can provide an "auto top-up" arrangement which replenishes the users account when it reaches a preagreed level. With a postpay account, this function will notify users that they have accrued tolls (usually on a monthly basis) and accept payment of those tolls from the user, either in person, through a mailed check or through an automated method such as Internet. If postpay bills are not paid within the agreed timeframe, this function will initiate the appropriate action to obtain payment.

Most programs allow for customers who wish to remain anonymous. Anonymous accounts are only possible with OBUs, because a video account relies on license plates, which – by definition – are not anonymous. When an anonymous account runs out of credit the user is required to either replenish or obtain a new OBU. If the credit runs out the user would be considered a violator and their personal information obtained from the Department of Motor Vehicles. The system handles these anonymous OBUs like standard prepay accounts.

Video Postbilling

With video postbilling, license plate images are captured by the toll collection equipment, the vehicle owner information is retrieved from the appropriate vehicle registration database, and the vehicle owner is billed on a periodic basis after incurring tolls. In effect, an account is created after the first use of the system. Since this option relies on the accessibility and accuracy of vehicle registration databases there is an inherent loss of revenue associated with this process. To counter this loss, most facilities charge a higher toll and/or a video post billing administrative charge.

In this scenario, all users are treated as customers until they fail to pay their post bill invoice(s) at which point they become toll violators and are handled by the violations process.

One-off Payments

A further payment option is to provide for infrequent or one-off customers who do not wish to register an account. This can be achieved by allowing the user to provide their license plate along with a toll payment. The system then attempts to match the license plate given by the user to its own video records. If a match is made, the video record is marked as paid. If a match occurs, there is no need to retrieve vehicle owner information from a vehicle registration database.

With this method, the primary responsibility for determining the toll liability lies with the user, who is expected to determine and then pay the appropriate charge. By making a user responsible for making payments based on their usage as opposed to sending users an invoice, the return can be maximized and the costs related to a video-based toll collection program can be reduced. Furthermore, since payment would be received even if the camera failed to get a clear image of the vehicle and there is no vehicle registration look up, there is less loss associated with this payment method when compared with other video tolling approaches.

This method effectively creates a temporary account for that vehicle (using only the license plate as identification) holding just the single toll payment. This payment can then be used to pay the toll when it is detected and processed by the back office.

The program might allow users to make a one-off payment either before (effectively a temporary prepay account) or after the toll has actually been accrued (effectively a temporary postpay account). The program can set an "allowed timeframe" in which users can make these one-off payments (London allows such payments up to 24 hours before/after the toll is/was accrued). If the payment is not received within this timeframe, appropriate follow-up action is taken.

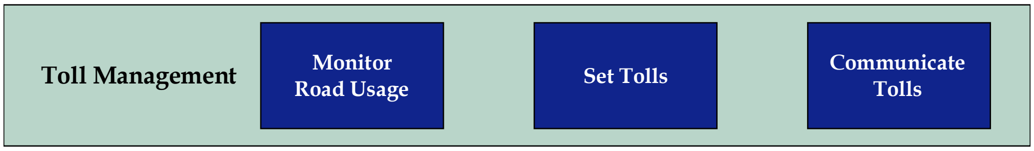
This approach also allows users to remain relatively anonymous; if they are able to pay by cash at a kiosk, the only personal information they need to supply is their license plate.

While highly suited to simple toll programs such as cordon or bridge, where a customer only has to pay the price communicated to them at the time of toll accrual, more complex tolling programs such as express lanes or tolled highways are less suited to one-off payments because the user needs to calculate their own toll based upon the number of toll points traveled.

Support User

This function will provide support to the toll customers, such as responding to user inquiries, updating user accounts, responding to correspondence and complaints and technical problems such as OBU failure. This function should offer a variety of contact channels, such as web site, e-mail, phone, text, mail, or walk-in, utilizing technologies such as Interactive Voice Recognition.

Toll Management



The toll management functions allow for the ability to determine traffic usage on the tolled roads, set toll rates, and communicate those toll rates to the drivers. The interaction between traffic levels and toll rates and the intensity of the need to communicate is highly dependent on whether tolling is being used as a congestion management tool.

Monitor Road Usage

How roadway usage is monitored primarily depends on if a static or dynamic toll rate is being used for congestion charging. If tolls are fixed and do not vary by time of day then there is substantially less need to monitor road usage.

Traffic levels can be monitored in several ways – vehicle speed, volumes, or density (a combination of speed and volume) – using a variety of traffic monitoring technology:

- **Cameras,** which can be viewed manually from a control office, can provide a real-time view of the traffic conditions on the road. New technology allows for automated traffic evaluation to be conducted from the camera images.
- **Automatic portable counters** consist of automatic recorders connected to pneumatic road tubes, laid across the road. These machines provide traffic count data which would be used for static toll setting.
- **Automatic permanent in-road counters** such as inductive loops are sometimes built into the pavement and used for long-term counts. This equipment can be expensive and disruptive to install.
- **Automatic roadside or overhead vehicle detectors** such as microwave, infrared, or acoustic devices have been widely used to provide vehicle count and density data.

Set Tolls

This function sets the appropriate tolls. Depending on the objectives of the system, the charges might be set to minimize congestion, maximize revenue, or a combination of the two. Toll systems can be open or closed; vary according to vehicle type, occupancy, or time of travel; be flat, static, or dynamic; and apply to a single direction or both. The most sophisticated toll systems may utilize a combination of several approaches.

Open versus Closed Tolling

An illustration of open and closed tolling concepts is shown in Figure 3.2. In an open tolling scheme, there are toll detection points along the road at set intervals, but not at every entry and exit point on the road. Open tolling systems minimize the number of toll points but only roughly reflect the length of the toll road used. Open systems also allow for some toll-free travel.

There are two open tolling variations, "open point tolling," and "open trip tolling." Under open point tolling, users are charged for every toll point they pass and their ultimate charge simply reflects the sum of the charge assessed at each toll point.

Under open trip tolling, the system still detects the vehicle at each toll point passed, but it only calculates the total charge once the driver has completed their trip (e.g., left the program). This allows intelligent charging to be applied which can be controlled by business rules particular to the program, for example offering discounts for certain journeys or offering tolls specific to certain segment combinations (i.e., one price for the next segment, another price for all or part of the remaining segments of a facility). This method of pricing is available in the MnPass system as well as Washington SR 167 and California SR 125.

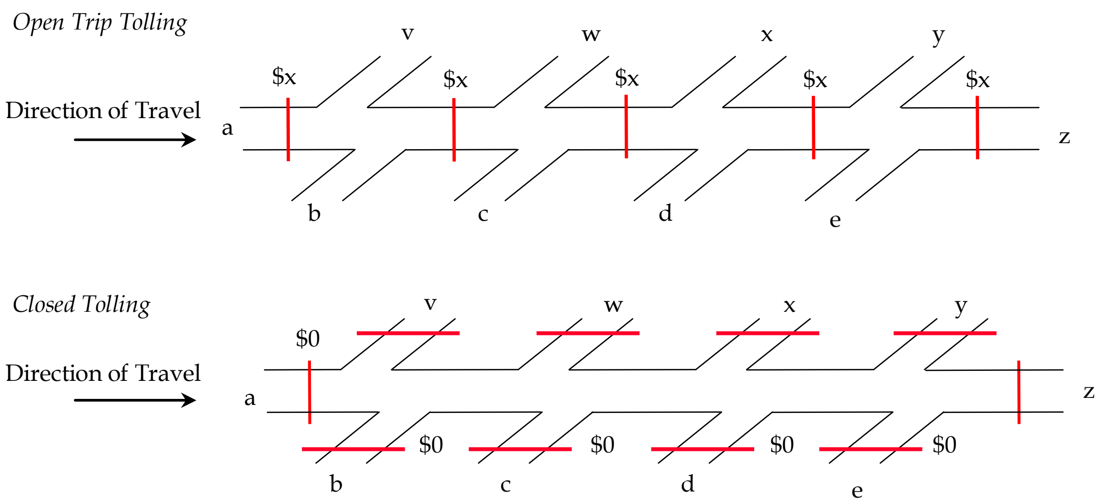
For example, in Figure 3.2, a driver entering the system at point A, traveling through three tolling points before leaving at point X may be charged a different toll than a driver entering at point C, traveling through three tolling points, and leaving at point Z. In each example, the program only calculates the final charge due when the user leaves the system.

Open toll systems do not need a toll point at every segment; however any segments without a toll point risk having certain drivers avoiding a toll for that "uncovered" section. The decision on number of toll points will therefore need to balance tolling point construction costs with desired coverage levels.

Closed systems have toll points at every entry and exit into the tolled road system. There is no toll to enter the system and the user is only charged when they leave the system; with the charge paid reflecting the distance driven or the particular combination of entry and exit points. These configurations provide a better link between the charge and the distance driven but generally require a far greater number of toll points than open toll systems.

Toll systems such as the New York Thruway and Pennsylvania Turnpike that use ticket-based tolling are examples of a closed toll system.

Figure 3.2 Open Trip and Closed Tolling Concepts



Open trip tolling with a mainline gantry at every segment is very similar to a closed system with gantries at every entrance and exit point (because no traffic can avoid passing a toll point). However, it is not truly closed because the program is still required to interpret that a user has left the system (usually by assessing the time since they last passed a toll point) and then calculating the correct toll.

Mainline gantries (potentially covering many lanes of traffic) are generally bigger, more expensive, and take more time to install than smaller entry or exit ramp gantries which only need to cover one or two lanes.

Hence, the choice of whether to offer open trip or closed tolling needs to consider the potential difference in costs that arise from the different size gantries required for each approach.

Variation in Tolls by Vehicle Type, Occupancy, or Time of Travel

Most toll systems have toll rates that vary by type of vehicle, with trucks paying more than cars. Each toll facility has its own policies in this regard. Starting in the 1970s, some facilities started offering discount rates for carpools, and the advent of HOT lanes in the 1990s further emphasized discounts or free travel for HOVs. There is longstanding automatic technology available to distinguish types of vehicles. Distinguishing vehicle occupancy, on the other hand, still requires human eyes, although ongoing research is trying to automate this function.

Changing tolls by time of day is relatively straightforward, especially in electronic tolling environments. The toll policy needs to be clearly stated and communicated, and the equipment set up to handle the toll schedule. Cashless systems accommodate time-of-day tolling more easily than those with attended toll collection since it eliminates the need to know at what time of day cash was collected.

Flat, Variable, and Dynamic Tolling

There are three ways that tolls can be set: flat, variable-static, and variable-dynamic.

A **flat** toll is the simplest. A segment of highway or a specific trip has a set toll rate that is the same whenever the highway is used. Rates might be assessed at a single point (as with the former Connecticut Turnpike and Merritt/Wilbur Cross Parkways) or on a distance basis (as with the Massachusetts Turnpike and New York State Thruway). Flat tolls have the least need for intense traffic monitoring – the main driving force of monitoring is for toll audit and reporting purposes.

A **variable-static** toll rate is published in advance and can be set by time, day, vehicle type, and/or occupancy if congestion pricing is the goal. Static tolls can be changed as often as weekly or monthly if there is a need to spread peak demand by adjusting the time-of-day parameters. Road usage needs to be monitored after the fact to make sure traffic congestion policy objectives are being met, so that tolls can be adjusted accordingly.

With a **variable-dynamic** system, toll rates are set based on current and potentially anticipated traffic levels, meaning that traffic needs to be constantly monitored and analyzed. Dynamic tolls are better suited for programs which have excess tolled road capacity in addition to non-tolled capacity (such as a tolled express lane). By adjusting the toll rate dynamically in response to road conditions, the system can achieve the desired traffic flow by raising the price at times of high demand and lowering the price at times of reduced demand. U.S. examples include SR 167 south-east of Seattle, I-15 north of San Diego, and MN/I-394 west of Minneapolis.

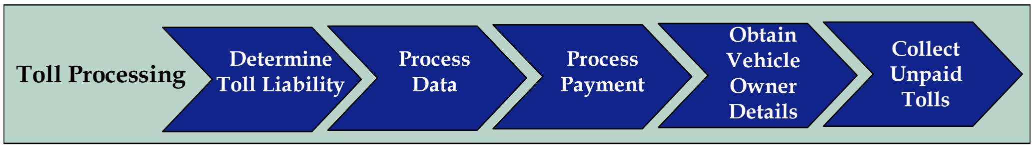
Communicate Tolls

The method by which toll rates are communicated to customers varies by the type of toll collection. Static tolls can be communicated on printed literature and on toll operator web sites, as well as with standard road signs. Dynamic tolls require a Dynamic Messaging Sign which can be updated electronically to display the current toll charge.

Interestingly, existing toll systems like the Massachusetts Turnpike and New York State Thruway that have distance-based tolling have no immediate means to communicate toll rates to their electronic tolling customers. These detailed toll tables would be impossible to communicate on road signage, but those customers that use the electronic tolling system do so optionally, and do not seem to miss this information. They find out the toll they paid when they receive an end-of-month statement. This could be a bigger issue in a cashless tolling environment with occasional users. Road signing that indicates per-mile rates may be an appropriate tool.

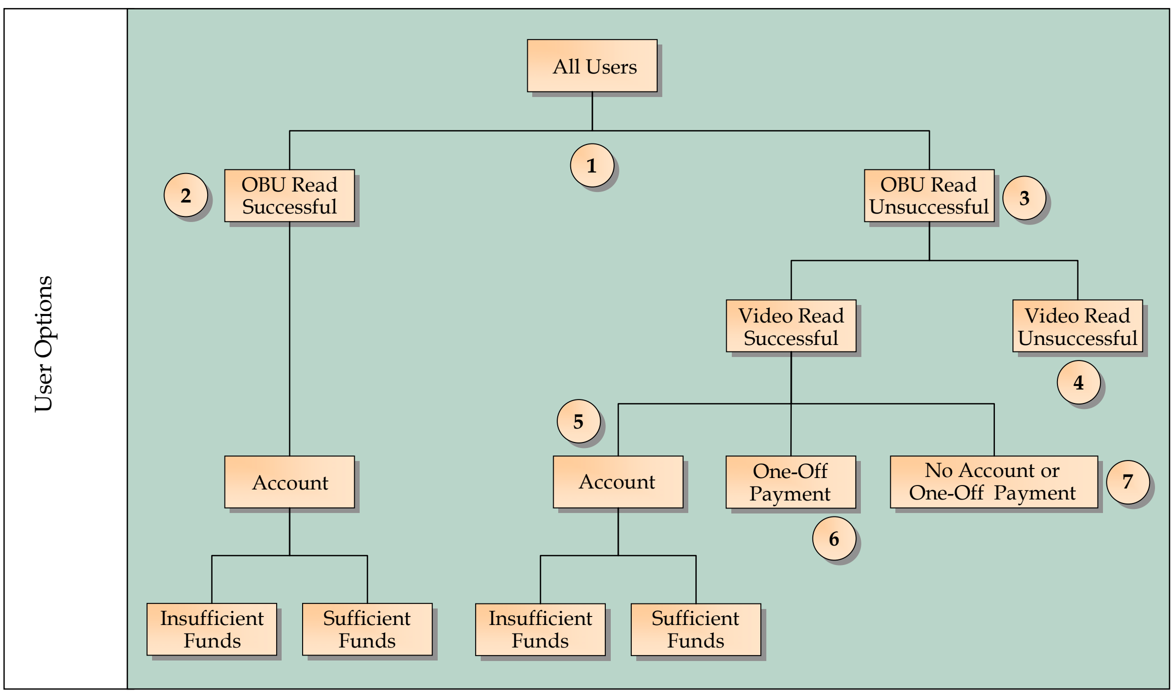
Highway 407 north of Toronto, Canada, which is a distance-based toll system, uses a variable-static approach (based on time of day and vehicle class) but does not display this information at the roadside; instead all users need to consult the published toll rate chart on the program's web site.

Toll Processing



This function detects the vehicle, calculates the toll rate, and processes the payment. Regardless of the technology used, the basic structure of detecting and paying for tolls is the same, as shown in Figure 3.3.

Figure 3.3 Processing Different Payment Options



Under AET, the system initially attempts to identify the vehicle by communicating with any On-Board Unit (OBU) in the vehicle (1).

If this is successful (2), the system then matches the read to the user's account which may or may not have sufficient funds to pay the toll.

If the system is unsuccessful (3), either through technical difficulties or because there is no OBU in the vehicle, the system will attempt to use video images to identify the vehicle.

If the video read is unsuccessful (4), the system cannot levy the toll and this constitutes lost revenue.

If the video read is successful (5), the system attempts to match the vehicle's license plate to a user account, which may or may not have sufficient funds to pay the toll, or any one-off payment made by the user (6).

If no account or one-off payment is matched (7), the system will need to employ alternative methods (such as vehicle registration database lookups) to collect the toll.

Determine Toll Liability

In order to determine the toll rate, the system needs to detect the vehicle and determine the vehicle class. Some systems may require a method for distinguishing HOV.

Vehicle Detection Technologies

The three primary technologies deployed for detecting the toll liability are:

1. Video;
2. Tag; and
3. GPS.

Video – This approach uses utilizes Automatic License Plate Recognition (ALPR) video cameras to read the license plate of passing vehicles. The cameras and image processing also may detect a number of characteristics of the image of a vehicle such as size of headlights, bumper location, etc. (known as the vehicle's "fingerprint") for improving the matching images of the same vehicle taken at different times, such as for matching toll entry and exit transactions.

Successful use of video technology can be disrupted by factors such as:

- Poor weather (snow, fog, and rain);
- Nonstandard plate fonts;
- Cloned/falsified license plates; and
- Nonstandard placement of plates (e.g., on trucks).

Typically this technology is more costly than using tags because it is less accurate and therefore requires more manual intervention. The user may or may not have a video account with the program. If they do, their license plate is matched to it and the appropriate toll levied. If they do not have an account and the program accepts one-off payments, the license plate is matched to the license plate data given at the time of payment. If neither is true, the system will use its license plate data to obtain the vehicle licensing information from the appropriate vehicle registration database and initiate alternative collection methods.

A user without an account who does not pay and who cannot be traced from the vehicle registration look-up represents lost revenue. There may be data sharing costs for certain state registration databases and there can be additional challenges in data sharing with international authorities.

Tag – Vehicles carry a tag (also called a transponder) that is read by a roadside antenna typically using radio frequency communications although systems are available that use infrared communications. Antennas are accurate enough to locate vehicles in a particular lane and also can be read at full highway speeds. Under this approach, video images of the vehicles are taken in the event that the tag read fails or no tag exists in the vehicle.

Tags can be read-only or read-write. Read-write transponders allow information to be sent back to and stored on the transponder (e.g., the last time that the transponder was read). E-ZPass currently uses read-write tags.

Tags, until recently, have been packaged in small plastic cases that are generally mounted with Velcro strips to the windshield of a vehicle. The case is required for the internal electronics, battery, and any lights or tones. Recently, passive powered tags have been packaged as stickers (or decals) that are applied to the windshield of a vehicle. Some vehicles have windshields that block transponder signals. For these vehicles, an externally mountable tag is offered, typically designed to attach to the vehicle's front license plate mounting points.

The fitting process can be performed by the toll program, outsourced to a commercial entity such as an auto garage, or conducted by the users themselves. However, given the relative ease with which tags can be fitted to vehicles, by far the most cost-effective approach is to mail out the tags with instructions on how to fit them. Prices can range from less than $10 to $40 apiece, with most battery powered or plastic cased transponders costing between $20 and $35 per unit and sticker tags currently are as low as $8.50 per unit.

Valid tag reads are matched to the user account and the appropriate toll levied. If a valid tag is not read, the license plate will be captured and most tag deployments will attempt to match this license plate to the tag account. If nothing matches, and no one-off payment is made, then the system will use the license plate read to obtain the vehicle ownership information from the vehicle registration database and initiate alternative collection methods.

GPS – Charging systems that use GPS as the on-board unit use location obtained from satellites to determine when the vehicle is on a charged road, and what the toll will be based on the location, and if applicable, the time. The cost of an OBU is estimated at between $100 and $400, depending on the level of sophistication of the device.

This technology lends itself to distance-based tolling (because the OBU can accurately calculate the distance traveled) and tolling in large areas (because less roadside detection equipment is required than for tag or video). GPS satellites can resolve a vehicle's location down to about 10 feet, however this may not be accurate enough to distinguish between parallel running lanes, hence this technology is not well suited to lane tolling. The GPS OBU may be combined with odometer readings to develop accurate mileage-based charges with the GPS identifying the tolling rate for each mile based on current location.

The process for fitting these OBUs can be performed by the toll program, outsourced to a commercial entity (such as an auto garage), or conducted by the users themselves; however, given the complexity of these units self-fitting is probably not a good option.

This location data is used by the toll system to determine toll liabilities, which can either be calculated inside the OBU (so-called thick client OBU), or processed in the back office (thin client OBU where travel data are sent via wireless communications). Where toll charges are calculated in the OBU, the charge can either be deducted directly from a smart card located in the on-board unit or stored for later uploading and charging against the customer's account or by billing the customer.

Under this approach, roadside equipment is not required to read the OBUs except for validating the correct functionality of the OBU and compliance with the program by ensuring vehicles are equipped with an operating OBU. The largest deployment of GPS toll collection is the truck tolling scheme in Germany. This deployment has over 300 gantries to collect video data from non-equipped vehicles and validate OBU compliance as well as over 250 mobile compliance units. Compliance can be validated by communication with the OBU as well as using tamper protection built into the device. Compliance also can be performed by using a network of cameras and comparing the license plate reads to the data from the OBU.

Depending on how many roads the toll covers the program may offer video billing for its non-GPS customers. If the toll covers a limited number of roads then it may be feasible to set up a network of cameras; however if the toll covers a substantial number of roads, it may prove too complex and costly to set up enough video cameras to provide video billing.

GPS tolling has been shown to be technically feasible and is in use for trucks in Europe. However, there are a number of barriers to deploying GPS which need to be considered:

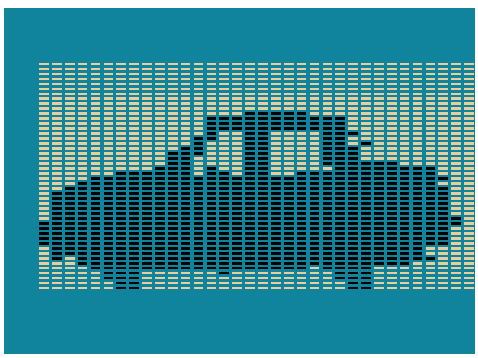
- Cost of deploying units across the vehicle population;
- Public perception that all their movements can be tracked even though privacy protections are put in place; and
- The need to offer alternatives for infrequent and through traffic. Unlike European trucking programs, it would be impossible to require all vehicles entering Connecticut to be equipped with GPS units or to pay for their intended vehicle miles traveled via kiosk.

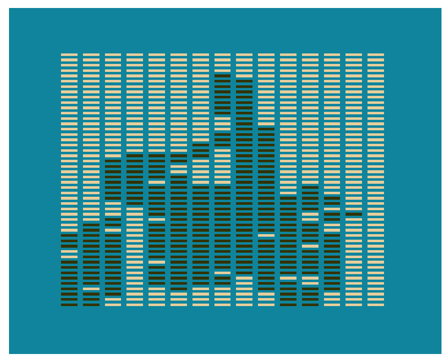
Vehicle Classification Technologies

The system may require a means of automatically classifying the vehicle, typically cars, different sizes of trucks and buses, as well as special vehicles (e.g., oversize/overweight). Some approaches include:

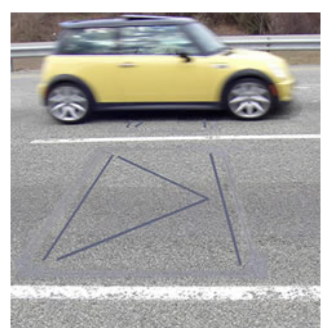
- The number of axles can be determined by a "treadle" (shown in the ground in photo to right). Treadles are speed independent axle-sensing systems that consist of sensors mounted in a metal insert. The metal insert is installed directly into a treadle frame in the road surface. By installing the treadles at an angle across the roadway, it also can be used to distinguish between single and dual tire vehicles (the Port Authority of New York and New Jersey do this at the Lincoln Tunnel). Treadles are used extensively by cash tolling systems, but would be unusual in cashless systems.

- The profile of a vehicle can be determined by light curtains and laser profilers, which use radar for velocity sensing and a profiling sensor to develop a profile of the vehicle. Some systems generate side profiles (which also can count axles) through multibeam transmissive light curtains (see images below), while others generate overhead profiles through a reflective overhead scanning laser.





- The length, speed, and number of axles can be determined by Advanced Inductive Loops embedded in the pavement (see photo to right). Inductive loops comprise a conducting loop installed in the roadway to detect the metal content of passing vehicles. Traffic monitoring apparatus energizes the loops and detects the passage of vehicles over the loops to provide for the classification of vehicles by axle count, with some systems also measuring vehicle profile, speed, and length.

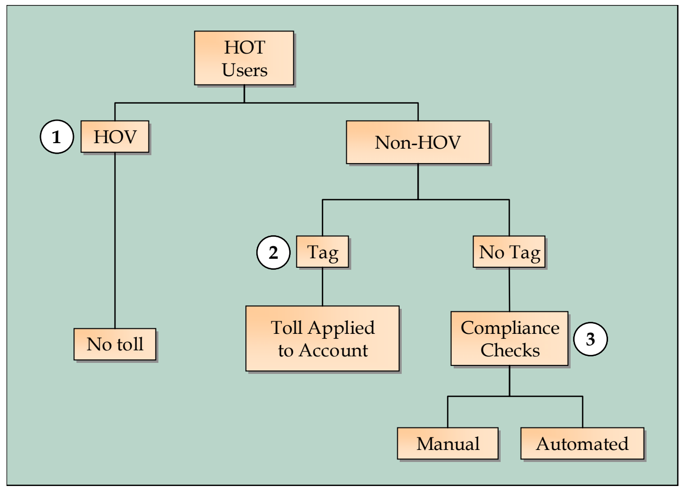


- The vehicle class also can be encoded on a tag or entered into the vehicle OBU. This may require the customer to provide evidence of their vehicle type when registering the account.

Vehicle Occupancy Detection Technologies

If the toll program includes HOT lanes or otherwise varies the toll by vehicle occupancy, the system requires a method of counting or declaring the number of occupants of the vehicle. Technology options for counting or validating vehicle occupancy are emerging to meet the needs of the marketplace. Recent advancements with infrared cameras appear to be able to detect human skin in a vehicle; however these have not yet been proven effective in actual toll environments. For now, then, the only method of validating occupancy remains visual police checks.

There is quite a bit of experience with HOT lanes around the U.S., and the most common approach, as utilized in Minnesota's I-394, is described below:



If a HOV user enters a HOT lane (1), no toll is applicable. Some programs require HOV users to use HOV-encoded tags which do not deduct any toll from the account. However to ensure compliance, police can perform checks using mobile tag readers. These tag readers will inform the police whether the tag in the car is for a HOV, and hence whether a fee is applicable.

Alternatively, for certain HOT lanes which use video billing, HOV users are required to preregister their license plate. When this license plate is processed, no tolls are subsequently levied. Here compliance checks are required to be performed visually.

If the vehicle is not a HOV, then a toll is applicable. Compliance is performed on a spot check basis by verifying that vehicles observed as non-HOV have registered a paid transaction on entry. Most programs require HOT lane users who are non-HOV to preregister for a tag account from which the appropriate toll is deducted (2).

If the vehicle has not preregistered they are identified as violators and appropriate checks need to be performed to determine this noncompliance (3). These checks can either be manual (visual) or automated (using occupancy counting technology). Some programs, such as Washington State's SR 167, encourage other drivers to report noncompliant users by phoning a hotline.

Some systems utilize separate lanes at the tolling point for HOV users so they are not charged via tag or license plate.

Process Data

This function processes the roadside data and then calculates the appropriate toll.

As vehicles pass the toll points, they are detected and classified. This roadside vehicle data is collected by roadside computers which process the data collected at each toll point.

For tag-based systems, this data will include the tag ID, as well as the toll point ID at which it was collected along with a collection timestamp. Video footage also will be collected, which may involve processing ALPR and OCR data at the roadside. Typically with a tag-based system, video images are only retained for tags that are determined as being associated with bad accounts or for vehicles that appear not to be equipped with a tag.

The roadside computers may apply business rules to this data (such as discarding certain images or tag reads), or assessing tolls based on the collected data, or may pass the entire data to the back office for manipulation.

Once the back office has received the data from the roadside, it will need to calculate the correct toll for that vehicle. It will use the vehicle identification data (such as a tag ID or license plate) to search for a corresponding account or one-off payment. By comparing the roadside data against its business rules, it will then determine any discounts for which the vehicle is eligible, before calculating the final toll to be levied. If no account or one-off payment can be found from the roadside data, it will pass the vehicle data onto the "obtain vehicle owner details."

Current tag-based systems also support license plate-based payments to tag accounts known as video tolls (V-Tolls) or image tolls (I-Tolls). Before moving to "obtain vehicle owner details," license plates are checked against those associated with tag accounts. If a match is made then the toll can be posted to the account. The E-ZPass network provides license plate data exchange to support this function between toll agencies.

Process Payment

Assuming a user account or one-off payment can be identified for the vehicle, this function applies the toll:

- For prepaid accounts the account's credit is debited, as shown in Figure 3.4;
- For postpay accounts the account is debited, as shown in Figure 3.5;
- For one-off payments received before the toll is accrued, the single payment received is debited, as shown in Figure 3.6; and
- For one-off payments received after the toll is accrued, the single payment received is debited, as shown in Figure 3.7.

If the prepay account holds insufficient credit (or if the minimum credit threshold is approaching), then this function will initiate appropriate mechanisms to notify the user and obtain payment.

Any tolls accrued by interoperable tags which are registered to accounts with other toll programs also are processed here and the appropriate charges passed on to those programs. This approach ensures that customers can use an entire interoperable network with one account and one tag (see later section on Interoperability for further details).

Depending on data handling rules, this function will need to dispose of the data once payment has been successfully taken within a certain timeframe.

Figure 3.4 Processing Prepaid Accounts

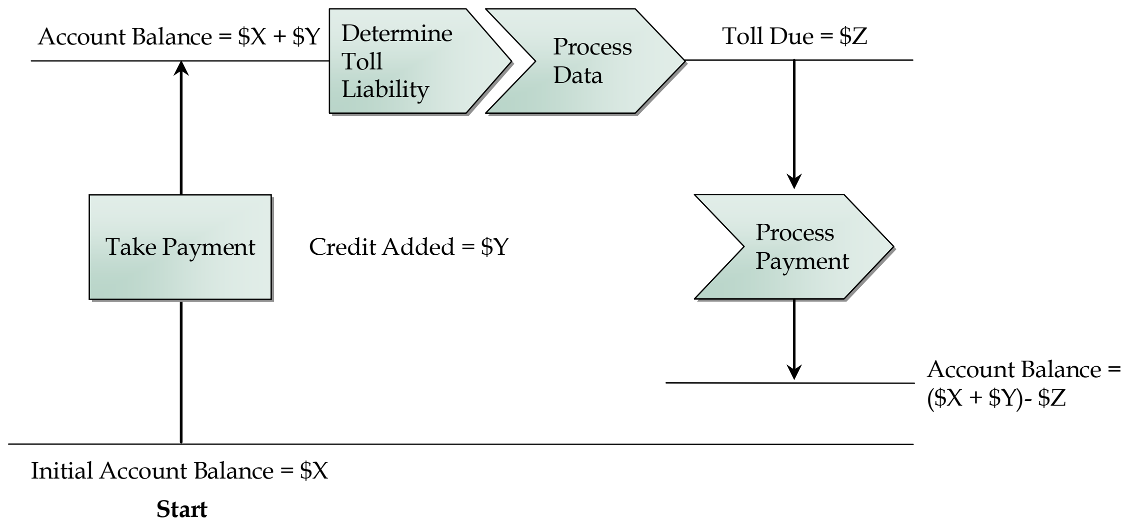


Figure 3.5 Processing Postpay Accounts

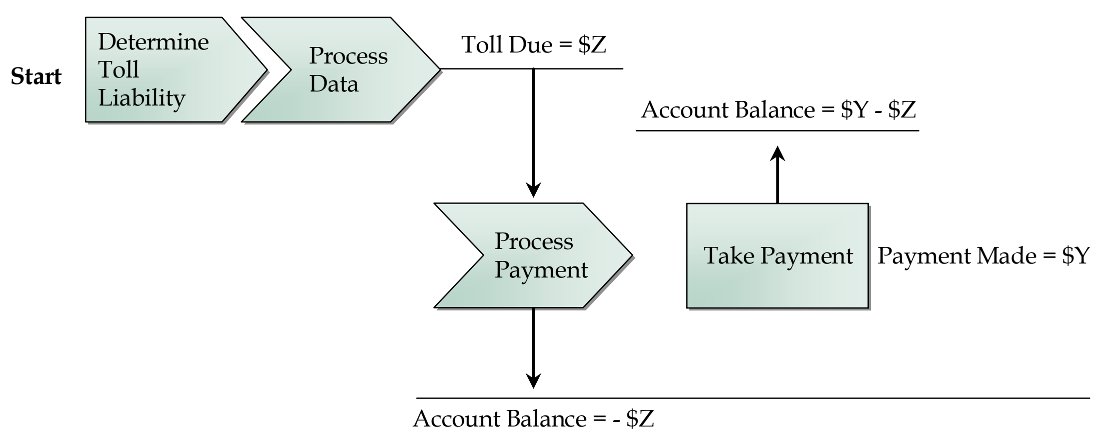


Figure 3.6 Processing One-Off Payments

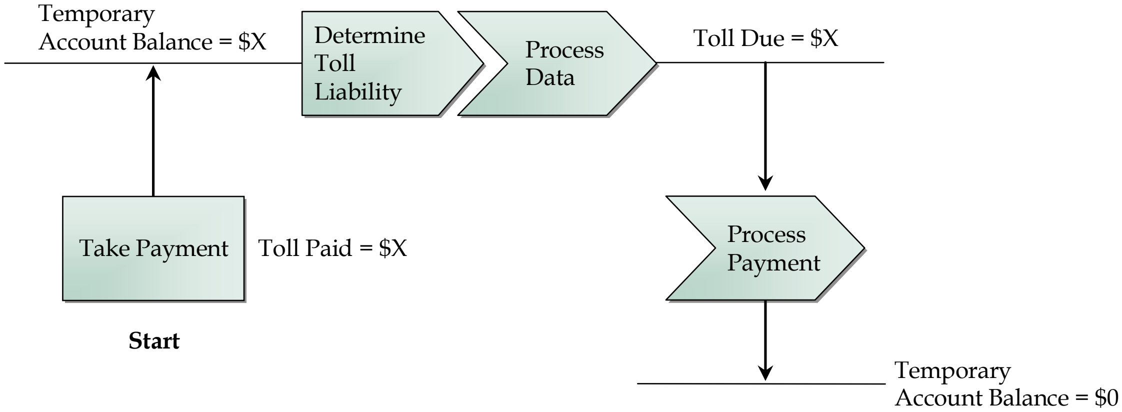
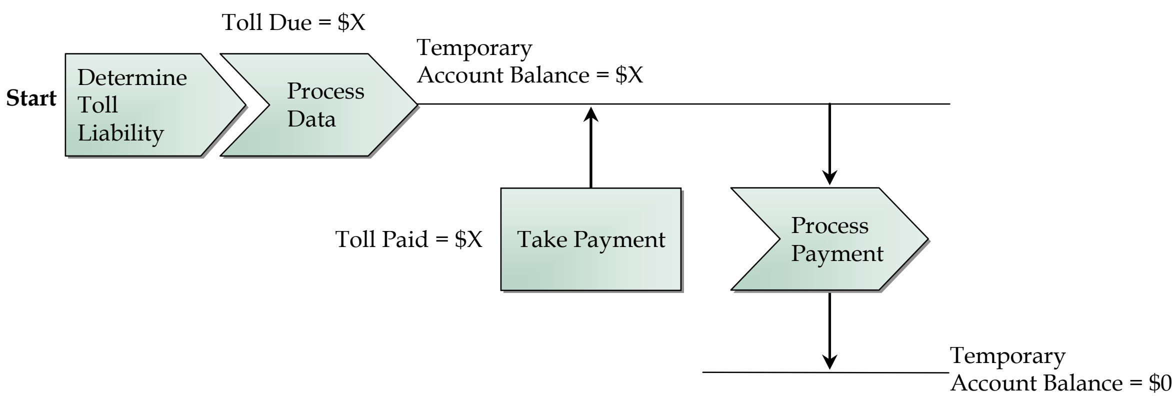


Figure 3.7 Processing One-Off Payments After Toll Is Accrued



Obtain Vehicle Owner Details

If a toll has been accrued but not paid and the toll cannot be matched to an account or one-off payment, the program needs to obtain the vehicle owner's details from the appropriate external vehicle registration database using the license plate as the identifier. If the license plate has recently been looked up, the system will use the cached results from that lookup rather than incurring additional costs for the same license plate.

Some toll agencies will perform this action for customers who have accounts with insufficient credit, as a means of double checking the vehicle owner.

If the tolling program offers video postbilling for users without accounts, this information will be used to initiate a video post bill which is sent to the owner of the vehicle. Under this approach, users are not violators at this stage – they are simply customers who have yet to pay.

If video postbilling is not offered, this information is passed to the "collect unpaid tolls" function for legal collection methods with users deemed violators at this stage.

According to the U.S. Bureau of Census, 17 percent of Americans change their residence every year. As a result, hit rates for successfully obtaining current names and addresses from the DMV are generally between 80 percent and 90 percent.

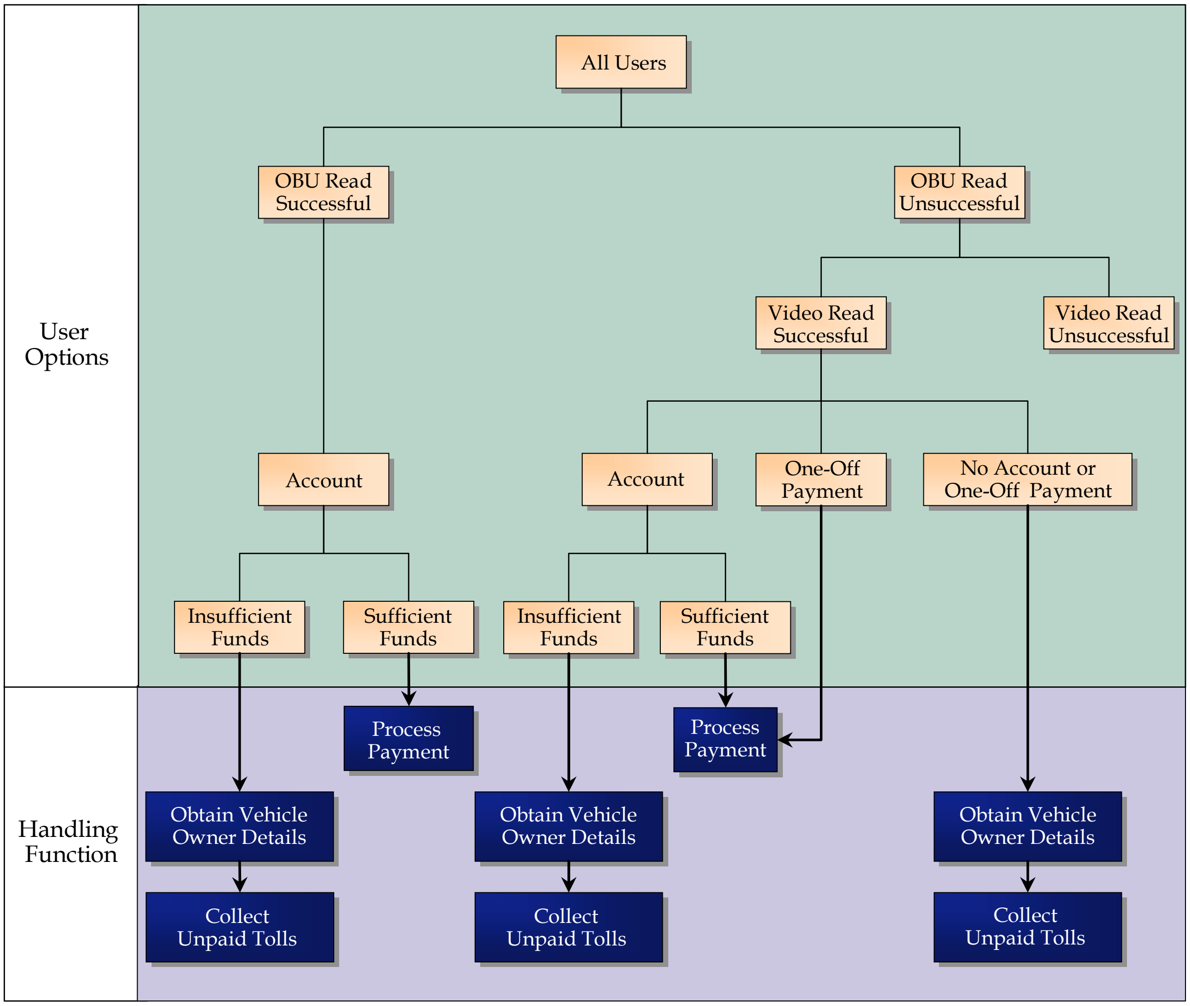
Collect Unpaid Tolls (including Legal Interfaces)

This function deals with those users who have accrued a toll, but not paid it within the allowed timeframe; this might be 24 hours for one-off payments, or up to 30 days for postpay accounts. Often programs will apply a service processing fee to cover collection costs, in addition to the toll amount.

Experiences from other toll authorities and similar programs (e.g., parking tickets) indicate that a number of people will pay their toll and service processing fees upon receipt of a demand letter. A second means of enforcement for in-state violators is placing a hold on the annual vehicle registration renewal process until outstanding tolls and related fees are paid. Since all electronic tolling is being pursued in a number of states, there are several activities underway to try to improve violation collection across state lines. Collections processes also can be initiated to trace the owner of the vehicle and attempt to obtain payment.

However, for the ultimate collection of toll violations, toll programs must look to law enforcement agencies and the local courts. As with any traffic or parking ticket, some violators will wish to appeal the citation to the courts which may result in costs and revenue loss for the program. Figure 3.8 outlines which function ultimately handles the user.

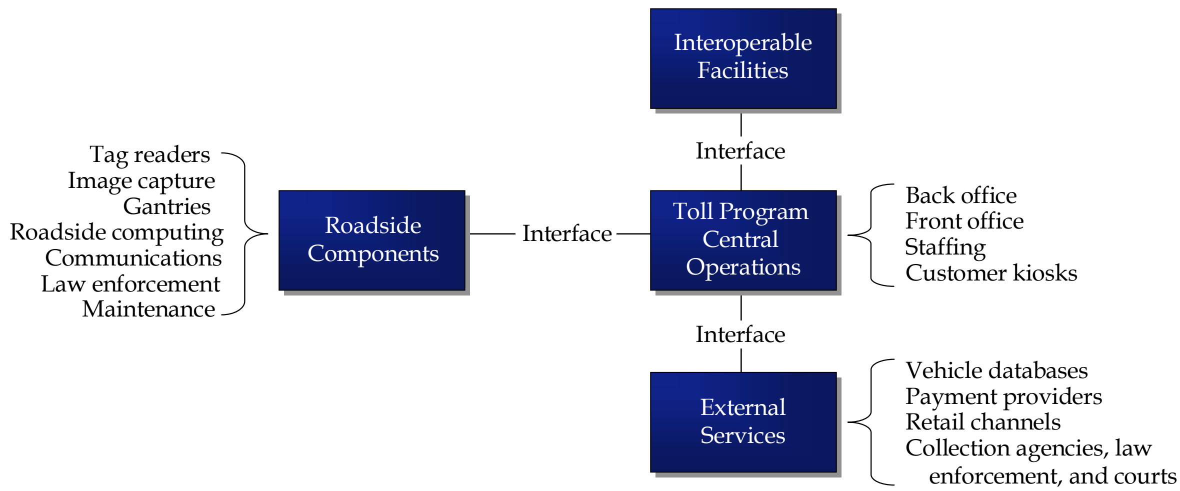
Figure 3.8 Collecting Unpaid Tolls



■ 3.2 All Electronic Tolling Deployment

This section outlines the components that need to be deployed to realize the functionality described in the previous section. For each high-level function described above there are a number of basic, required components or design elements that all tolling concepts will need to include. Figure 3.9 summarizes the various basic program and roadside components and external services.

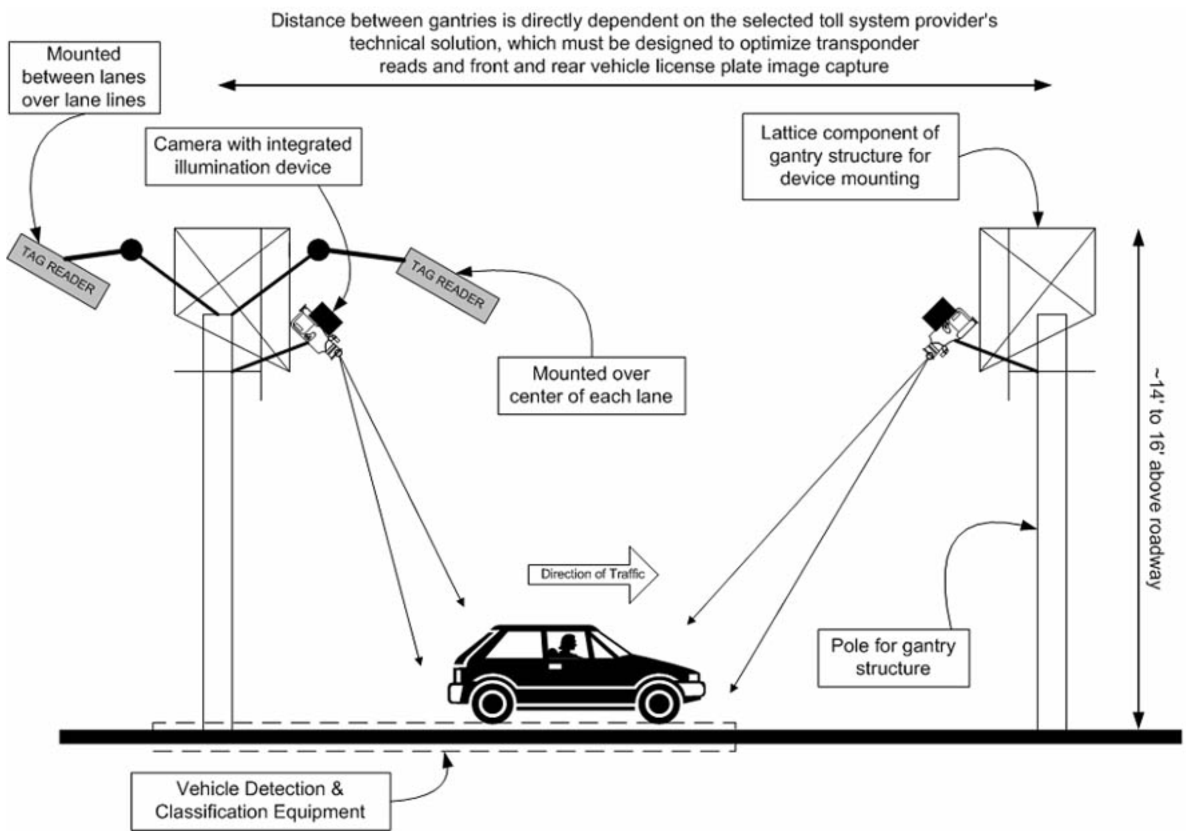
Figure 3.9 Basic Program, Roadside Components, and External Services Diagram



Roadside Components

This section outlines the roadside components which require deployment to operate a traditional tag-based AET system. Figure 3.10 illustrates typical roadside components for an AET system.

Figure 3.10 Roadside Components of AET Systems



Tag Readers

For tag-based AET systems, the program must install overhead antennas to capture the identification number of the passing tags. The antennas typically emit radio frequencies to communicate with the tags. The tag readers process the signals received from the antennas to read the tag data and generate signals to send messages for storage on the tag. Readers may be installed in a standalone box at the roadside or may be part of the antenna housing.

Image Capture

All AET systems require the use of Automatic License Plate Recognition (ALPR) video cameras to capture images and read the license plates of passing vehicles. ALPR systems use Optical Character Recognition (OCR) to read the license plate, and commonly take advantage of infrared to allow the camera to function at night and improve recognition accuracy. Recent advances include high-resolution cameras and use of ultraviolet-sensitive cameras to enhance the amount of data that can be extracted. Cameras are typically installed overhead to ensure a clear view of the vehicle license plate. The capture of images of drivers is prevented by legislation in some states and most toll operations generally try to avoid this for privacy protection reasons.

Some vehicles, such as tractor-trailers, may have different license plates front and rear. Others, such as motorcycles or cars from certain states, may only have rear-mounted license plates. For most deployments with mixed vehicle class traffic, video cameras would need to be both forward and rearward facing to ensure a license plate read is achieved for all vehicles.

Gantries

A gantry is the roadside structure on which tag readers, cameras, and signs are mounted and is the major civil construction component required to support AET. Gantries are commonly used in multilane highways, when signs posted on the side of the road would be difficult for all drivers to see. Gantries can have legs on both or only one side of the road depending on road layout. Advanced gantry design include protected walk ways and tilt back equipment mounting that allow maintenance of the gantry without disrupting traffic flow or creating a potential safety issue.

For a multilane installation (e.g., across a freeway), the gantry is required to be rigidly secured on both sides of the roadway to prevent movement and vibration. It is possible to cover a single lane (such as on a ramp) with a cantilever and pole mounting provided this is close enough to the monitored lane. However, to prevent movement effecting camera or classification equipment accuracy, most electronic toll systems utilize an across the road gantry design.

Where both front and rear images of vehicles are required, it is recommended that two gantries be installed to allow the same trigger point to be used to capture both front and rear images. This maximizes the ability of the system to correctly match up the front and rear images of the same vehicle. The exact spacing of the gantries depends on a toll system vendor's specifications and algorithms. In some locations, a single rectangular gantry structure covering many feet of lane length is used instead of two gantries.

In comparison with sign gantries, toll gantries need to be rigid to prevent movement of equipment but are not subject to the same level of wind loading due to the mounted equipment and therefore do not need to be as strong. Low-cost gantries typically use a box frame type of construction.

Roadside Computing

All AET systems require roadside computing units to process and store the data from the readers and cameras. These units also can perform actions on the data before sending it to the back office (such as OCR processing). These units are typically installed close to, or attached to, the gantries.

Communications

A communications network will be required to transmit data from the roadside equipment to the back office. Typically, this will be achieved through a combination of fiber optic cabling and telecommunications network services.

Law Enforcement

In addition to any automated technology, some programs may utilize law enforcement officers to provide additional enforcement capability. These officers may be proactive (e.g., checking that vehicles are in compliance with program rules such as number of occupants for HOT lanes) or passive (e.g., just providing a visual deterrent) and may utilize alerts generated by roadside equipment if a blacklisted or violating vehicle is detected.

Maintenance

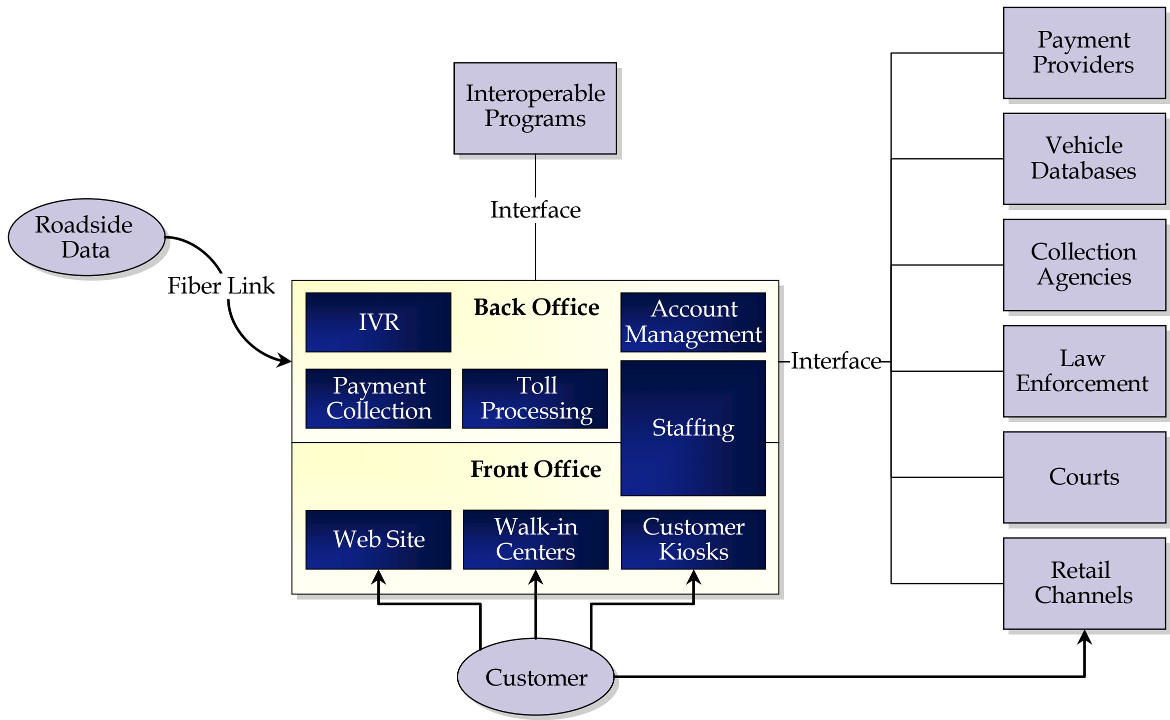
Maintenance crews will be required to maintain the roadside toll equipment and communications connections. While AET leverages highly reliable technology, often in redundant configurations, rapid response maintenance will be required to minimize any potential for revenue loss. An ongoing preventative maintenance program also will be required, particularly to maintain camera image quality.

The importance of proactive preventative maintenance cannot be overstated. With AET, the entire revenue stream of the toll organization is dependent on reliable operation of the system. It absolutely must be maintained to the highest standards, or customers will lose faith in the ability of the system to capture transactions, thus creating a downward spiral of revenue loss.

Toll Program Central Operations

This section outlines the aspects of the central operations necessary to operate a tolling program. Figure 3.11 illustrates a typical arrangement for the central components and external interfaces of an AET program.

Figure 3.11 Toll Program Control Operations



Back Office

The core component for any AET program is the back office. The back office comprises both hardware and software to support the central functions such as account establishment, processing toll transactions, and addressing collection issues. The back office system will be connected to the communications network to receive transaction data from the roadside equipment and to communicate with the external services. The back office system will include the functionality to support automated account access such as via the web and interactive voice response telephone system.

Front Office

The program's primary customer interface is through its front office operation. This component will perform the customer management functions such as account creation and management. The front office is typically housed in a Customer Service Center and offer contact channels such walk-in counters, mail, web site, phone, and e-mail.

Web Site

The vast majority of tolling deployments in the U.S. offer web-based services whereby users can register new accounts, view their toll transactions, update their account information, purchase tags, and add credit to their accounts.

Staffing

The program will require extensive staffing and management to operate the system. The primary staffing areas include management, customer service, financial, and systems. Staff will require a variety of skills and will work across all functions of the program, with customer service representatives operating the front office and technical and management resources operating the back office.

Customer Kiosks (Optional)

The program may wish to use customer kiosks to enable customers to pay their tolls, replenish their accounts, and possibly perform basic account updates without the need to contact the Customer Service Center. Kiosks provide a potential way to allow for one-off cash payment options. A basic kiosk would utilize a touch screen to update account information and be capable of processing different payment types. More advanced kiosks based on vending machine type technology also can issue tags. Germany's Toll Collect system is a prominent example of this facility; the kiosks let drivers without OBUs enter their route information and pay any subsequent charges.

External Services

AET programs require interfaces to a number of external services to perform their operation.

Vehicle Registration Databases

In the United States, each state maintains its own vehicle registration database. Toll programs require an interface to these agencies to obtain vehicle owner details to support video billing or for the collection of unpaid tolls via a violations enforcement process.

For out-of-state vehicles, it is necessary to obtain access to the registration information from the vehicle owner's home state. Separate interfaces are required for each database (i.e., there is no single interface to all databases) or a commercial provider can be utilized. Many states provide look-ups at no charge once the interface is established; however, fees can range as high as $8.00 per license plate look-up. A few states do not provide external look-up capabilities. Most states provide automated remote network access although some still require an electronic copy of a file to be provided on disc. Third-party commercial providers typically charge between $0.50 and $1.50 per plate look-up for the states they support. When implementing toll programs involving license plate look-ups, the recommended approach is to pursue direct connections to state databases that represent the highest percentage of home states for vehicles using the facility. Using this approach, it is feasible to obtain in excess 90 percent of plate look-ups with no ongoing costs other than maintaining the interface.

Access to international licensing information is more problematic because there currently are no vehicle data sharing agreements with Canadian and Mexican authorities.

A further consideration in this process is the accuracy of these databases. Due to the high percentage of individuals who move their residence each year (17 percent), the databases are at best 90 percent accurate at any one time due to delays in updating information. Mail forwarding will find many of the incorrectly located vehicle owners but some percentage, on the order of 5 to 10 percent, will not be located through this process. This represents a leakage in the video tolling process and increased follow-up costs through services such as skip tracing that should be accounted for in the program. For this reason, it is important to maximize use of transponders and encourage travelers to proactively register their plates or make one-off payments.

Payment Providers

Under AET, toll programs require an interface to the appropriate payment providers (such as credit cards and banks) to obtain payment for tolls once authorized by their customers. Typically, the back office provider will enter into a merchant account agreement with a payment provider such as a bank. Due to the rules dictated by payment providers, the back office operation must employ extensive security measures, both physical and electronic, to prevent access to user financial data by unauthorized parties. This will require compliance with the Payment Card Industry Data Security Standards (PCI DSS).

Depending on the type of payment being processed, the provider will charge a transaction fee plus a percentage of the payment being processed. Use of automated clearinghouse transactions (ACH) that directly debits a user's bank account is most cost-effective as there is no percentage fee but just a small transaction charge usually in the $0.10 to $0.20 range. However, this method of payment can take several days to a month to clear, increasing the possibility that a prepaid account holder can develop a significant arrears balance.

Credit card transactions typically incur a $0.08 to $0.20 transaction fee plus a 1.5 percent to 3 percent percentage fee per transaction. The rates vary between payment providers and card types processed.

Collection Agencies, Law Enforcement, and Courts

For those violators who do not pay their outstanding tolls after letters from the toll program, an interface to the law enforcement and legal system is required. The following processes can be employed:

- **Collections –** A collections company will typically take unpaid accounts for a contingency fee of between 10 percent and 20 percent of the collected amount. They employ skip tracing techniques to locate the individual and direct telephone contact to attempt to obtain payment. Depending on the policies of the agency, they also may mark the credit records of non-paying individuals.

- **Court –** The legislation in many states allow summonses to be issued to non-paying customers to require them to appear in traffic or civil court. Additional penalties are usually applied at this stage. In addition to supporting legislation, this requires close coordination with the court system and development of interfaces for summons file exchange. This process can be treated primarily as a deterrent by publicizing cases that are successfully prosecuted or as an income-generating process if sufficient volume can be handled by the court system.

- **Administrative Hearing –** In some locations, such as Massachusetts and Illinois, administrative hearings can be held instead of utilizing the court system. Since these processes are set up outside the constraints of the court system they can typically handle more cases. Supporting legislation would give these hearings similar powers to the courts along with definition of the required due process that would be subject to similar standards to court proceedings.

- **DMV Interface –** In order to provide the necessary incentives for individuals to comply with court or administrative hearing judgments, most states also allow a placement of a hold on vehicle registrations or driver license renewals for unpaid toll violations. While holds on driver licenses can be more effective, the time between renewals and the large inconvenience caused if an error is made means that holds on registrations is often a more appropriate choice.

Retail Channels

Some AET programs may form partnerships with retail outlets such as service stations on highways or grocery stores to expand the capability for customers to obtain tags, pay their tolls, replenish their accounts, and possibly perform basic account updates. These retail outlets would require some interface to the system and also appropriate training for their staff. Recent expansion in Florida included an agreement and interface with the Publix grocery chain. In this implementation, account holders make payments at the grocery store using a keychain barcode to identify their account and permit the store to transmit the transaction to the back office.

Interoperable Facilities

The need for interoperable toll programs arises from the customer desire of "one tag, one account." Toll programs can be interoperable on two levels:

Tag Interoperability

Under this model, the same transponder can be used with each toll program, but the customer must set up separate accounts with each. This occurs in the Northeast U.S. where "companion accounts" are sometime set up at other E-ZPass agencies when discounts are given only to local customers.

System Interoperability

With this level of interoperability, account information is exchanged between programs such that the customer needs only set up one account and use one tag. The E-ZPass network is a good example of system interoperability where a tag issued in one E-ZPass state can be used at any E-ZPass facility within the 16 states that participate.

4.0 Consideration of Public-Private Partnerships and Contractual Issues

As this report discusses the implementation options for the various congestion pricing or tolling alternatives, Connecticut needs to consider the extent to which the private sector can or should be involved in any of the alternatives. Since Connecticut does not have legal authorization for a transportation-related public-private partnership (PPP) financial program, the State would need to decide how many tools it wishes to have available for application on transportation projects, how to create such a program, and how such a program would be administered. Connecticut does have provisions for traditional non-financing PPP's such as Design/Build. It is beyond the scope of this report to offer information on how to implement a PPP program, but significant resources are available on that subject from the FHWA, accessible at http://www.fhwa.dot.gov/ppp/index.htm. Using this available information, this section of the report offers a primer on a variety of PPP project delivery and financing approaches, overall issues to address in creating a state PPP program in particular with respect to tolling and pricing, and how to decide when to implement a project through a PPP.

■ 4.1 PPP Approaches

The 2004 U.S. DOT *Report to Congress on Public-Private Partnerships* defines a PPP as follows:

> A public-private partnership is a contractual agreement formed between public and private sector partners, which allow more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system. While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed.

PPP approaches can be loosely classified in two major groupings: 1) project efficiency; and 2) project financing. The first set of approaches are designed to accelerate the delivery of a project or increase the efficiency by which the project is delivered. The second set of approaches is aimed at the entire life cycle of the project, involving other parties in executing ongoing functions and in paying for the initial and ongoing expenses of the project. All these approaches can be contrasted to the traditional means by which public agencies execute projects – generally known as the Design-Bid-Build approach.

In the Design-Bid-Build approach, the design of a project is executed and completed separately from its construction, although both stages usually involve a private firm under contract to the public sector. Long-term ownership, maintenance, and operations of the project are typically the province of the public sector, even if the project's capital costs are financed through tax-supported or revenue-backed debt financing. One shortcoming of this traditional method is that it does not match incentives, risks, and rewards during the life cycle of a project, because the sequential nature of the project delivery process, silos of organizational responsibility, and separate pools of funding for each project development element rarely connect to reveal how different decisions can affect the efficiency of downstream project elements. Examples of these mismatches include:

- Materials specified in design plans may not reflect the latest technological advances, nor are they necessarily chosen for lower life-cycle maintenance costs. Procedures for approving new materials or changing standard specifications are administered by a risk-averse public sector primarily concerned with keeping initial capital costs low and reducing the risk of material failures.

- Construction contractors might have experience that could identify materials or alternate construction techniques that could offer savings in construction costs. But, the contractor bids a fixed, lowest cost price, so the firm has no incentive to offer cost saving ideas other than those which would inure to the contractor's benefit.

- If construction costs are increasing at a rate of 10 percent a year, it may make sense to offer a sizeable bonus to a design engineer to complete the plans earlier than contracted so that the project can go to construction sooner. Yet, if engineering contracts are negotiated and managed (or measured) as a percentage of the original project estimate rather than a system that would share the savings from quicker bid letting with the design firm, then the design firm has no reason to finish early.

PPP approaches which focus on project efficiency include these four:

1. **Fee-Based Contract Services** – Contract with private sector firms for services typically provided by public sector employees, which might include construction management, pavement maintenance, consulting engineer management, or call center operations.

2. **Construction Manager at Risk** – Contract with a private sector firm selected during design, in which the firm reviews design plans for constructability and bid quantities, and agrees with the public sector owner on a guaranteed maximum price for construction, and the firm then selects and manages the contractor(s).

3. **Design-Build** – Contract with a group of firms, including engineers and contractors, with which the public sector executes one contract for the completion of design and construction of a project for a guaranteed maximum price.

4. **Design-Build with Warranty** – Same as a design-build contract, but the design-build entity warrants the performance of materials and construction for a certain amount of time; i.e., a pavement warranty for 20 years (or a certain number of axle loadings) during which the firm performs all pavement maintenance services.

PPP approaches which focus on project finance include these four:

1. **Design-Build, Operate, Maintain (DBOM)** – Performance-based contract with a group of firms for the design, construction, and operation and maintenance of a facility for a specified period of time, bid as a guaranteed maximum price for the entire period covered by the contract.

2. **Design-Build, Finance, Operate (DBFO)** – Similar to a DBOM, but the private firms are responsible for a portion of the financing of the project, in return for the ability to keep user fee revenues over the life of the contract, while the public sector retains ownership of the underlying asset. The public sector may bid the contract for an up-front fee, for the lowest public subsidy, and/or a share of project revenues.

3. **Build, Operate, Transfer (BOT)** – Similar to a DBFO, the private firms also would own the transportation facility and the right to collect project revenues, and agree to transfer ownership of the facility to the public sector at a certain time and meeting certain standards for remaining useful project life (through reconstruction requirements).

4. **Build, Own, Operate (BOO)** – Contracts under which all responsibility and risks are transferred to the private sector, and the private sector retains ownership of the facility and its project revenues for perpetuity.

Table 4.1 is a summary of the relative public and private sector project responsibilities under these eight PPP approaches, compared to the Design-Bid-Build method.

Table 4.1 Types of PPP Approaches in Surface Transportation Projects

PPP Approach	Responsibility for Project Element					
	Design	**Construction**	**Maintenance**	**Operations**	**Financing**	**Ownership**
Traditional Design Bid Build	Public/Private Sector	Public/Private Sector	Public Sector	Public Sector	Public Sector	Public Sector
Fee-based Contract Services	Private Sector	Public/Private Sector	Public/Private Sector	Public/Private Sector	Public Sector	Public Sector
CM @ Risk	Public/Private Sector	Private Sector	Public Sector	Public Sector	Public Sector	Public Sector
Design Build	Private Sector	Private Sector	Public Sector	Public Sector	Public Sector	Public Sector
DB with Warranty	Private Sector	Private Sector	Public/Private Sector	Public Sector	Public Sector	Public Sector
DB Operate Maintain	Private Sector	Private Sector	Private Sector	Private Sector	Public Sector	Public Sector
DB Finance Operate	Private Sector	Private Sector	Private Sector	Private Sector	Private Sector	Public Sector
Build Operate Transfer	Private Sector	Private Sector	Private Sector	Private Sector	Private Sector	Public/Private Sector
Build Own Operate	Private Sector	Private Sector	Private Sector	Private Sector	Private Sector	Private Sector

Public Sector   Public/Private Sector   Private Sector

Source: Cambridge Systematics analysis, definitions of approaches from *User Guidebook on Implementing Public-Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report 05-002*, July 2007, FHWA.

4.2 Institutional Considerations in Establishing a PPP Program

The 2007 FHWA *User Guidebook on Implementing Public-Private Partnerships for Transportation Infrastructure Projects in the United States* offers extensive advice to states ready to implement PPP programs. Just as Connecticut has executed this report to consider cross cutting, policy-level considerations in tolling, and road pricing rather than jump to project-level analysis, Connecticut would do well to spend time deciding what kind of PPP program they want to have before executing a program to advance road pricing projects. The 2007 FHWA PPP Guidebook offers a series of questions to prompt internal discussions of PPP program development:

What is the institutional context for the PPP program? States having implemented PPP programs do so to address a variety of problems. For some, PPPs might address internal agency capacity constraints to manage mega-projects; for others, PPPs appear to be a means of bringing private capital to address state funding shortfalls; for others, ongoing entreaties from the private sector may be the cause for creating a program to handle the requests. A state should be clear about what kind of criteria it will use to assign projects to PPP delivery (addressed in the next subsection).

Does the sponsoring agency have the statutory and regulatory authority for PPPs? Having the necessary legal authority to proceed with PPP projects is a necessary condition for a state; otherwise, private firms would have no assurance that a PPP contract with the State will be binding and enforceable. Since Connecticut has no such authority for PPP projects, the State would have to craft a statutory and regulatory regime that offers the flexibility to solicit PPP proposals to implement alternatives in this report or to solicit or accept PPP proposals for other greenfield road or bridge projects.

What are the potential public and private partner responsibilities, risks, and returns? PPP projects are likely to be most successful when they balance the risks and returns between the public and private sector in a way that shares rewards and mitigates risks for both parties. Careful delineation of risks and rewards is a productive step in crafting a sustainable, productive PPP program. Table 4.2 lists some of the risks and rewards that must be addressed in the statutes and procedures creating a PPP program.

Does the sponsoring agency have the capabilities and resources to develop and manage a PPP program and the resulting projects? While a new PPP program will likely require specialized advice for program definition and procedures, the State would be wise to carefully connect the PPP procedures with the overall agency mission and responsibilities, rather than create stand-alone organizational structures that fail to recognize that PPPs are a means of advancing the interests of the agency, not an end unto itself. Therefore, part of the PPP program development process should be an analysis of the public sector resources necessary to implement the program. This not only requires an assessment of the kinds of knowledge, skills and abilities required of program personnel, but also what kind of outside assistance would be necessary to analyze proposals and draft contract documents. Consultant contracts must balance the public sector's need for independent analysis and its need for decisive action; otherwise, consultants might endlessly bill hours or cut corners to achieve project execution incentives.

What kind of procurement approach should be used to select qualified PPP teams? CS' 2007 report for the USC Keston Institute for Public Finance and Infrastructure Policy, *Protecting the Public Interest: The Role of Long-Term Concession Agreements for Providing Transportation Infrastructure*, offers a thorough discussion of how the PPP procurement process can be designed and executed in a way that protects the public's interests as it secures the resources of the private sector for projects, including various suggestions for how proposals are structured, solicited, evaluated, awarded and administered. While many PPP resources focus on procurement processes to attract the private sector, the Keston Institute report concludes that if the procurement process is designed with sufficient and appropriate transparency, then the PPP process is much more likely to achieve and sustain the public acceptance and political support it needs to be successful. Connecticut should strive for a PPP procedure that attracts private competition but is transparent enough to satisfy a skeptical public.

Table 4.2 Potential Rewards and Risks of PPP Approaches by Partner

Potential Rewards	Potential Risks
Potential Rewards to Public Sponsor • Reduced financial constraints/increased financial capacity; • Expedited project initiation and faster delivery; • Access to innovative techniques and specialized expertise; • Integration of project development and delivery with life-cycle cost incentives; • Greater choices in project approaches; • Increased competition and accountability; and • Risk transfer to entity better able to manage.	**Potential Risks to Public Sponsor** • Transaction/administrative costs to procure and monitor PPPs; • Taxation constraints; • Moral hazard; • Control over transportation assets and toll rates; • Public acceptance; • Compensation and termination clauses; • Environmental/archeological clearance; • Permitting costs; and • Right-of-way costs.
Potential Rewards to Private Partner • Higher rate of return compared to conventional project delivery approach; • Greater control over assets/operation/user fees; • Lower life-cycle costs; • Increased revenues from financial transactions; • Opportunity to apply best practices and new technology to increase productivity and meet performance standards at lowest life-cycle costs; and • Opportunity for value capture from direct users and indirect beneficiaries.	**Potential Risks to Private Partner** • Change in law; • Economic shifts; • Public acceptance/protectionism; • Currency/foreign exchange; • Political support/stability; • Moral hazard; • Project development/maintenance costs; • Project delivery schedule; • Financial feasibility/traffic and revenue levels; • Liability for latent defects; • Prohibition against noncompete clauses; • Compensation/termination clauses; and • Transparency requirements.

Source: *User Guidebook on Implementing Public-Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report 05-002*, July 2007, FHWA, page 82.

4.3 Applying PPP Approaches to Projects – Theory

This section has offered information on the various PPP approaches, and information to consider as Connecticut develops a PPP program. This subsection discusses the process of how to apply PPP delivery to a given project.

Generally, the public sector could consider a PPP delivery under the following circumstances:

- The public agency has legal authority to use a range of PPP mechanisms;
- A large and complicated project ($500 million or more in cost) has been identified that addresses significant transportation needs and/or brings public benefits;
- The project enjoys strong support from community leaders, elected officials; and agency management;
- The public sector lacks the organizational or funding resources to deliver the project by conventional means;
- The project has the potential of generating revenues (tolls, property development, and shadow payments) which could be captured to finance capital and operating expenses of the project; and
- A range of potential private sector competitors are capable, available, and interested in competing to deliver the project and gain a return on their investment during the life of the project.

Table 4.3 sets out some project-related elements to determine how to apply PPP approaches, explained in two sets of criteria, one relating to the choice of using PPPs and one relating to the choice of which PPP approach to use.

Table 4.3 Criteria for Selecting PPP Approaches in Surface Transportation Projects

Threshold Criteria for Considering PPPs		Decision Factors for Selecting PPP Approach	
Project Scale	**Public Demand**	**Project Stage and Risk Profile**	**Project Revenue and Funding Potential**
Project size in terms of cost and financing requirements – the higher the cost the more likely the private sector will be needed to bridge the financing gap.	Urgency of project to satisfy transportation mobility need.	Preliminary concept planning favors joint development and life-cycle PPP approaches that maximize potential for cost minimization and value capture maximization.	Scarce public funding sources to meet transportation program budgets are enhanced by pooling multiple modal program resources.
Project design and construction complexity – the more complex the design and the more sophisticated the financing the greater the potential role of private partners.	Significant transportation-related economic development potential.	Public sector takes responsibility for environmental clearance, obtaining most permits, and most right-of-way acquisition, including advanced acquisition.	PPPs enhance ability of project to secure adequate financing and funding to support the project's developmental based on user pricing and/or economic development value capture.
Project functional scope (whether financing and/or O&M are included) – the broader the more likely private partners can leverage public resources to meet the needs.	Broad public support for PPP approach to project delivery, financing, and funding approaches used.	Design is at less than 30 percent to optimize best practice input by PPP team.	Legal authority must exist to permit sponsoring agency to engage in PPPs that include use of private capital financing.
Capability of sponsoring public agency not adequate to deliver project by itself in a timely manner.	Broad and sustaining political support for PPP approaches to leverage scarce public funds and expedite project delivery.	Postconstruction responsibility for O&M and preservation transfers significant project performance risk to the PPP team though O&M contract or brownfield long-term concession lease.	Projects with high initial costs and long-range revenue potential require alternative financial approaches which can be more readily obtained through a PPP arrangement.
Low-risk tolerance of sponsoring public agency for large, complex projects.	Presence of project in state or local transportation improvement plans (STIPs or TIPs).	The greater the risks of the project and the public sponsor's aversion to risk the more likely that a PPP approach will be considered.	Projects that lack financial feasibility will not attract private sector interest – therefore sponsoring agencies should not limit PPPs to the least feasible projects.

Source: *User Guidebook on Implementing Public-Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report 05-002*, July 2007, FHWA, page 23.

5.0 Privacy

With all-electronic tolling, customers do not have the option of making cash payments. All of the available approaches depend in some way on identifying the vehicle. This can raise concerns about privacy. Depending on the AET technology deployed and the payment options provided, there are a variety of personal data points that may be gathered by this system requiring a clear privacy policy. The formulation of this policy is critical to the public acceptability of any tolling system in Connecticut. This section identifies the general privacy issues related to AET as well as appropriate mitigation strategies that should be followed to provide reasonable privacy protection according to strict principles. Agencies planning to implement AET have three main privacy issues to consider, each of which require careful mitigation to ensure public acceptability and legal compliance are achieved. These issues are:

1. **Collection of Personal Information –** Such as identity, financial and journey information;

2. **Retention of Personal Information –** Large amounts of personal data is retained; and

3. **Sharing Personal Information with Other Parties –** Pressure to share information may arise.

The remainder of this section discusses these issues in greater depth, as well as providing appropriate mitigation strategies.

5.1 Issue 1 – Collection of Personal Information

In order to administer a tolling or congestion pricing system, personal information may be required from the customers of that program. The personal information disclosed by the customers falls into three types:

1. Identity information;

2. Financial information; and

3. Journey information.

Identity Information

This information includes data such as the name, address, telephone number, vehicle license plate, e-mail address, and date of birth of the toll customer. Depending on toll facility design, this may include images of vehicles (and possibly their occupants) taken by video camera. A customer's identity information generally has two sources: it is either voluntarily provided by the toll patron when opening an account or it is obtained (maybe without customer consent) when license plate images are used to identify the vehicle's registered owner by checking vehicle registration database records.

In the United States, individual state vehicle registration databases maintain vehicle ownership information. When a vehicle uses a toll facility in the State in which it is registered and identification by license plate is necessary, the toll authority must generally obtain the information via an electronic interface to the specific vehicle registration database. For some authorities, a handful of authorized employees have direct access to the vehicle registration database. Most agencies have established automated interfaces for the electronic exchange of the information.

For out-of-state vehicles, it is necessary to obtain access to the ownership information from another state's vehicle registration database. Separate agreements may be required for each vehicle registration database, and some states do not have laws in place to allow for access to their information (California was among these until August 2007). Specific data privacy rules may vary from state to state.

Access to international licensing information also would help to increase the efficiency and effectiveness of toll violation processing. However, Canadian provinces may prohibit the release of a Canadian citizen's information to another country. Although some toll authorities offer anonymous AET account options, all but a small percentage of customers register an account that requires some identity information. Upon registration, it is general practice that the customer must agree to the Terms of Use prepared by the tolling authority which will contain a clause regarding the customer's identity information and how it will be used by the toll agency.

Financial Information

This includes information such as credit or debit card number, bank details and credit check results. This is disclosed by customers when paying a toll, replenishing an account, or registering a payment means with an account. If the toll facility offers a postpay account option, they may require the customer's credit score, which is obtained via a credit check. In this instance, the user also is required to supply their social security number.

Journey Information

This includes information such as where and when a vehicle has been driven. Journey information is disclosed whenever a customer passes a tolling point or passes tolling information to the system, and a picture of a motorist's journey can be built up from this data. Typically this occurs because the tolling points identify the vehicle (e.g., using tag ID or license plate) and pass that information to the back office.

This information is required to administer the tolling system but also can provide an excellent source of traffic data for analytical purposes, where journey data is a good source of highway/traffic flow statistics. Some tolling agencies allow for the use of anonymous, aggregated usage statistics and traffic characteristics distilled from transponder data and license plate recognition, as long as no vehicle or driver's individual system usage and driving patterns are identified.

There is a clear hierarchy of the privacy impact of different types of journey information disclosed by a toll customer (Table 5.1):

Table 5.1 Hierarchy of Privacy Implications of Journey Information

Hierarchy	Type of Journey Information	Disclosed by Customer When	Privacy Impact
Less privacy impact.	Single point data.	Passing a single tolling point, such as a cordon or bridge toll.	Can determine where a vehicle was at a single point in time.
↓	Route data.	Passing a succession of tolling points, such as on a tolled highway (open or closed).	Can determine (or infer) where a vehicle was at certain points in time along a particular route.
More privacy impact.	Exact position over time.	Using GPS OBU for distance-based tolling.	Can determine a vehicle's precise location over time.

This type of journey information is one of the most cited privacy concerns with electronic tolling. Once this data is stored, it is often accessible through subpoena by law enforcement or other legal entities to provide evidence in a variety of court cases.

Mitigation for Issue 1 – Collection of Personal Information

A number of ways exist to mitigate issues relating to identify information, described below:

- **Anonymous Accounts** – The program can provide for customers who wish to remain anonymous when paying their tolls by offering OBUs that come associated with a certain amount of credit via an anonymous account. When the OBU runs out of credit the user is required to either replenish or purchase a new OBU. If the credit runs out the user is deemed a violator and their details obtained from the vehicle registration database. The system handles these anonymous OBUs like standard prepay accounts. Without personal data associated with an OBU, it is difficult to replace the funds associated with lost or stolen devices.

- **One-off Payments** – The program can provide for customers who do not wish to register an account. This can be done by allowing the user to enter license plate data along with a toll payment (which could be done in cash via a retail channel or customer kiosk). The system then attempts to match the license plate given by the user to its own video records. If license plate data is matched to a toll payment, this transaction will be closed and there will be no need to use the license plate data to retrieve personal information from a vehicle registration database. Privacy concerns also can be addressed by providing a variety of means and multiple locations for processing these one-off payments.

- **Allow Cash Payments –** Conducted via walk-in centers, kiosks or retail channels, customers could make one-off payments and replenish their accounts using cash rather than disclosing their financial information.

- **Offering Equivalent Non-tolled Alternatives –** An equivalent non-tolled alternative is a route that offers similar journey distances to that offered by the tolled route (by comparison, a non-equivalent alternative might be a detour on slower or longer routes, which greatly inconvenience the driver). Equivalent non-tolled alternatives might include the non-tolled lane next to an express lane or a parallel running non-tolled highway. Motorists may choose to take the tolled route because of reduced congestion, but by offering motorists non-tolled equivalent alternatives to the tolled route, they have a choice of whether they take the toll road and hence whether they disclose any personal information.

- **Anonymizing the Journey Data** – Tag IDs can be encrypted and anonymized such that only the trip record is stored. Additionally, the tag data is deleted after the vehicle has left the facility. New York/New Jersey's TRANSMIT[21] is an example of how

[21] The TRANSMIT project uses a network of readers in the New York City area to read E-ZPass tags solely for travel time measurement purposes. Tag reads from one location are scrambled and compared to similarly scrambled reads from another location allowing travel times between the two locations to be calculated.

transponder read data can be successfully used for a variety of traffic analysis purposes while retaining user privacy. This process is useful for the use of tag data for traffic measurement purposes but can disrupt the audit trail required for account management.

It should be noted that options to increase user privacy generally decrease user convenience. This is a tradeoff that a toll program needs to recognize and communicate clearly to customers.

5.2 Issue 2 – Retention of Personal Information

Once disclosed by the customer, the system will hold large amounts of data on people, their journey patterns, preferences etc. The retention of this data may result in perceived risks to people's privacy.

Some data is often held indefinitely. For many U.S. agencies, this may include transaction information, still images, and recorded video. This policy is a result of many influences, including requirements of vehicle licensing laws, absence of law or policy limiting length of data retention, availability of inexpensive storage, and little or no incentive to dispose of it. Many agencies archive the information from the primary database to improve system performance, but information can be retrieved as needed.

Mitigation for Issue 2

Some potential ways to mitigate issues of data retention include:

- **Data Encryption and Protection Policies –** Credit company rules and laws generally require that credit card information not be used for any purposes other than toll collection and account replenishment. The payment card industry has established and is now enforcing comprehensive data security standards that prevent any unauthorized access to credit card numbers. These standards apply to the software that handles the credit card numbers, the encryption for storage and transmission as well as physical access to processing facilities, computer systems and networks and storage of paper copies of financial information. For example, to protect this information within the toll collection agency, when referencing customer account information within the Customer Service Center application, only the last several digits of the account number should be visible. Within the customer database, the information must be encrypted. Other payment methods, such as direct deposit, should be handled similarly and within the bounds of additional laws that restrict their use. Other safeguards, such as prohibiting handwritten capture of credit card numbers, also may be implemented.

- **Data Purging Policies –** An aggressive data purging policy should be implemented. In some cases, the policy is to delete transaction information after payment is successfully collected, however this practice can lead to difficulty in reconciliation and rectification of any errors made by the customer or central operation. One practice is that the encrypted evidential record with the license plate image is retained up to 13 months after the charge has been paid, while others delete the data without delay. Each data element or table in the system as well as scanned or paper records should be reviewed to identify the level of personal information contained and the length of time that it should be maintained in the system or in archive. Appropriate security polices also must be put in place to protect archived data.

5.3 Issue 3 – Sharing of Personal Information with Other Parties

Typically, the personal information collected could be used by a variety of other agencies and organizations, and the toll operator may come under pressure to release information (e.g., for law enforcement purposes) or to sell information. Potential pressures for data sharing can include commercial organizations, law enforcement, other toll agencies, and members of the public.

In most cases, if a driver persistently fails to pay their charges or attempts to defraud the program, the agency may record the vehicle's movements and disclose the relevant details to local authorities to assist in tracing persistent evaders. Authorities may be given the license plate number and typical commuting pattern of a "most wanted" evader, who may then be pulled over and ticketed or detained. Additionally, if a third party such as the police requests a copy of an image for a legitimate purpose under the terms of an agreement, then the agency may disclose a previously recorded image if this is still held. These requests are dealt with on a case-by-case basis.

Mitigation for Issue 3

Some mitigation measures for the issue of sharing personal information include:

- **Clear Data Access Policies –** Policies should be put in place to ensure that this information may not be accessed by anyone other than the registered customer or agency customer service representative. Access to the information is restricted to entities with a court order and law enforcement agencies with jurisdiction over the particular facility or an agreement with the toll agency. A typical arrangement involves a clause that license plate recognition camera images cannot be made public or used in any court proceeding not related to toll collection. Names and addresses of ETC account holders cannot be shared with commercial interests, but such information may be exchanged with the entities operating or having jurisdiction over the tolled facility.

- **Limit Intra-Agency Access to Customer Data –** Access to customer account data and vehicle registration database records should be given to authorized toll collection staff on a need-to-know basis. Customer service representatives may be required to sign a statement that they will uphold customer privacy policies. Background checks on staff are commonly conducted.

- **Limit Inter-Agency Data Exchange of Customer Data –** Provide only the necessary information between agencies to support interoperability. For example, E-ZPass interoperability is achieved by sharing only a transponder identification and status. No personal information is shared between agencies for basic toll interoperability.

- **Strict Guidelines Govern Data Availability to Third Parties –** Most agencies require a court order for any access. For example, information on who traveled where and when should not be available to the police, transportation engineers or anyone outside of the Toll Authority. Generally, the release of personal information to third parties such as law enforcement or a collection agency will be predicated on Federal or state laws. Documentation may be released to debt collectors and others. However, information about the toll point crossed and the time this occurred is protected and confidential.

6.0 Public Acceptance

The world of tolling has become more complex and the public's views on tolling and road pricing has become more difficult to predict. In an attempt to identify trends in public opinion relative to tolling the Transportation Research Board of the National Academy of Sciences recently produced a report compiling public opinion data on toll roads and pricing. The report *NCHRP Synthesis 377: Compilation of Public Opinion Data on Tolls and Road Pricing* compiles 110 data points from polls, focus groups, and customer surveys on tolling across the United States. Eight themes emerged in the report when evaluating public opinion on tolling. Those eight themes are:

- The public wants to see the value;
- The public wants to react to tangible and specific examples;
- The public cares about the use of revenues;
- The public learns from experience;
- The public uses knowledge and available information;
- The public believes in equity but wants fairness;
- The public wants simplicity; and
- The public favors tolls over taxes.

7.0 Concept A – New Toll Express Lanes

Overview

This concept analyzes the addition of new tolled express lanes to existing interstate highways. **There are two corridors in Connecticut where additional lane capacity is being considered – I-95 between Branford and the Rhode Island state line, and I-84 between Waterbury and the New York state line (Figure 7.1).** The rationale behind adding new tolled capacity to existing highways is to raise revenue to pay for the new lanes – revenue that might not otherwise be available. As the corridor becomes more congested, an express toll lane also provides a congestion-free alternative for those who find the need for a quicker or more reliable trip. Unlike HOT lanes, where high-occupancy vehicles are free or discounted, with express toll lanes, all vehicles would pay a toll.

Building a new toll lane is similar to building a new toll road in that drivers can continue to use the existing free capacity or chose to pay for the new capacity. However, there must be enough congestion in the non-tolled general-purpose lanes or there is no incentive for drivers to pay for what they can otherwise experience at no toll cost.

Therefore, in order to make the most use of the tolled lane, as well as to generate the most revenue, the toll should vary based on congestion levels. This could be accomplished either through a published toll schedule based on historical patterns or dynamically, based on actual traffic levels on the highway.

Project Description

The I-95 corridor was most recently studied in a 2004 report[22] prepared for ConnDOT that provided an assessment of the transportation-related deficiencies and needs in this corridor and an evaluation of potential improvement concepts. A 1999 study[23] by ConnDOT's Bureau of Policy and Planning, Office of Inventory and Forecasting identified the need for additional capacity on I-95. That study recommended further analysis to assess the

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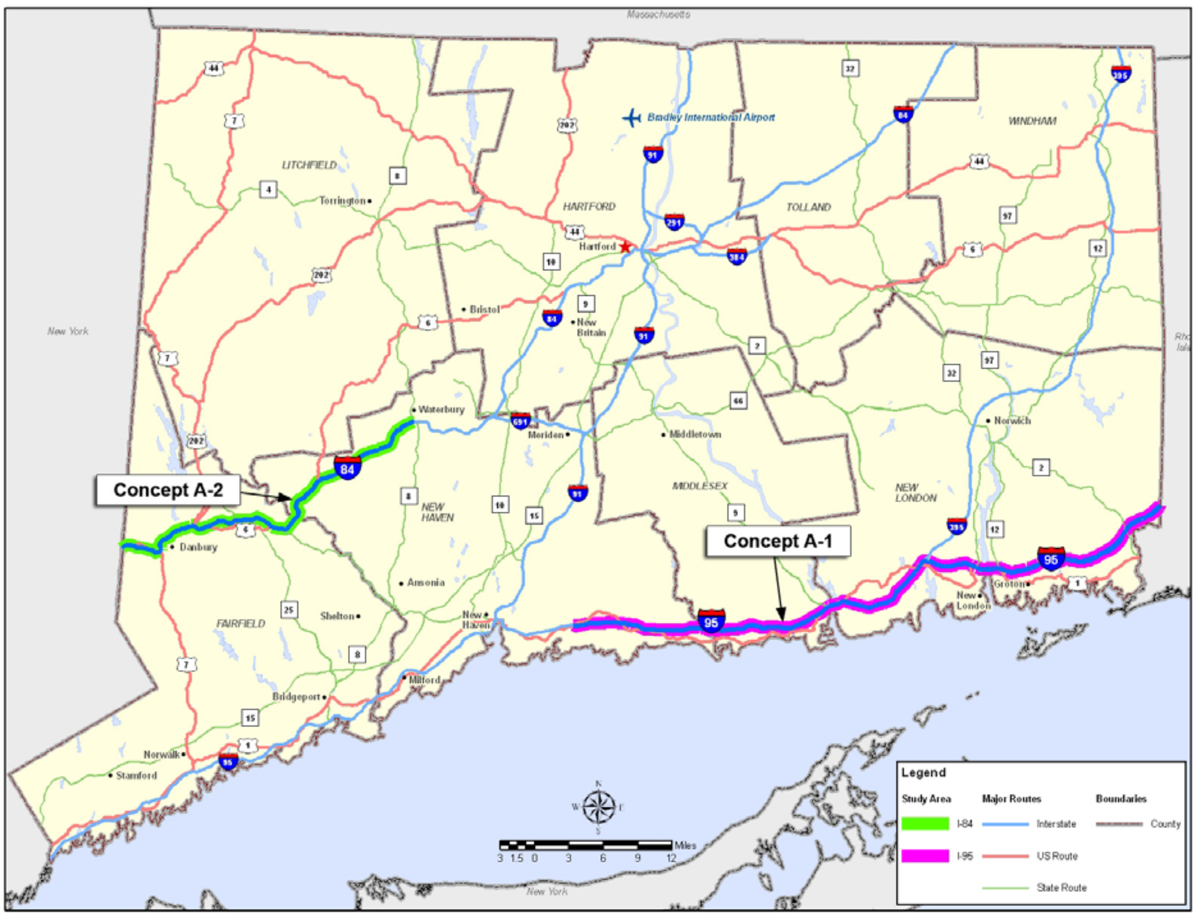
[22] I-95 Corridor Feasibility Study – Branford to Rhode Island, Final Report. Prepared for the Connecticut Department of Transportation. Prepared by Clough, Harbour & Associates LLP. December 2004.

[23] The Southeastern Connecticut Corridor Study.

feasibility of providing a third travel lane in all two-lane sections of I-95 between Branford and the Rhode Island state line.

The I-84 corridor was studied in a 2001 report[24] prepared for ConnDOT that provided an assessment of the transportation-related deficiencies and needs and an evaluation of potential improvement concepts. The 2001 study focused on approximately 13 miles of this corridor from Interchange 18 in Waterbury to the Housatonic River. Among the various transportation strategies considered was the addition of a general-purpose lane in each direction, increasing the cross-section to three lanes in each direction.

Figure 7.1 Concept A – New Toll Express Lanes



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24 I-84 West of Waterbury Needs and Deficiencies Study – Final Report. Prepared for the Connecticut Department of Transportation. Prepared by Wilbur Smith Associates. November 2001.

7.1 Institutional and Legal

The Express Lanes Demonstration Program allows for tolling on any existing Interstate or non-Interstate facilities that are modified or constructed to create toll lanes. A network of facilities managed under the same authority also can qualify as a single demonstration project. This program is intended to manage high levels of congestion and reduce emissions, and could be used to fund the I-84 or I-95 Express Lane projects (A-1 or A-2 under Concept A).

Under this program, automatic (electronic) toll collection is required for express lanes, to avoid congestion and delays. In addition, revenue generated – in excess of revenue intended for debt service, reasonable rate of return on private financing, and operations and maintenance costs – may be used for any other highway or transit project, carried out under Title 23 or 49 of the U.S. code anywhere in the State.

7.2 Technology and Deployment

Construction

This concept will require lane separation between the new tolled express lanes and the general purpose or free lanes. The only existing express toll lane is in operation in Orange County, California, and that has two lanes in each direction over about 10 miles, with only one entrance/exit at either end. Some recent HOT Lane projects that are in operation have multiple on and off opportunities, which complicates the toll collection and enforcement process.

The potential projects in Connecticut, I-84 and I-95, both have frequent on and off ramps, so there is a need to balance opportunities for drivers to enter and exit the express lanes with the traffic flow and safety concerns of access/egress that is too frequent. Existing HOT lane operations in similar environments have used defined striped entrance and exit points to the toll lanes, or else batons placed at intervals[25] to achieve separation between the express lane and the general-purpose lane.

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[25] FHWA's Manual on Uniform Traffic Control Devices suggests that the spacing in feet between channelizing traffic separators be no greater than the 1.0 times the speed of traffic in mph. (e.g. 60' for traffic traveling at 60 mph.) However to prevent weaving in and out of the Express lanes, other agencies have had to use spacing as short as 10 feet.

Toll Collection Concept

In order to ensure that all traffic in the express lane pays a toll, it is desirable to minimize the number of entry and exit points. Many existing toll lane operations have toll collection points in between on- and off-zones in an open tolling arrangement. But depending on the configuration of the highway, it may be more cost-effective to put toll gantries over individual on- and off-zones (closed tolling). Any cost difference between each approach would be driven by the number and type of gantries required (as discussed on page 3-22), and would require more detailed study.

Tolls would be assessed based on the distance traveled, so the toll system will need to keep track of a vehicle through one or more toll zones, and then calculate the entire toll for the trip based on how many zones were used.

Technology and Roadside Components

This concept requires accurate identification of the vehicle lane of travel to ensure that users in the toll lanes are charged and in non-tolled lanes are not charged. Both video and transponder-based tolling are well proven in this area and are applicable to this concept. Express-lane deployments to date have all required users to have transponders, and all others were considered violators. This helps to minimize operational cost and simplifies back office operations. A more extensive long-distance system such as that envisioned on I-84 and I-95, might want to allow the opportunity for video toll collection, but this would require careful consideration.

If this concept utilizes dynamic pricing, deployment of toll rate signing using DMS in advance of each express-lane entrance will be required. A toll collection gantry will need to be installed on each express-lane segment. The complexity of the equipment will be somewhat driven by the vehicle types that are permitted to use the lane. If trucks are excluded, a single span gantry housing only rear viewing cameras could be utilized. Otherwise, two gantries would need to be installed at each toll point to mount the front and rear facing video cameras required for tractor-trailers with differing plates.

Payment Types

All existing express-lane deployments require prepaid accounts with transponders. However, the requirement to have a transponder would be a barrier to occasional use except where the existing traffic has a high penetration of transponders that were obtained for use on other toll facilities (such as E-ZPass). Offering one-off payments may prove complex for some customers to understand (e.g., they would need to keep track of how many sections they traveled in order to calculate the correct toll), and also would introduce some complexity for the program which would need to receive, store and reconcile users' declarations against vehicle sightings.

Toll Policy

All existing express-lane deployments have used some form of variable tolling. SR 91 in Orange County, California uses a time-based published toll schedule, as does I-25 in Denver. Others use dynamic tolling. The point of variable tolling is to achieve reliable, free flow travel in the tolled lanes, providing value to the customer as a result. It is likely that an express-lane implementation on I-84 or I-95 in Connecticut would want to follow a similar policy, and we have assumed this in our quantitative analysis.

Most existing express-lane deployments exclude trucks.[26] This provides a more reliable traffic flow and does not result in additional truck movements into the far-left lane where express lanes are usually located. This also simplifies the requirements for express-lane vehicle classification and detection technology.

Toll Program Operation

The back office effort to support limited express lanes will be relatively modest commensurate with the potential number of users and transactions that would be generated. Given that use of the facilities will be optional, there is not a compelling need to provide extensive walk-in customer service to obtain transponders other than that which provides cost-effective distribution of the devices.

Interoperable Programs

Given Connecticut's proximity to the E-ZPass network, customer benefit, and program cost savings would arise from adopting system interoperability with the E-ZPass network.

■ 7.3 Potential PPP Approaches

Newly built express toll lanes have some potential for delivery through a variety of PPP approaches. Given the lack of an established toll road operating expertise within Connecticut state government, an approach that assigns project delivery and operations responsibility to the private sector, like a DBOM, would be effective. Compensation to the private sector could use an approach called an availability payment, whereby payments are made when the private sector maintains the road open to traffic based on certain performance standards.

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[26] The I-394 HOT lanes in Minneapolis allow trucks with a gross vehicle weight of under 26,000 pounds.

If the anticipated net revenue stream for the project is positive, the State also may consider delegating some or all of the financial responsibility for the project to the private sector as well, like using a mechanism such as DBFO. The State could estimate the extent to which state-issued revenue bond debt through the State Bond Commission could support the project, as one element of generating a public sector comparator value for the project to use in evaluating PPP proposals for express-lane projects. The selection criteria could include, in addition to qualitative measures of competence and reliability, lowest public funding required and/or highest project revenue sharing amount proposed. This also presumes Federal waivers are granted for tolling new capacity on Interstate highways.

■ 7.4 Privacy

Registered users will be required to disclose identity and financial information in order to register accounts. One-off users will be required to disclose their license plate, and possibly their credit/debit card details (if they chose to pay using this method). Because this concept only tolls a limited number of lanes, drivers have a choice of using tolled or non-tolled lanes and hence whether they disclose any personal information to the facility. Users that do choose to use the tolled lane will be disclosing route journey information.

■ 7.5 Technical Analysis of Project A-1 – Express Toll Lanes: I-95 – Branford to Rhode Island

Transportation Impacts

The 1999 study of I-95 between Branford and the Rhode Island line found that the most severe congestion occurs on Friday through Sunday in the summer months. Traffic along this corridor is a combination of commuter traffic and recreational traffic heading to and from attractions in the southeast region of Connecticut and in adjacent areas of Rhode Island and on Cape Cod. These attractions include Hammonasset State Beach, Mystic Marine Life Aquarium, Mystic Seaport, Rocky Neck State Park, Harkness Memorial, Mohegan Sun Casino, Foxwoods Resort Casino, Rhode Island beaches and Cape Cod.

The 2004 study[27] included an analysis of tolling the proposed additional lane capacity. The analysis considered only the Friday summer traffic conditions and concluded that even under the most congested conditions experienced in the corridor that a tolled express

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[27] Feasibility Study I-95 Corridor Branford to Rhode Island. July 2004. Feasibility of Managed ('Value-Priced') Lanes. Prepared for Clough, Harbour & Associates. Prepared by Parsons.

lane parallel to the existing two general purpose lanes would not provide enough revenue to pay for the capital and operating cost of the project.

Average daily traffic (ADT) estimates for years 2000 and 2025 between each interchange from Branford to the Rhode Island border were taken from the 2004 study report. PM peak-hour traffic for 2002 and 2025 representing summer Friday travel also were provided within the 2004 study report. The 2004 report based the assessment of I-95 on peak summer Friday traffic conditions and travel times.

The attractiveness of a tolled express lane is dependent upon there being congestion in the non-tolled parallel general purpose lanes. Congestion in the general purpose lanes is a result of too much demand relative to capacity, and/or operational deficiencies such as bottlenecks and access/egress friction at interchanges. Since congestion can vary significantly throughout the day and in these cases by season of the year, we estimated a 24-hour distribution of demand in each direction along the I-95 corridor.

Hourly distribution data was summarized from hourly count data collected along I-95 through Connecticut's traffic management center and from available hourly counts in ConnDOT's traffic count locator program for both corridors. Hourly demand profiles were estimated for an average weekday, an average Friday, a summer Friday (for I-95), and an average weekend day. For I-95, year 2015 traffic volume was estimated through interpolation between year 2000 and 2025, while year 2030 traffic was developed by extrapolating from year 2025 traffic.

Future travel demand exceeding the available capacity of the two free lanes was assumed to be captured by the express toll lane. The toll rate assumed to be in place for the express lanes was determined by calculating the time savings benefit of the express lane compared to the general purpose lanes and multiplying by the average value of time. VMT, VHT, average speed, toll transactions, and toll revenue were estimated for 2015 and 2030. These measures were compared against the No Build condition to demonstrate the effectiveness of this tolled express lane scenario.

Operational impacts and annual revenue were estimated for years 2015 and 2030. A 30-year revenue stream was prepared by interpolating between the 2015 and 2030 forecasts and by applying a nominal growth factor through 2044. This revenue stream was then used in the financial analysis.

In our analysis of this concept, we developed estimates of operating conditions in the general purpose lanes and the express lane for No Build (two general purpose lanes in each direction) and Build conditions (two general purpose lanes and one express toll lane in each direction). We would expect the highest usage of the express lane in their early years of operation to occur on Fridays during the summer season followed by Fridays in general. Because of lack of congestion, we would not expect many people to choose to pay a toll in the express lanes on other weekdays and weekend days during the early years of operation.

When averaged over the entire year in the assumed first year of operation (2015), we estimate that the overall average speed of the corridor would increase by about 0.5 miles per hour over an average day (see Table 7.1) resulting in vehicle hours of delay being reduced by 6.2 percent. The higher change in delay reflects the fact that the baseline estimate of delay is relatively low, because it is only expected on summer Fridays and that considerable improvement during that period is expected from the express lanes. For summer Fridays, improvement in average speed compared to the entire day was estimated to be about 3 miles per hour. This benefit would be significantly higher than this during the p.m. peak period when summer Friday traffic is highest. Because the express lanes are estimated to be used minimally during other times of the day, the overall daily benefit of the express lane would be small.

By 2030, estimated traffic volumes will reach levels in the corridor that will make the express lane attractive to users during additional hours of the day resulting in an improvement in speeds between the Build and No Build conditions of about four miles per hour on an average daily basis.

Table 7.1 Forecast Traffic Operational Impacts – 2015 Levels
Project A-1: Express Toll Lanes – I-95 – Branford to Rhode Island

	Vehicle Miles Traveled (VMT)	Vehicle Hours Traveled (VHT)	Average Speed	Vehicle Hours of Delay
No Build	4,809,600	84,500	56.9	10,490
Build	4,809,600	83,800	57.4	9,840
Percent Impact	-	-0.8 %	0.9 %	-6.2 %

Transit Impacts

CTTransit's New Haven Division operates local and interregional fixed route bus service along this corridor. To the east of New Haven, one local bus route is operated parallel to the corridor into Branford. Estuary Transit District (ETD) also operates local shuttle service along the corridor from Madison to Old Saybrook. The S-Route, operated by DATTCO for CTTransit, is an interregional route that operates along Route 1, parallel to I-95, from New Haven to Old Saybrook.

The Southeast Area Transit Authority (SEAT) provides corridor bus service along I-95 from New London to North Stonington. SEAT also provides local service along the corridor from East Lyme to North Stonington.

While Metro-North Railroad commuter service terminates at New Haven, the Shoreline East commuter rail service is available in the I-95 corridor from New Haven east to New London. Longer distance trips would be accommodated by Amtrak.

In general, transit capacity in this region could accommodate trips diverted from automobiles, both for short local trips as well as long intercity trips from New London to New Haven, or municipalities in between. Depending on trip origins and destinations, some of these trips could be easily provided by bus transit or by Shoreline East trains. Train station parking lots along the Shoreline East would be likely to serve as park-and-ride lots, as would several lots along I-95.

As this tolling option focuses on the construction of new lanes and tolling only the added capacity, there would not be any significant negative impact on the existing traffic lanes. Thus, while transit may prove attractive to riders – particularly if it benefits from new revenue streams via tolling – there is no reason to expect significant auto to transit diversion. To the contrary, the extra capacity could be expected to encourage some travelers to move from transit to highway.

Toll Revenue Estimates

The express lanes would not be expected to attract much traffic in 2015, except on summer Fridays. As a result, we forecast that annual toll revenue in 2015 would be less than $1 million per year (Table 7.2.). However, by 2030, we would expect congestion levels and, therefore, use of the express lanes to increase significantly, to about $5.7 million per year.[28] The significant increase in revenue from 2015 through 2030 is typical with express lane projects that rely on congestion levels in the non-tolled capacity.

Table 7.2 Annual Toll Revenue: 2015 and 2030
Project A-1 – Express Toll Lanes: I-95 – Branford to Rhode Island

Year	Annual Toll Revenue (2008 Dollars)
2015	$631,000
2030	$5,740,000

[28] State of Connecticut Department of Transportation. 2007 Traffic Volumes State-Maintained Highway Network (Traffic Log). Prepared by Division of Systems Information, Bureau of Policy and Planning. In cooperation with U.S. Department of Transportation – Federal Highway Administration.

Implementation Requirements

The two projects in this concept (I-95 and I-84) respectively cover over 57 and 32 miles of roadway and aim to provide a reliable level of service to travelers opting to use the express lanes. For this level of analysis, it has been assumed that entrance and exit points will correspond to the existing freeway entrance and exits and that all travelers using the express lanes will be charged. This will require about 62 and 34 tolling points respectively to cover both directions of traffic. However, each tolling point only needs to cover a single lane of traffic.

Express lanes are normally limited to passenger vehicles and so this project would not require deployment of extensive classification equipment to determine vehicle class for differential tolls. However, to optimize use of express lanes, dynamic pricing would be used requiring deployment of an extensive traffic sensor network, CCTV cameras for viewing vehicle flow and dynamic message signs to communicate the current toll rate. Since there will be a requirement to clear incidents quickly, this concept would require deployment of additional roadside assistance trucks and personnel. Since equipment will be distributed along the length of this roadway, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The back-office needs for this project are modest due to the relatively small number of transactions and, therefore, the low number of accounts required even for the combination of both projects. We anticipate that all users will be required to have tags which cuts down on the level of video processing required but slightly increases the number of accounts anticipated. Given these limitations, the back-office would be of minimal size and, for most years, the pricing uses a minimum annual cost for running such an operation rather than a per account charge. Given the low volume of accounts and that use of the tolled facility is optional, this concept does not require a large number of walk-ins and the number of accounts does not justify provision of this service until late in the deployment of the projects. Due to the length of the facilities and hence the region covered, a fairly large number of retail channels are anticipated to support account payment through partnership with one or more store chains.

Toll Collection Costs

Table 7.3 identifies the total costs to implement and operate the new toll express lanes projects over 30 years for the individual and combined projects.

Table 7.3 Life-Cycle Toll Collection Costs (Millions)
Concept A – Express Toll Lanes

Scenario	Total Capital Cost	Total O&M Cost	Total
Project A-1: I-95 – Branford to Rhode Island	$195.7	$192.3	**$388.0**
Project A-2: I-84 – Waterbury to New York State Line Branford	$113.7	$133.2	**$246.8**
All Projects Combined, A-1 and A-2	$306.4	$280.9	**$587.3**

The capital cost for these projects is driven by the number of tolling points that need to be installed to toll every segment of the proposed express lanes. Less than 10 percent of the capital is to cover tag purchases over the 30 years. As stated above, for these projects the backoffice operating costs are mostly calculated using the minimum cost to run a dedicated backoffice to process the transactions, contributing about 20 percent of the O&M costs. The ongoing operations costs are also dominated by the toll equipment maintenance costs, which make up about 40 percent of the ongoing costs. Roadside service and law enforcement costs are estimated at about 20 percent of the O&M costs.

Implementation Strategy

At a high level, the tasks required to implement a tolling system in Connecticut are the same for most concepts. These tasks are described below, and while many are sequential, an absolute order should not be implied from this list as some could proceed concurrently:

- **Further Studies and Consensus Building** – Several further studies will need to be undertaken in order to fully understand potential system design, the traffic implications, cost/benefit factors, and any environmental impacts that may arise. If these studies reveal any contentious aspects (such as impact on protected land, or the need for Federal review), significant delay can be introduced while these issues are resolved. Taking direction from (and providing input to) these studies will be consensus building activities, which will engage elected officials, stakeholder groups and members of the public to foster support for the proposed toll system.

- **Studies Sufficient for Funding** – In order to secure funding, it is likely that several investment-grade studies will need to take place. These studies may include traffic and revenue, detailed design and business case analyses. The outcome of these studies will often inform any final funding decisions from the legislature.

- **Legislation and Funding –** Development and implementation of legislative requirements necessary to support the program will be required, including drafting, reviewing and enacting any new or changing legislation, and securing appropriate program funding. To minimize risk, it may be preferable to ensure that all necessary legislation and funding is in place before any further tasks are started, especially those involving commercial negotiations such as procurement tasks. It may require multiple legislature rounds to obtain the legislation and funding necessary to allow procurement to commence, such as the need for a further "gap funding" round.[29]

- **Assemble Program Staff –** This task secures the staff necessary to deliver the program whether they are existing state agency staff, staff for a new toll agency or private concessionaire management staff or a combination of these. This task is likely to include the procurement of consultant support to that team. Typically, this team will need to be operational before supplier procurement can commence.

- **Procurement –** Procuring goods and services will be required to implement the program. Procurement includes the requirement development, the dialogue with potential bidders, and the contractual negotiations with the chosen supplier. The procurement can either be run as a single bid to contract a sole supplier (who then is responsible for procuring and managing any subsequent subcontractors needed to deliver the program), or as multiple bids to separately contract each supplier required to deliver the program.

- **Design –** This task will include designs for highway construction, roadside equipment installation, and back-office system implementation, with these three design activities often occurring in parallel to allow subsequent build activities to start as soon as possible.

- **Build –** This task uses the design documents to physically construct the tolling system. This task will include highway construction, roadside equipment installation, and backoffice system implementation. Public relations and marketing activities will be particularly important during this phase as construction becomes visible.

- **Test –** This task tests the system prior to "go live," with most testing being conducted in parallel to the final stages of the build phase, although an end-to-end system test would be performed once all equipment is in place.

- **Distribute Tags –** Prior to go-live the program will need to distribute tags to those customers wishing to use E-ZPass or similar system to pay their tolls. Not all tags need to be distributed before go-live, and this task will be an ongoing effort with tag distribution activity extending past the go-live date. However, the program may wish to make tags available to customers up to six months before go-live, perhaps offering 'early bird' discounts to encourage sign-up. This distribution is likely to be

[29] "Gap funding" is the money required to cover any shortfall between anticipated revenues from tolls levied on planned toll systems and the amount of money the agency will need to pay off the bonds issued to build the system.

accompanied by a significant marketing effort to ensure electronic toll volume targets are met.

- **Go-Live –** Depending on requirements and constraints, the program may opt for a 'big-bang' approach, or adopt a phased delivery (where tolling is introduced on certain sections of the road over time, rather than all at once). Adopting a phased approach reduces delivery risk, but might introduce challenges to the equity of the system if certain user groups or state residents are impacted before others. Since this concept involves building, and then tolling new capacity, the equity concern should not be an issue here.

Implementation Durations

Typically, the duration of any study (including those sufficient for funding,) legislative and funding steps are affected by the complexity of the proposed system, the extent of Federal involvement, and any political, stakeholder, or geographic conditions specific to the proposed system. Given that Project A-1 includes construction of new lanes on a Federal highway, and that its funding mechanism could be through a Federal program (the Express Lanes Demonstration Program), there is a risk that these tasks could be extended while Federal review takes place. Drivers using this roadway are not forced to pay the toll (they can choose a non-tolled lane), so consensus building should have fewer delays than otherwise might be expected if the toll were unavoidable. Clearly, a wide range of factors could impact these initial tasks, and hence their duration could vary from one year to more than 10 years, although a reasonable estimate for planning purposes is three years. It also is likely that parts of these initial tasks can be conducted in parallel, although careful management would be required to reduce the risk of dependencies introducing delay (for example, certain study outputs may be required for legislative or funding approval).

Once legislation and funding has been achieved, the duration of the subsequent tasks is driven by the complexity of requirements and the geographical coverage of the system. Given that Project A-1 involves an express lane with relatively simple rules governing who is charged, a less risky (and hence potentially shorter) procurement and design phase could be anticipated.

The duration of the design and build phases will reflect this. Industry estimates suggest two tolling points can be constructed per month for a project of this nature, which results in a roadside construction duration of approximately 30 months.

It should be noted that this project requires the construction of new pavement, built next to in-use lanes of traffic; this type of highway build typically has greater safety requirements than green field construction, and so the duration of this component is likely to dominate the build task.

Given industry experiences, this suggests the following durations (see Table 7.4 below).

Table 7.4 Illustrative Implementation Durations
Concept A-1 - Express Toll Lanes

Task	Duration (Months)
Further Studies and Consensus Building	36 months
Studies Sufficient for Funding	18 months
Legislation and Funding	36 months
Assemble Program Staff	9 months
Procurement	18 months
Design	9 months
Build – Highway	84 months
Build – Roadside Equipment	30 months
Build – Back-Office	9 months
Test	3 months
Distribute Tags	6 months
Go-Live	0

Implementation Schedule

There are several ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability.

One such arrangement is detailed in the Gantt chart in Figure 7.2; this format allows key dependencies to be highlighted and the critical path[30] to be identified (in red).

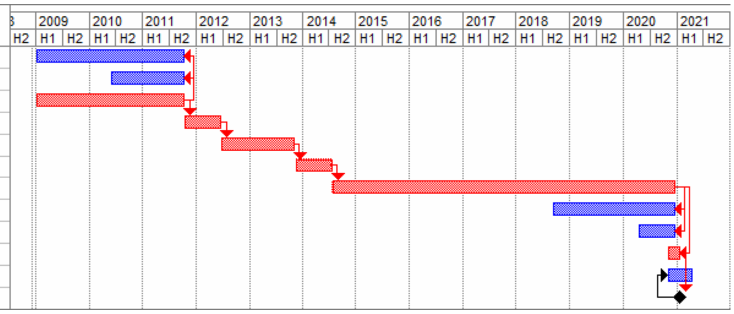
Environmental

Alternative A-1 would cross the State from south to north on Interstate 95, traversing a diverse range of urban, suburban, and rural landscapes. This alternative is expected to have no significant adverse impacts on the environment. There will be no diversion of traffic to local roads and there will be minimal change to traffic flow patterns on the affected highways.

[30] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

Figure 7.2 Illustrative Implementation Schedule
Concept A – Express Toll Lanes

ID	Task Name	Duration	Predecessors
1	Further studies and consensus building	36 mons	3FF
2	Studies sufficient for funding	18 mons	3FF
3	Legislation and funding	36 mons	
4	Assemble program staff	9 mons	3
5	Procurement	18 mons	4
6	Design	9 mons	5
7	Build - highway	84 mons	6
8	Build - roadside equipment	30 mons	7FF
9	Build - back office	9 mons	7FF
10	Test	3 mons	7FF+1 mon
11	Distribute tags	6 mons	12SS-3 mons
12	Go-live	0 mons	10



Alternative A-1 is expected to have a beneficial effect in terms of the following criteria (see Table 7.5 and Figure 7.3):

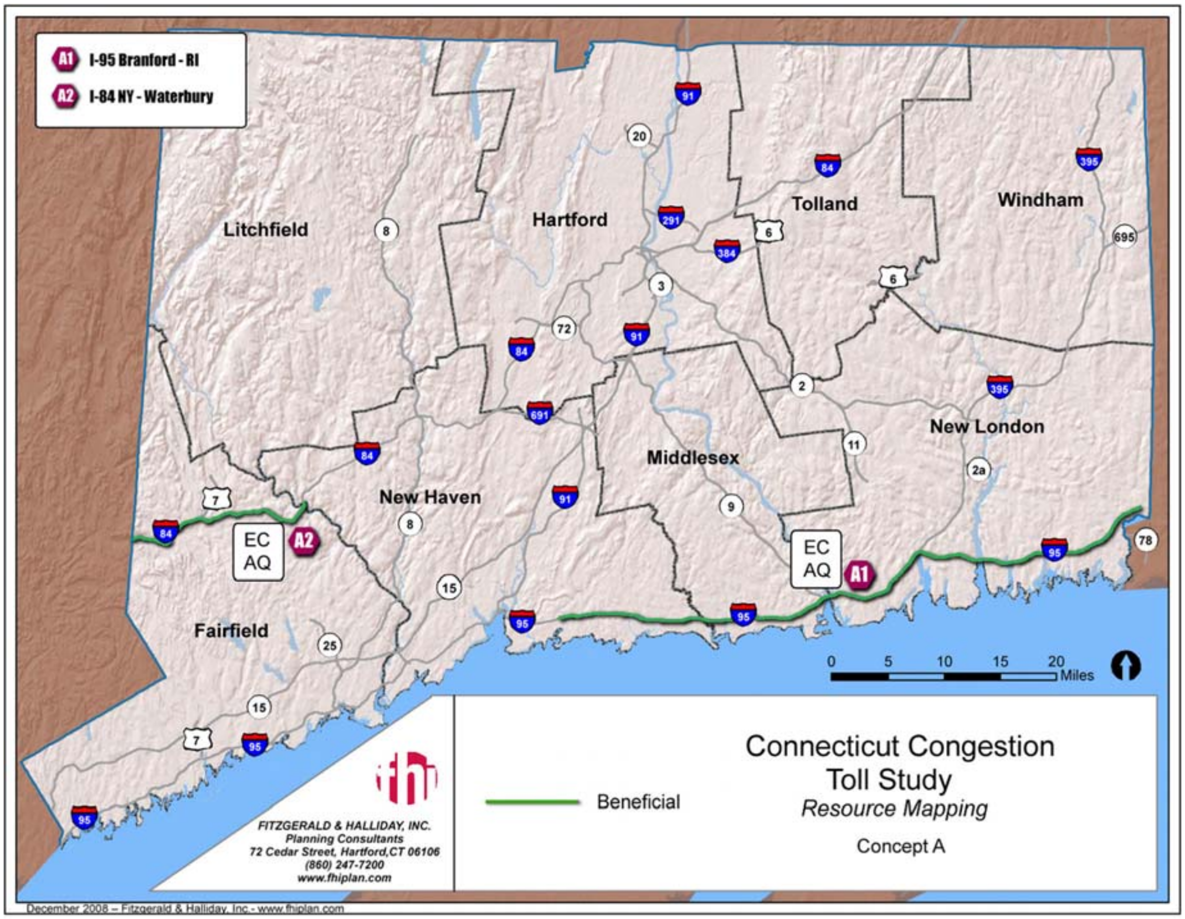
- **Air Quality –** While vehicle miles of travel remains constant among the alternatives, vehicle hours of travel and vehicle hours of delay both decrease with Alternative A-1. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions.

- **Energy Use and Conservation –** Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be expected to be consumed due to fewer vehicles sitting in traffic, yet speeds will not increase to a degree that would result in an overall drop in miles per gallon achieved.

Table 7.5 Environmental Impact Summary
Project A-1 – Express Toll Lanes: I-95 – Branford to Rhode Island

		Impact Description	
Resource	**Potential Impact**	**Magnitude**	**Location(s)**
Natural			
Water Quality (WQ)	No		
Air Quality (AQ)	Yes	Beneficial	A1 – I-95 Corridor
Social/Community			
Community Disruption (CD)	No		
Bicycle and Pedestrian (BP)	No		
Noise (NS)	No		
Energy Use/Conservation (EC)	Yes	Beneficial	A1 – I-95 Corridor
Environmental Justice (EJ)	No		
Cultural/Historic (CH)	No		

Figure 7.3 Environmental Impact Locations
Project A-1 – Express Toll Lanes: I-95 – Branford to Rhode Island



Economics

This project involves building a new express toll lane adjacent to existing toll-free lanes. This means that no one that currently is driving for free will be made worse off, and those that choose to pay the toll will do so because they believe that the value of travel time or reliability savings is higher than the cost of the toll.

If the project were to be funded entirely from toll revenue, there should be no significant negative economic impacts. The project would improve conditions both for those that choose to pay the toll and those that do not. However, as noted in the financial evaluation, this project could not come close to paying for itself with toll revenue. If the project were to move forward, the non-toll money used to finance the project would be diverted from other potential improvements in Connecticut. In this case, it would be important to understand the relative value of spending dollars on this project compared to other potential uses of funds.

Equity

All travelers would still have the option to use the untolled highway lanes, which should be no worse off than before implementation of the tolled lanes. If the project were to be fully funded by toll revenue, there should be no significant equity issues. However, the financial analysis shows that the toll lanes would need to be significantly supported by other revenue sources. These revenue sources might be used to fund projects that may have benefit to travelers in other parts of the State or in different income categories, which could impact the equity considerations for this project.

Safety

Typical safety and operational issues associated with electronic open-road tolling of new express lanes on a highway include:

- ***Speed differentials*** between the express lane and the general purpose lanes that may cause problems for traffic changing from one lane to the other. Usually, these are buffer-separated facilities with designated entrances and exits to and from the express lane. Vehicles entering and exiting the express toll lanes at locations other than those designated for such movements may cause potential conflicts with vehicles in the adjacent travel lane(s). The design of the new toll lanes should be such that vehicles cannot cross in and out except at designated locations.

- ***Weaving*** through the general purpose lanes to reach the entrance location to the express lanes can be a safety issue. Signage informing motorists of "Next Express Lane Entrance" and similar systems would help to reduce last-minute or sudden weaving.

- Issues related to the ***starting and ending points of the express*** lanes must be handled in the design process.

7.6 Technical Analysis of Project A-2 – Express Toll Lanes: I-84 – Waterbury to New York State Line

Transportation Impacts

In the 2001 study of I-84, ConnDOT and the Council of Governments of Central Naugatuck Valley identified peak-hour traffic congestion and safety deficiencies as the major issues along Interstate 84 between the Housatonic River in Southbury and Interchange 23 in Waterbury. Average daily traffic (ADT) estimates for year 2015 between each interchange from Waterbury to the New York state line were estimated by utilizing

ConnDOT's 2007 traffic log report and interpolating between the 2006 and forecast 2030 traffic estimates provided in that report.

The methodology for estimating traffic and revenue under tolled conditions for the proposed express lane was the same as for I-95 (Project A-1). Year 2030 data was forecast directly for I-84 in the previous studies.

Estimates of operating conditions in the general purpose lanes and the express lanes were summarized for No Build (two general purpose lanes in each direction) and Build conditions (two general purpose lanes and one express toll lane in each direction). Table 7.6 provides a summary of the overall corridor impacts for 2015. We estimate that most of the usage of the express lane would occur on Fridays during the early years of operation. We do not expect average weekday and weekend day traffic volumes to reach levels that would significantly contribute to traffic and revenue in the express lane. The overall average speed of the corridor is estimated to increase by about 1.3 miles per hour over an average day. However, vehicle hours of delay is estimated to be reduced by 13.8 percent on average, reflecting the usage and benefit of the express lane during the peak congested time periods. By 2030, estimated traffic volumes are forecast to reach levels in the corridor that will make the express lanes attractive to users during additional hours of the day resulting in an improvement in speeds between the Build and No Build conditions of about five miles per hour on a daily basis.

Table 7.6 Operational Impacts – 2015 Levels
Project A-2 – Express Toll Lanes: I-84 – Waterbury to New York State Line

	VMT	VHT	Average Speed	Vehicle Hours of Delay
No Build	2,763,900	50,900	54.3	8,342
Build	2,763,900	49,700	55.6	7,194
Percent Impact	-	-2.4 %	2.4 %	-13.8 %

Transit Impacts

Contiguous transit services are limited throughout the I-84 corridor between Waterbury and the New York state line; therefore, any diversions to transit that are not within selected local communities with bus service would need to be accommodated by new express buses. However, given that the express lanes will improve traffic operations in the corridor and paying a toll to use them will be voluntary, no significant mode shift from auto to transit should be expected.

A strong network of local bus service does exist in Waterbury, as it does in Danbury and surrounding communities such as Bethel, Brookfield, and New Milford, each of which supports the Danbury transit market. In between, local transit availability is limited or nonexistent in Newtown, Southbury, and Middlebury.

Local bus service in Danbury is operated by Housatonic Area Regional Transit (HART). Service in Waterbury is operated by North East Transportation Company (NET) for CTTransit. Both Danbury and Waterbury are served in the north-south direction (not along the I-84 corridor) by Metro North Railroad (MNRR) branch lines.

Therefore, short trips diverted from I-84 could be accommodated by transit in Danbury or Waterbury and their immediate environs, but longer, regional trips would be more difficult to accommodate. Peter Pan operates limited commuter bus service between Danbury and Waterbury and between the two cities and New York City. Some NET local bus service runs parallel to Route 8 in Waterbury and Naugatuck; however, this corridor has limited transit resources.

The creation of new toll express lanes would not have a substantial impact on transit service itself on the I-84 corridor. However, revenues generated from these lanes could support increased regional transit connections. Commuter service on I-84 proper would benefit from express lanes and improved travel flow, connecting Danbury and Waterbury as well as offering opportunities to tie into network connections to Hartford and New Haven. Local bus services could benefit from funding increases with more frequent services and better feeder/distributor routes connected to regional services.

Toll Revenue Estimates

The I-84 express lane is estimated to generate $1.1 million and $5.5 million in toll revenue for 2015 and 2030, respectively (Table 7.7). It is estimated that in 2015, the express lanes would be significantly underutilized except during Fridays. However by 2030, utilization is estimated to increase significantly. The significant increase in revenue from 2015 through 2030 is typical with express lane projects that rely on the eventual demand saturation of the non-tolled capacity.

Table 7.7 Estimated Annual Toll Revenue in 2015
Project A-2 - Express Toll Lanes: I-84 – Waterbury to New York State Line

Year	Annual Toll Revenue (2008 Dollars)
2015	$1,143,000
2030	$5,549,000

Implementation Requirements

Implementation requirements for Project A-2 are discussed under Project A-1

Implementation Strategy

The tasks are identical to Project A-1, but there is approximately half as much express lane to be built and half as many tolling points for this project, so it is reasonable to expect the design and build durations to be reduced accordingly (although perhaps not by 50 percent – there are certain minimum times to run a design and build project regardless of size).

Implementation Schedule

Similar in nature in Project A-1, with the exceptions mentioned above.

Environmental

Alternative A-2 would cross the State from south to north on Interstate 84, traversing a diverse range of urban, suburban, and rural landscapes. Alternative A-2 is expected to have no significant adverse impacts on the environment. There will be no diversion of traffic to local roads and there will be minimal change to traffic flow patterns on the affected highways.

Alternative A-2 is expected to have a beneficial effect in terms of the following criteria (see Table 7.8 and Figure 7.4):

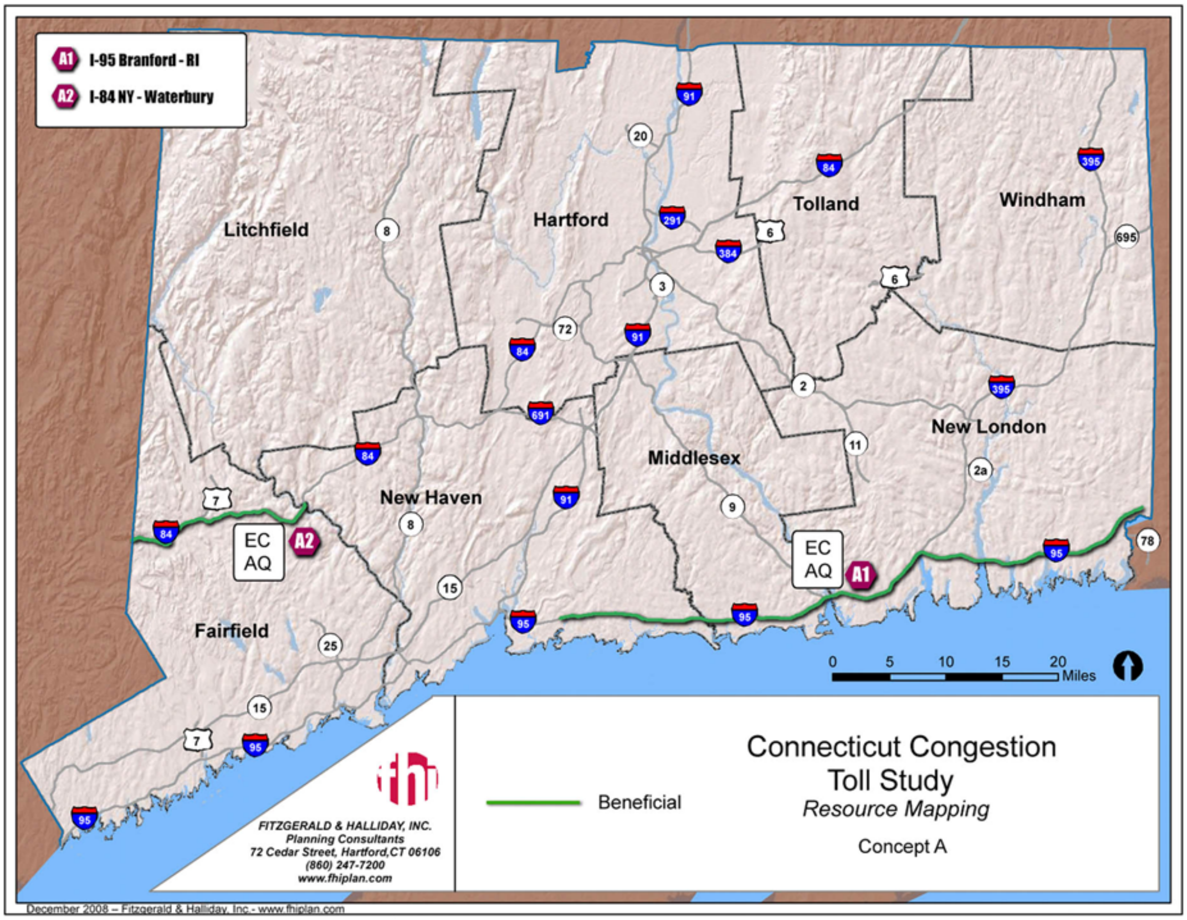
- **Air Quality –** While vehicle miles of travel remains constant among the alternatives, vehicle hours of travel, and vehicle hours of delay will both decrease with Alternative A-2. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions.

- **Energy Use and Conservation –** Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be expected to be consumed due to fewer vehicles sitting in traffic, yet speeds will not increase to a degree that would result in an overall drop in miles per gallon achieved.

Table 7.8 Environmental Impact Summary
Project A-2 – Express Toll Lanes: I-84 – Waterbury to New York State Line

		Impact Description	
Resource	**Potential Impact**	**Magnitude**	**Location(s)**
Natural			
Water Quality (WQ)	No		
Air Quality (AQ)	Yes	Beneficial	A2 – I-84 Corridor
Social/Community			
Community Disruption (CD)	No		
Bicycle and Pedestrian (BP)	No		
Noise (NS)	No		
Energy Use/Conservation (EC)	Yes	Beneficial	A2 – I-84 Corridor
Environmental Justice (EJ)	No		
Cultural/Historic (CH)	No		

Figure 7.4 Environmental Impact Locations
Project A-2 – Express Toll Lanes: I-84 – Waterbury to New York State Line



Economics

The economics consequences of Project A-2 are the same as for Project A-1.

Equity

The equity consequences of Project A-2 are the same as for Project A-1.

Safety

The safety issues associated with this project are identical to those reported for Project A-1.

7.7 Technical Analysis of Project A-3 – All Projects Combined, A-1 and A-2

Toll Revenue Estimates

Annual revenue estimates for the I-95 and I-84 corridors were added together, reflecting the potential implementation of both projects (Table 7.9.). All revenue is assumed to be in year 2008 dollars. The two projects would generate almost $1.8 million in revenue in 2015 and over $11 million in 2030.

Table 7.9 Annual Toll Revenue: 2015 and 2030
Projects A-1 and A-2 Combined

Year	Annual Toll Revenue (2008 Dollars)
2015	$1,774,000
2030	$11,289,000

Implementation Requirements

Combined implementation requirements are the same as for each project individually.

Implementation Strategy

Similar in nature to Project A-1, except that implementing both projects in this concept concurrently may increase the duration of the further studies, design and build time due to greater geographical coverage, length of expressway that must be constructed, and the larger number of tolling points required. To some extent, this greater duration can be mitigated through the addition of project resources to carry out tasks in parallel (such as those installing the roadside equipment and constructing the express lane); however, this may carry with it a higher cost and a larger project will still require a somewhat longer duration.

Implementation Schedule

Similar in nature in Project A-1, with the exceptions described above.

Given that this project implements three separate stretches of contiguous tolled road, adopting a phased delivery approach, potentially with one tolled road delivered at a time, would help to reduce the technical risks normally associated with large deliveries. Risk would be reduced because individual tolled roads carry fewer vehicles than the whole project, thus the population of users is reduced. It also would allow deployment lessons to be learned from phase to phase.

Environmental

The environmental issues are identical to those reported on for projects A-1 and A-2.

Economics

The economic issues are identical to those reported on for projects A-1 and A-2.

Equity

The equity issues are identical to those reported on for projects A-1 and A-2.

Safety

The safety issues are identical to those report for projects A-1 and A-2.

7.8 Financial Analysis of Concept A – New Toll Express Lanes

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 with a shortfall of $94.0 million on I-95 and $34.7 million on I-84 (Table 7.10). When the initial capital cost of toll collection is added in, that shortfall grows further, and when accounting for the cost of the highway widening itself, a shortfall of over $1.5 billion is expected for I-95, and almost $0.5 billion for I-84.

Table 7.10 Financial Analysis of Concept A – New Toll Express Lanes

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	(94.0)	(34.7)
Initial Capital Cost of Toll Collection System	90.2	59.6
Total Highway Construction Costs	1,366.1	371.0
Life-Cycle Surplus/(Shortfall)	**(1,550.3)**	**(465.4)**

Table 7.11 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for Project A-1. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system and highway widening. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Positive net revenues for Project A-1 are not generated until after 2030. Significant toll collection capital costs are projected every eight years for Project A-1 for major toll collection infrastructure replacement. One such replacement cycles falls in 2030 and it is reflected in the recurring capital costs for that year.

Table 7.11 Annual Toll Revenue and Expense Estimates
Concept A-1 – I-95 Express Toll Lanes
(Millions of Year-of-Expenditure Dollars)

			Annual Costs			
Year	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$2.04	0.8	0.0	6.9	0.2	(6.3)
2020	$2.37	1.9	0.1	8.0	0.3	(6.5)
2025	$2.75	4.5	0.2	9.4	0.6	(5.7)
2030	$3.18	11.0	0.5	11.1	71.3	(72.0)
2035	$3.69	18.7	0.9	13.1	0.7	4.0
2040	$4.28	31.9	1.6	17.5	0.6	12.3

Table 7.12 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for Project A-2. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system and highway widening. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Positive net revenues for Project A-2 are not generated until after 2030. Significant toll collection capital costs are projected every eight years for Project A-2 for major toll collection infrastructure replacement. One such replacement cycles falls in 2030 and it is reflected in the recurring capital costs for that year.

Table 7.12 Annual Toll Revenue and Expense Estimates Concept A-2 – I-84 Express Toll Lanes
(Millions of Year-of-Expenditure Dollars)

			Annual Costs			
Year	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue (Millions, YOE)**
2015	$2.04	$1.4	$0.1	4.8	0.2	(3.7)
2020	$2.39	$2.8	$0.1	5.6	0.3	(3.3)
2025	$2.81	$5.4	$0.3	6.5	0.5	(1.9)
2030	$3.29	$10.6	$0.5	7.7	39.3	(36.9)
2035	$3.82	$15.7	$0.8	9.1	0.3	5.6
2040	$4.42	$23.3	$1.2	10.7	0.2	11.2

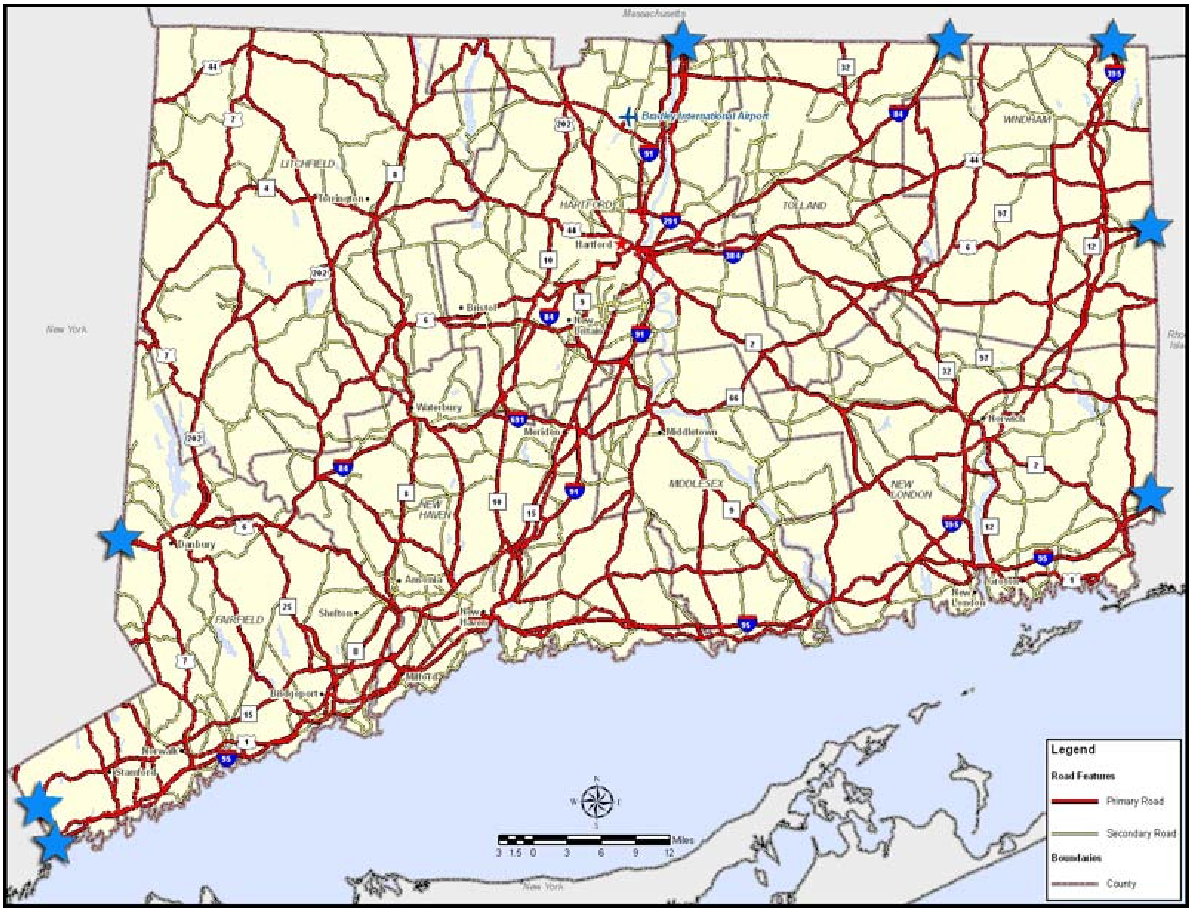
8.0 Concept B – Border Tolling at Major Highways

Overview and Project Description

The goal of the Border Tolling Concept is revenue generation, with the funds then potentially used to finance various transportation improvements, although not necessarily near these border crossings. This concept involves collecting tolls at the following limited-access crossings between Connecticut and its neighboring states as shown in Figure 8.1:

- I-95 – New York;
- I-95 – Rhode Island;
- I-84 – New York;
- I-84 – Massachusetts;
- Route 15 – New York;
- I-91 – Massachusetts;
- I-395 – Massachusetts; and
- Route 6 – Rhode Island.

Figure 8.1 Concept B – Border Tolling at Major Highways



All border locations were assumed to have the same toll, and the toll level would be constant all day. Three levels of toll were evaluated, as shown in Table 8.1:

Table 8.1 Toll Rates for Concept B – Border Tolling

Class	Level 1	Level 2	Level 3
Car	$1.00	$3.00	$5.00
Van	$1.50	$4.50	$7.50
Single-Unit Truck	$2.00	$6.00	$10.00
Tractor-Trailer Combination	$3.00	$9.00	$15.00

8.1 Institutional and Legal

Existing roads leading to borders with other states potentially could be tolled under the Interstate System Reconstruction and Rehabilitation Toll Pilot Program, which applies if and when the Interstate highways are in need of reconstruction or rehabilitation. However, it appears that all revenue collected under this program must be used for only debt service, reasonable return on investment of any private person financing the project, and any costs necessary for the improvement of and the proper operation and maintenance of the road being tolled, which may limit the potential use of revenue from this concept considerably.

Depending on how a border tolling program is structured, there may be issues with the U.S. Constitution's Interstate Commerce Clause. The commerce clause dictates that where the burden of a state regulation falls on interstate commerce in favor of local business and trade, the regulation is generally invalid. This has been the topic of discussion lately in both Massachusetts and Illinois where holders of an electronic transponder were given toll discounts. In both cases, state residents were either given a discount on the transponders or were exclusively allowed to purchase them.[31,32] While a full legal opinion on this concept may be warranted, for purposes of this report CS conducted a preliminary review of some recent case law which discusses the commerce clause questions border tolling might raise.

The commerce clause of the United States Constitution grants Congress the authority to "regulate Commerce... among the several states." U.S. Const. art. I, § 8, cl. 3. The clause contains both an affirmative grant of power and a "further, negative command, known as the dormant commerce clause... that prevents a State from... placing burdens on the flow of commerce across its borders that commerce wholly within those borders would not bear." Am. Trucking Ass'ns, Inc. v. Mich. Pub. Serv. Comm'n, 545 U.S. 429, 433, 125 S. Ct. 2419, 162 L. Ed. 2d 407 (2005).

A state law or policy violates the dormant commerce clause if it "clearly discriminates against interstate commerce in favor of intrastate commerce" or "if it imposes a burden on interstate commerce incommensurate with the local benefits secured." Grand River Enters. Six Nations. Ltd. v. Pryor, 425 F.3d 158, 168 (2d Circle 2005). The dormant commerce clause is designed to "prevent economic protectionism and retaliation between states and to allow markets to flourish across state borders, thus prohibiting 'laws that would excite... jealousies and retaliatory measures between the states.'" Ben Oehrleins & Sons & Daughters, Inc. v. Hennepin County, 115 F.3d 1372, 1382 (8th Circle 1997).

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31 Guilfoil, J., *Pike Sued for Fast Lane, E-Z Pass Toll Differences*, The Boston Globe, [http://www.boston.com/news/local/articles/2008/10/11/pike_sued_for_fast_lane_e_zpass_toll_differences/], 11 October 2008.

32 Associated Press. *Illinois tolls to double for some*, Milwaukee Journal Sentinel, [http://www.jsonline.com/story/index.aspx?id=263052], 30 September 2004.

Most of the recent case law CS reviewed on commerce clause challenges to tolling originated in Massachusetts, and specifically on tolling programs in Boston for the Big Dig. There were both Federal and state court decisions that upheld every tolling practice challenged as violative of the Commerce Clause – charging lower tolls for transponder users, charging lower tolls for some sister-transponder programs but not others, and charging much lower tolls for residents of some Boston areas.

The most recent case was Kelen v. Mass. Tpk. Auth., 22 Mass. L. Rep. 456 (Mass. Super. Ct. 2007). Two plaintiffs, one from Massachusetts and the other from out-of-state, each challenged the toll program that charged them $2.50 but Boston residents only about $.50 to use the same facilities. They raised equal protection claims, privileges and immunities claims, and commerce clause claims. They lost on all counts, on motions to dismiss. This means that taking every fact they pled as true, the court found they had no cause of action. However, in language which does not appear essential to its holding, the Kelen case specifically mentioned "borders," stating: "The plaintiffs fail to allege that the toll program has any impact at all on interstate commerce. The toll gates are not situated around the borders of Massachusetts, but instead are located in central locations in and around Boston. These tolls do not prevent any person access to the Commonwealth. Any burden on interstate commerce here is negligible, if it exists at all."

An earlier Federal case, Doran v. Mass. Tpk. Auth., 348 F.3d 315 (Ist Cir 2003), upheld the tolling practice of giving $0.50 FASTLANE discounts to users of transponders purchased in Massachusetts and several surrounding states, but not other states. The reason was because the choice was the driver's, and the Court of Appeals concluded that a driver's "anticipated frequency of use" of the particular roadway is the primary factor determining whether a driver will join the discount program. Applying "the frequency calculus," the court found that the program created no resident versus nonresident classification. Id. at 318. The case of Saunders v. The Port Authority of New York and New Jersey, 2004 U.S. Dist. LEXIS 8482 (DC SDNY 2004) was decided on essentially the same grounds, and involved discounts for transponder users for certain bridges and tunnel entrance tolls to New York.

Some states have toll facilities that have toll booths essentially at the state line. Both Indiana and Ohio have their turnpikes tolled for the entire width of their states. There also are instances where a toll from one state into another is only charged one way. Further, the Pennsylvania Turnpike and PennDOT applied recently to toll all of I-80, but this application was denied by FHWA for reasons unrelated to the proposed toll locations. However, as part of that proposal, short trips on I-80 within Pennsylvania were proposed to have no toll charged, a concept called the "toll incentive." Essentially, Pennsylvania residents using I-80 for a distance of one or two exits would not be charged a toll, and certain news stories reported that trucking associations might have filed legal challenges based upon that "toll incentive" concept as a violation of the commerce clause.

In summary, based upon the case law CS reviewed, it appears that having tolls at the state border has not been found to be a per se violation of the commerce clause. This is in fact in place in other states. However, whether it is constitutionally permissible to place tolls at a border and have tolling practices that give discounts (or free passage) to in-state drivers does not appear to have been decided. Given the actual and threatened litigation surrounding tolling practices in other states, it would seem that there is a high probability that a legal challenge to border tolling will occur.

A separate issue is whether FHWA will approve the conversion. On this issue, it is observed that FHWA based its decision on the PennDOT tolling conversion application on a strict reading of the statutes on the issue of use of the toll revenues. Again, although not part of the decision document, given FHWA's anecdotal aversion to third-party legal challenges, the "toll incentive" and threatened litigation may have influenced FHWA, as well.

8.2 Technology and Deployment

Construction

No major construction would be needed for this concept other than installation of tolling gantries, and creation of the back office infrastructure.

Toll Collection Concept

Tolls would be collected at a single point on each entry (or exit) made. Tolls could be collected in one direction or in both directions. For purposes of this preliminary study, we assumed that tolls would be collected in both directions.

Technology and Roadside Components

This concept would require a toll gantry at every tolled entrance/exit to the State. Gantries would need to cover all lanes for which a toll is due (e.g., depending on whether the toll is inbound only or both inbound and outbound). Since all vehicles would be tolled, the roadside equipment would need to deal with and distinguish between cars, trucks, and motorbikes. This means image capture equipment would need to be front and rear facing to ensure that all vehicles can be identified.

Payment Types

Since all road users crossing the border on major highways will be required to pay a toll, and that there may be a high number of occasional users, it is not feasible to mandate that all vehicles be equipped with a transponder. Therefore, video billing must supplement transponder billing, possibly with a higher toll to cover increased costs. Given the high volume of traffic and the interstate-nature of the tolled corridors, it is unlikely that the system would require preregistration, although a preregistration option, potentially at a lower toll to encourage its use could be an option.

Toll Policy

Because the decision to cross the toll barrier is made far from the tolling point (i.e., at the point of origin), dynamic tolling would not be appropriate. This leaves either variable time-based tolling with a published schedule or flat tolling. Higher tolls for trucks also are likely.

Toll Program Operation

By definition, a large number of out-of-state traffic is likely to incur tolls with the border tolling concept. Therefore, it is essential to have robust interfaces with vehicle registration databases to ensure collection of toll payments and violation enforcement. Because of the nature of geographic distribution of the tolling points, it will be a challenge to provide an adequate walk-in center. Instead, a retail channel or widespread customer kiosks may need to be deployed in order to collect payments. It is anticipated that a kiosk processing several hundred payments a day could pay for itself in terms of video billing cost savings. Provision of this collection method would be determined by how many unbankable customers exist and it can address equity concerns even if the daily collection rate does not justify deployment based on cost alone.

Interoperable Programs

Due to the complexity and, therefore, cost of using license plate images, leveraging the E-ZPass network to achieve as high a penetration of tag-based customers is the most cost-effective solution. Any transactions collected via tag are not subject to leakage due to camera, weather, or DMV lookup issues. Furthermore, the cost of collecting a tag-based transaction is likely to be 10 to 50 percent of the cost of collecting a video image transaction. Most agencies in the Northeast are seeing a 70 to 80 percent E-ZPass tag penetration rate, which significantly reduces the overall collection costs. The London Congestion Charge – which is based solely on license plate technology in an environment with little plate variation – has very high collection costs.

■ 8.3 Potential PPP Approaches

The design, construction, and installation of toll collection gantries and equipment could be delivered through a design-build or construction-manager at risk approach. Since Connecticut lacks tolling expertise within state government, the turnkey construction and operation of border tolling locations could be appropriately delegated to the private sector, either through two contracts (design-build and operations and maintenance) or through one DBOM contract supported by a one-time, up-front, debt financed capital payment and a percentage of toll revenues collected, or a DBFO supported by a percentage of toll revenues. Proposal selection could be based on lowest capital and/or toll collection percentage proposed.

Since this concept involves tolling existing highways, using a long-term concession agreement where the private sector takes revenue risk and is responsible for toll setting would be difficult to justify from a policy perspective.

■ 8.4 Privacy

This concept only tolls the major entry points into the State, and so no equivalent, non-tolled alternatives exist for users who do not want to disclose any personal information. This means that if a user wishes to avoid disclosing information, they will need to take an alternative non-tolled entry that may be slower or less convenient for them and, therefore, is not an equivalent option. Users that do enter the State at the tolled points are only revealing single point journey information.

■ 8.5 Technical Analysis of Concept B – Border Tolling at Major Highways

Transportation Impacts

We obtained average daily traffic (ADT) and vehicle classification data for locations near the borders from the Connecticut Department of Transportation (ConnDOT) and estimated 2015 and 2030 volumes based on future trend lines established in 2008 by ConnDOT's Bureau of Policy and Planning.

The analysis looks at "direct" and "diversion" routes, with the diversion routes usually involving getting off the main highway immediately before the tolling location, and getting back on immediately after. In order to estimate traveler response to tolls, we estimated the travel time that would be expected if a driver were to stay on the highway and compared it to the travel time of the best alternative route (or routes). Since traffic diverting off the main highway onto the second-best alternative will slow traffic on that alternative we adjusted our estimates of travel time on the alternative route accordingly. Typically, that second-best diversion route involved getting off the main highway in advance of the toll, and getting back on after the toll. Part of the diversion route was typically in the adjoining state. We then converted the total cost of time for both routes into a dollar equivalent, added in the cost of the toll, and compared the two values to estimate the likely diversion of traffic to alternative routes (and retention of traffic at the toll collection point).

The value of time for cars was established using the methodology presented in the Tool for Rush-Hour User Charge Evaluation (TRUCE 3.0) model developed by FHWA, using various socioeconomic data from the Bureau of Labor Statistics (BLS) and the U.S. Census Bureau for communities along each corridor. Whereas the value of time for cars is more regionally specific, separate values of time for vans, single-unit trucks, and tractor trailers were established and used for all study corridors. These values were based on a study recently conducted by Cambridge Systematic in Vancouver, British Columbia. In this application, the diversion model uses the same trip length for each class of vehicle, following either the highway or the diversion route.

Current speeds for the relevant section of the highways and along the diversion routes were estimated from values obtained from multiple directional and interactive mapping web sites, from data on hourly and daily traffic levels, and from volume-to-capacity (V/C) ratios for these corridor crossing areas. The speeds for future analysis years were lowered using speed-flow curves to reflect the growth of the traffic by those years. We assumed that no significant improvements would occur to either the highways or the bypass roadways in these corridors.

The end result includes estimates of the diversion from the highway under various tolling scenarios for each vehicle class, the number of tolled vehicles and associated toll revenues, and the approximate changes in VMT and Vehicle Hours Traveled (VHT).

Diversion to Alternate Routes and Overall Impacts on VMT and VHT

The border crossing concept evaluated the frequency with which drivers would choose to take a diversion route to avoid the border toll. The diversion routes established are the shortest travel distance between the end points of the study corridor along routes within reasonable proximity to the respective corridors, providing a potentially viable option for diverted traffic. The main assumption is that many of the travelers diverting would want to get back onto the highway after avoiding the toll, which is why the highway and diversion route distances are relatively similar in length. Table 8.2 presents the diversion routes and their corresponding lengths that were used to evaluate each of the border crossings. Derived from mapping sources and knowledge of the area, these routes were selected as potentially reasonable alternative routes for those choosing to avoid the toll.

Table 8.2 Diversion Routes for Concept B – Border Tolling

		Length in Miles	
Border	**Diversion Route**	**Direct**	**Diversion**
I-95 – New York	Route 1 and Louden Road	2.32	2.80
I-95 – Rhode Island	Route 3 and Route 216	1.08	1.66
I-84 – New York	Route 202/6	4.61	5.10
I-84 – Massachusetts	Breakneck Road	4.32	4.85
Route 15 – New York	North Ridge Street (New York) and Route 120 (Connecticut)	4.25	5.14
I-395 – Rhode Island	Route 123	2.66	3.47
I-91 – Massachusetts	Route 5	3.92	4.02
Route 6 – Rhode Island	I-395 and Route 101 and Route 94	8.0	13.25

Table 8.3 shows the projected level of diversion at each crossing and the percentage of total highway vehicles that would divert. The I-95 border crossing with New York has few reasonable diversion routes, therefore, we would expect diversion to be low (one percent at the lowest toll rate, up to 15 percent at the highest toll rate). The I-95 border crossing at Rhode Island, on the other hand, would be expected to have much higher diversion in percentage terms – almost 13 percent at the lowest toll rate and almost 30 percent at the highest toll rate.

Table 8.3 Diverted Vehicles at Border Crossings by Toll Level: 2015 and 2030
Concept B – Border Tolling

	2015					
	Toll Level 1		Toll Level 2		Toll Level 3	
Border Crossings	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**
I-95 at New York Border	1,502	1.00%	14,184	9.44%	23,663	15.75%
I-95 at Rhode Island Border	5,459	12.89%	10,516	24.84%	12,588	29.73%
I-84 at New York Border	4,361	5.29%	12,123	14.71%	17,534	21.28%
I-84 at Massachusetts Border	5,049	9.45%	11,523	21.55%	13,883	25.97%
I-91 at Massachusetts Border	1,160	1.34%	8,618	9.97%	16,345	18.91%
SR at 6 Rhode Island Border	467	4.60%	628	6.19%	1,502	14.79%
I-395 at Massachusetts Border	3,455	13.79%	6,048	24.14%	7,234	28.87%
Route at 15 New York Border	517	1.00%	5,173	8.94%	8,277	16.00%

Table 8.3 Diverted Vehicles at Border Crossings by Toll Level: 2015 and 2030 (continued)

Concept B – Border Tolling

	2030					
	Toll Level 1		Toll Level 2		Toll Level 3	
Border Crossings	Number of Vehicles	Percent of Total Vehicles	Number of Vehicles	Percent of Total Vehicles	Number of Vehicles	Percent of Total Vehicles
I-95 at New York Border	1,711	1.00%	16,154	9.44%	26,950	15.75%
I-95 at Rhode Island Border	6,217	12.89%	11,977	24.84%	14,337	29.73%
I-84 at New York Border	4,966	5.29%	13,807	14.71%	19,969	21.28%
I-84 at Massachusetts Border	5,751	9.45%	13,123	21.55%	15,811	25.97%
I-91 at Massachusetts Border	1,321	1.34%	9,814	9.97%	18,615	18.91%
SR at 6 Rhode Island Border	531	4.60%	716	6.19%	1,710	14.79%
I-395 at Massachusetts Border	3,935	13.79%	6,888	24.14%	8,239	28.87%
Route at 15 New York Border	589	1.00%	5,892	8.94%	9,427	16.00%

Tolls at the borders would result in some drivers using routes that take longer than their current routes, causing significant increases in VHT. For Toll Level 2 (Table 8.4), we would expect VHT at the border crossing to increase by 64 percent at the I-95 crossing with New York and by 99 percent at the border crossing with Rhode Island. Double-digit percentage increases in VHT are expected at all of the border crossings in 2015. The Technical Appendix (Volume 3) provides additional details of this analysis for other toll rates and years.

Since the alternative routes are typically not much further than the route that uses the main highway, the changes in VMT are expected to be relatively minor. In some cases, the alternative route involves fewer miles, but since speeds are so much slower, VHT degradation is significant.

Table 8.4 VMT, VHT, and Speed Changes

Concept B – Border Tolling

	I-95 at New York Border							
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	348,528.96	355,337.20	6,808.24	1.95%	396,935.76	404,689.59	7,753.83	1.95%
VHT	5,361.98	8,827.20	3,465.22	64.63%	6,106.70	10,053.20	3,946.50	64.63%
Average Speed	65.00	40.25	-24.75	-38.07%	65.00	40.25	-24.75	-38.07%

Table 8.4 VMT, VHT, and Speed Changes (continued)
Concept B – Border Tolling

I-95 at Rhode Island Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	45,722.88	51,822.27	6,099.39	13.34%	52,073.28	59,019.81	6,946.53	13.34%
VHT	703.43	1,401.54	698.11	99.24%	801.13	1,596.20	795.07	99.24%
Average Speed	65.00	36.98	-28.02	-43.12%	65.00	36.98	-28.02	-43.12%

I-84 at New York Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	379,882.44	385,822.75	5,940.31	1.56%	432,643.89	439,409.25	6,765.36	1.56%
VHT	5,844.35	8,075.93	2,231.58	38.18%	6,656.06	9,197.58	2,541.52	38.18%
Average Speed	65.00	47.77	-17.23	-26.50%	65.00	47.77	-17.23	-26.50%

I-84 at Massachusetts Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	230,947.20	237,054.16	6,106.96	2.64%	263,023.20	269,978.34	6,955.14	2.64%
VHT	3,553.03	4,650.04	1,097.01	30.88%	4,046.51	5,295.88	1,249.37	30.88%
Average Speed	65.00	50.98	-14.02	-21.57%	65.00	50.98	-14.02	-21.57%

I-395 at Massachusetts Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	66,648.96	71,547.75	4,898.79	7.35%	75,905.76	81,484.94	5,579.18	7.35%
VHT	1,025.37	1,477.41	452.04	44.09%	1,167.78	1,682.61	514.82	44.09%
Average Speed	65.00	48.43	-16.57	-25.50%	65.00	48.43	-16.57	-25.50%

I-91 at Massachusetts Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	338,899.68	339,761.44	861.76	0.25%	385,969.08	386,950.52	981.44	0.25%
VHT	5,213.84	7,003.64	1,789.80	34.33%	5,937.99	7,976.37	2,038.38	34.33%
Average Speed	65.00	48.51	-16.49	-25.37%	65.00	48.51	-16.49	-25.37%

Table 8.4 VMT, VHT, and Speed Changes (continued)
Concept B – Border Tolling

Route 15 at New York Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	219,861.00	224,465.15	4,604.15	2.09%	250,397.25	255,640.86	5,243.61	2.09%
VHT	4,397.22	5,730.18	1,332.96	30.31%	5,007.95	6,526.04	1,518.09	30.31%
Average Speed	50.00	39.17	-10.83	-21.66%	50.00	39.17	-10.83	-21.66%

Route 6 at Rhode Island Border								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	81,216.00	84,515.24	3,299.24	4.06%	92,496.00	96,253.47	3,757.47	4.06%
VHT	1,624.32	1,801.33	177.01	10.90%	1,849.92	2,051.51	201.59	10.90%
Average Speed	50.00	46.92	-3.08	-6.16%	50.00	46.92	-3.08	-6.16%

Impact on Highway and Local Roadway Traffic Operations

We estimated the impact of traffic that would be expected to divert off of the main highway on the alternative routes. The discussion below uses the potential impacts of Toll Level 2 car and truck tolls in 2015 as an illustrative example of likely impacts under this tolling concept. Diversions for the other toll levels would be higher or lower, and diversions in subsequent years would be higher (see the Appendix for actual results under Toll Levels 1 and 3). All daily and hourly figures are for total diverted vehicles (cars and trucks) in both directions combined.

I-95 at New York Border – About 14,000 vehicles would be diverted on a daily basis, or approximately 1,400 in the highest peak hour. (A peak hour to daily volume ratio of 10 percent is assumed as an industry standard.) Eastbound traffic would likely exit onto I-287 and then Route 1 through Port Chester, returning to the highway via Byram Avenue. In the westbound direction, vehicles would exit in Byram and follow the same route in reverse. Putting 1,400 vehicles onto Route 1 would have a significant impact on traffic and the surrounding communities. Traffic already is heavy in these periods, and this added traffic could create significant back-ups at signalized intersections along the route, affect turning movements, and cause back-ups on ramps. Possibly of more importance would be the impact on downtown Port Chester and the downtown business district of Byram. Given the volume of traffic and high number of trucks, safety would be a critical concern to these local communities, particularly in Byram where the roadway is much narrower.

Route 15 at New York Border – About 5,200 vehicles per day (520 in the peak hour) would be diverted. Vehicles traveling eastbound and going to locations north of Route 15 and east of Route 7 in Norwalk would likely stay on the highway because of a lack of east-west roadways. Vehicles traveling eastbound to locations south of Route 15 or beyond Route 7 would most likely divert to Route 1 via I-287 and would use I-95 entering at Byram. These vehicles could then return to Route 15 at Route 7 in Norwalk or via other connecting highways further east. Westbound vehicles would follow the same paths in reverse. Moderate overall impacts would be expected. However, these vehicles would add to the traffic already diverted from I-95, increasing the traffic and safety impacts in downtown Port Chester and Byram, as described above.

I-84 at New York Border – About 13,800 vehicles per day (1,380 in the peak hour) would be diverted. Vehicles crossing the border in either direction could use Route 6/202, which runs parallel to the highway. The diversion of heavy trucks would be an issue although the overall numbers in any given hour would be relatively small. Route 6/202 which parallels I-84 is a commercial corridor in Danbury with a lower intensity of use in the New York section. It is capable of handling the additional traffic albeit with some additional congestion and ramp delays, and community impacts would be minimal give the nature of the surrounding land uses.

I-91 at Massachusetts Border – About 1,000 vehicles per day would be diverted (100 in the peak hour). Vehicles crossing the state line going southbound could exit onto Route 5 at Agawam, and could return at exit 49 in Connecticut. Vehicles going northbound would make the reverse movement. Once again, the numbers are too small to measurably affect traffic. Route 5 is a heavily traveled roadway. As a result, the additional traffic could be accommodated with some congestion impacts, but with minimal impact on the surrounding community.

I-84 at Massachusetts Border – About 8,100 vehicles daily (810 in the peak hour) would be diverted onto local roads between exit 74 in Union and the first entrance to I-84 in Massachusetts. Traffic diverted from I-84 would have to use local roadways located in a mostly low-density rural/residential area. Thus, the additional traffic could have an impact on community character. Safety also would be a concern as the roads are not built for high volumes/speeds or the capacity to handle large commercial vehicles.

I-395 at Massachusetts Border – About 6,900 vehicles would be diverted daily (690 in the peak hour). I-395 is paralleled by Route 193 and Route 12, both of which have entrances and exits near the border in both states. Routes 193 and 12 are two-lane state highways. The combination of the two could carry the additional volume. However, given the low intensity of uses along these roadways, there would be some safety concerns with the additional volume and travel speed.

Route 6 at Rhode Island Border – Less than 630 vehicles would be diverted daily (63 in the peak hour). There are two options for diverted traffic entering and exiting on Route 6; one would be to use local roads in and around Killingly, and the second would be to take Route 101 where it meets Route 6 several miles into Rhode Island. For Route 6, the number of diverted vehicles would be a minimal increase, with no impact expected.

I-95 at Rhode Island Border – About 10,500 vehicles would be diverted daily (roughly 1,000 in the peak hour). Going eastbound, traffic would use exit 93 in North Stonington, and immediately enter on Exit 1 in Rhode Island, using Route 184. Westbound traffic could do the same thing in reverse. The anticipated impact would be highly localized along Route 184 in an area of very little development. The major impact in this area could be ramp delays and traffic queuing to get onto the highway.

Transit Impacts

The following are discussions of the potential transit-related issues raised under the border tolling concepts at the eight proposed locations. Estimates are for 2015, and for the mid-level (Level 2) tolls, and figures for 2030 would be approximately 15 percent higher. The daily and hourly diversion figures in the transit discussion represent diverted cars only, in both directions combined.

I-95 and Route 15 – In the southwest, border tolling applies to Interstate 95 and Connecticut Route 15 at the New York border. These routes are parallel to one another and parallel to the Metro-North Railroad. For interstate trips, the transit services that would accommodate traffic diverted from highway tolling include Metro-North, Amtrak (regional and long-distance rail), the I-Bus (operated by CTTransit), and selected local bus routes, including CTTransit's Routes 11A and 11B which connect Port Chester, New York to Greenwich and Stamford.

The number of automobile diversions on I-95 at the New York border is estimated at approximately 11,500 cars only (trucks have been factored out) daily or roughly 1,100 cars in both directions (combined) during the morning or evening peak hour. Assuming an average car occupancy of 1.2 persons (1,379 person trips) and a potential transit mode share of these person trips of up to 10 percent, this accounts for an estimated 138 person trips diverted to transit in each direction during the peak hours. This relatively low volume of trips can be accommodated by the current transit network.

While Route 15 is not directly served by transit, some market overlap may exist with the I-95 corridor. The number of car trips expected to be diverted from Route 15 as a result of border tolling is approximately 5,200 daily or roughly 520 cars during the peak hour in both directions. This would result in additional transit demand slightly lower than the I-95 corridor as outlined above.

At Connecticut's southeastern border with Rhode Island, existing transit options in the I-95 corridor are limited. Amtrak provides interstate rail service between Boston and New York, including stops at New London, New Haven, and other intermediate points. Short trips diverted from I-95 due to tolling are not likely to be transferred to Amtrak's service. Shoreline East offers commuter rail service from New London west to New Haven.

Interstate trips subject to tolling on I-95 between Connecticut and Rhode Island result in even fewer trip diversions – an estimated 6,200 cars daily or roughly 620 cars during the morning or evening peak hours. An occupancy rate of 1.2 trips per car results in 744 total person trips, or 372 trips diverted in each direction during the peak one-hour periods. A

10 percent transit mode share results in only 37 potential trips in each direction during the peak hours.

The Southeast Area Transit Authority (SEAT) provides corridor service along I-95 from New London to North Stonington, but does not cross into Rhode Island. SEAT also provides local service along the corridor from East Lyme to North Stonington.

Additional investment would be required in regional transit services to provide alternatives for interstate transit between Connecticut and Rhode Island in the I-95 corridor.

I-84 – Limited transit service exists at the I-84 crossing at the New York state line other than local bus service in Danbury. Peter Pan operates some commuter bus service in the corridor toward Waterbury and Hartford. This service could benefit from additional frequency and provide an alternative for trips diverted from I-84 due to tolling. Enhanced local shuttle services also could feed the commuter bus network to provide additional incentive and capacity for transit usage in mid-distance trips to Waterbury, Hartford or points south, including Stamford.

At the New York border, the number of anticipated car diversions from I-84 as a result of tolling is 9,582 daily or 958 cars in both directions during a single peak hour (morning or evening). Assuming 1.2 persons per car, this represents 1,150 potential trips diverted from the highway. If 10 percent were to switch to transit, this would lead to 115 trips in both directions during a peak hour, or 57 trips in each direction. Assuming appropriate origins and destinations, even the limited transit available now on the I-84 corridor would be able to accommodate such an increase without major investment.

At the Massachusetts border, the I-84 corridor does not feature viable transit alternatives. A total of 7,530 cars daily or 753 car in a peak hour are expected to divert from I-84 as a result of border tolling. Using a 1.2 person per car occupancy rate this represents 904 person trips. While transit is not a viable option at present, a 10 percent transit mode share of these diversions would still only account for 45 person trips in each direction during the morning and evening peak-hour periods.

I-395 – The Northeastern Connecticut Transit District (NCTD) operates some flexible route service along the I-395 corridor in Killingly, Putnam, and Thompson. These services would not accommodate interstate travel subject to border tolling, but could provide access and feeder service to future regional and interstate bus services. Demand in this area would be limited, however, and unlikely to support major transit service investments in the near term.

Anticipated car trip diversions from I-395 are minimal; 4,678 daily or 468 peak-hour cars would divert from the highway, representing 562 peak-hour person trips assuming average vehicle occupancy of 1.2 persons, in the event of new border tolling. A 10 percent transit mode share would thus result in 56 trips total, or 28 transit trips in each direction.

Route 6 – The only transit services in the Route 6 border crossing are CTTransit's Willimantic Express buses from Windham/Willimantic west into Hartford. The Windham Region Transit District (WRTD) operates some local bus service in the vicinity of the corridor in Willimantic. No transit services cross into Rhode Island from eastern Connecticut. Regardless, the number of anticipated trip diversions (from cars) is negligible at roughly 438 cars daily and 43 cars in both directions combined during the peak hour. Any transit mode share from volumes this low would be insignificant.

I-91 – North of Hartford, the I-91 corridor is served by the Windsor Locks/Enfield Express Route operated by CTTransit. Frequency on these services may not be sufficient to provide sufficient incentive to deviate from I-91 (even with tolling), yet additional investment in transit services from tolling revenues could provide enhanced travel options both locally and interstate. Ultimately, because these services terminate within Connecticut, the express routes are only viable as an alternative to border tolling if park-and-ride locations are easily accessible from local roads not subject to a border toll.

An estimated 6,828 cars daily or 683 cars in the peak hour are expected to divert from I-91 as a result of border tolling, or 820 peak-hour person trips. A 10 percent transit mode share would result in 82 trips in both directions during the single morning or evening peak hour, or 41 trips in each direction. This demand would be easily accommodated by transit to the extent that existing services that terminate south of the state line could attract new users via local roads and park-and-ride facilities.

The I-91 corridor has limited Amtrak rail service between Massachusetts and Connecticut (and points south). Commuter rail service from New Haven to Springfield, Massachusetts currently is being investigated. If implemented, this would provide additional interstate transit options in the I-91 corridor and could be competitive with automobile trips, particularly in conjunction with tolling measures.

Toll Revenue Estimates

Annual toll revenue at Toll Level 1, 2, and 3 in 2015 would range from approximately $225 million to $940 million in 2015, and from $256 million to $1.1 billion in 2030 (see Table 8.5).

Table 8.5 Estimated Annual Toll Revenue Concept B – Border Tolling 2015 and 2030

2008 Dollars

Toll Trips and Revenue Projection for Toll Level 1				
Border Crossings	**Toll Trips 2015**	**Revenue 2015**	**Toll Trips 2030**	**Revenue 2030**
I-95 at New York Border	54,284,888	$69,392,656	61,824,456	$79,030,524
I-95 at Rhode Island Border	13,460,280	$19,453,902	15,329,764	$22,155,865
I-84 at New York Border	28,485,758	$38,515,728	32,442,114	$43,865,135
I-84 at Massachusetts Border	17,669,892	$27,064,786	20,124,044	$30,823,885
I-91 at Massachusetts Border	31,132,419	$37,888,834	35,456,465	$43,151,030
SR at 6 Rhode Island Border	3,535,188	$4,370,535	4,026,186	$4,977,553
I-395 at Massachusetts Border	7,884,376	$10,123,602	8,979,365	$11,529,620
Route at 15 New York Border	18,693,358	$18,693,358	21,289,720	$21,289,720
Total	**175,146,159**	**$225,503,401**	**199,472,113**	**$256,823,332**

Toll Trips and Revenue Projection for Toll Level 2				
Border Crossings	**Toll Trips 2015**	**Revenue 2015**	**Toll Trips 2030**	**Revenue 2030**
I-95 at New York Border	49,656,123	$190,744,086	52,612,236	$334,652,772
I-95 at Rhode Island Border	11,614,231	$50,243,822	13,227,319	$57,222,131
I-84 at New York Border	25,652,532	$104,164,285	29,215,384	$118,631,547
I-84 at Massachusetts Border	15,307,166	$70,126,772	17,433,130	$79,866,745
I-91 at Massachusetts Border	28,410,303	$103,678,619	32,356,155	$118,078,595
SR at 6 Rhode Island Border	3,476,104	$12,765,501	3,958,896	$14,538,488
I-395 at Massachusetts Border	6,937,960	$26,482,126	7,901,520	$30,160,315
Route at 15 New York Border	16,993,962	$50,981,886	19,354,125	$58,062,740
Total	**158,048,381**	**$609,187,097**	**176,058,764**	**$811,213,333**

Toll Trips and Revenue Projection for Toll Level 3				
Border Crossings	**Toll Trips 2015**	**Revenue 2015**	**Toll Trips 2030**	**Revenue 2030**
I-95 at New York Border	46,196,110	$293,841,458	52,612,236	$334,652,772
I-95 at Rhode island Border	10,857,860	$78,249,000	12,365,896	$89,116,917
I-84 at New York Border	23,677,528	$160,050,753	26,966,073	$182,280,024
I-84 at Massachusetts Border	14,445,643	$109,973,061	16,452,010	$127,778,105
I-91 at Massachusetts Border	25,589,682	$156,756,206	29,143,790	$183,887,730
SR at 6 Rhode Island Border	3,157,429	$19,407,994	3,595,961	$22,103,549
I-395 at Massachusetts Border	6,505,036	$41,386,145	7,408,405	$48,717,280
Route at 15 New York Border	15,861,031	$79,305,156	18,063,850	$90,319,615
Total	**146,290,318**	**$938,969,773**	**166,608,220**	**$1,078,855,992**

Note: Annual traffic growth based on ConnDOT's projection of 1% annual statewide highway growth through 2030.

Implementation Requirements

In this concept, a tolling point will be constructed at each of the eight selected border crossings. It has been assumed that the toll would be applied in both directions, requiring a gantry on each side of the road. Since all traffic will be tolled, the gantry will need to cover all lanes and will incorporate classification equipment to enable charging a different toll to trucks. This concept would likely not use dynamic pricing so that traffic monitoring equipment and dynamic message signs for toll rates are not required as part of this concept, although it is likely that some dynamic messaging signs would be installed to convey other information to drivers. Given the geographic spread of the tolling points, it is anticipated that new fiber optics would not be installed for communications but that leased data lines would be used. Since this concept is not associated with provision of a highly reliable trip time unlike an express lanes concept, no allocation has been made for additional highway service trucks or personnel. CCTV cameras would not be required for traffic monitoring but would be used to monitor tolling equipment. Allowance has been made for additional enforcement staff to provide toll evasion deterrent and toll enforcement support at each tolling point.

The large number of transactions associated with this concept indicates the need for a fairly large back office operation comparable to some of the larger existing E-ZPass service centers. However, it has been anticipated that the transactions will leverage some of the existing E-ZPass account holders from other states. Given that all traffic will be tolled and that border crossings may see a high number of users that do not make frequent trips, a high level of video transaction processing has also been estimated. Since travelers will not have much alternative other than to pay the toll, a fairly comprehensive customer service operation has been estimated involving four regional walk-in centers and partnership with a grocery store type chain to provide payment locations.

Toll Collection Costs

Table 8.6 identifies the total costs to implement and operate the border tolling project over 30 years under the different proposed toll rates.

Table 8.6 Life-Cycle Toll Collection Costs (Millions)
Concept B – Border Tolling

Scenario	Total Capital Cost	Total O&M Cost	Total
Toll Rate 1	$338.8	$1,277.4	**$1,616.3**
Toll Rate 2	$353.6	$1,534.0	**$1,887.6**
Toll Rate 3	$294.2	$1,761.9	**$2,056.0**

The equipment installation and operations cost for this concept are fairly modest given that only eight border crossing need to be instrumented for a total of 16 tolling points (one in each direction.) The capital costs for this concept are driven by the number of tags that need to be purchased over 30 years to support the anticipated account volume. The back-office costs are also significant due to the account and video transaction processing volume which make-up nearly 70 percent of the operating costs for toll rate 1. The processing costs associated with the revenue that would need to be processed through a credit card merchant account also contributes a significant percentage (15 percent) to the ongoing O&M amount for toll rate 1.

The principal changes for toll rate 2 are a change to the number of accounts and tags that are needed as well as a significant increase in revenue processing costs (up to 26 percent of O&M) for credit card companies due to the increased revenue.

For toll rate 3 the principal changes over toll rate 1 are a change to the number of accounts and tags that are needed as well as a significant increase in revenue processing costs (up to 42 percent of O&M) for credit card companies due to the increased revenue.

Implementation Strategy

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. Introduction of border tolling also may raise constitutional issues surrounding the Interstate Commerce Clause, which may add further time to the legislative tasks. Coordination with neighboring states would be highly desirable and time-consuming.

All traffic is tolled for this concept and hence the technical requirements are reasonably simple (compared to toll lane concepts), it also has limited geographical coverage (major border points only) and hence far fewer tolling points. This simplicity will reduce the design, build, and test task durations accordingly, although the wide geographical spread of the tolling points may negate some of these gains, especially in the testing. Industry estimates suggest two tolling points can be constructed per month for a project of this nature, but given the dispersed nature of this project, a roadside construction duration of around 18 months might be feasible. It is likely a small amount of roadway construction will be required around the tolling points, such as enforcement pull-offs and drainage.

Accordingly, the tasks to implement this concept, and their likely durations, are noted below in Table 8.7:

Table 8.7 Illustrative Implementation Durations
Concept B – Border Tolling

Task	Duration
Further Studies and Consensus Building	36 months
Studies Sufficient for Funding	12 months
Legislation and Funding	36 months
Assemble Program Staff	9 months
Procurement	12 months
Design	6 months
Build – Highway	12 months
Build – Roadside Equipment	18 months
Build – Back-Office	6 months
Test	6 months
Distribute Tags	6 months
Go-Live	0

Implementation Schedule

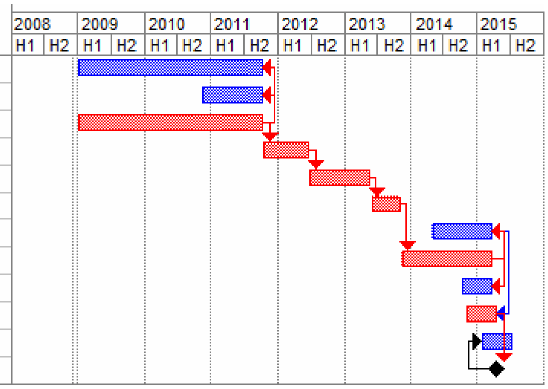
There are many ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability.

One such arrangement is detailed in the Gantt chart in Figure 8.2 below; this format allows key dependencies to be highlighted and the critical path[33] to be identified (in red). This approach shows implementation by 2015.

[33] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

Figure 8.2 Illustrative Implementation Schedule
Concept B – Border Tolling

ID	Task Name	Duration	Predecessors
1	Further studies and consensus building	36 mons	3FF
2	Studies sufficient for funding	12 mons	3FF
3	Legislation and funding	36 mons	
4	Assemble program staff	9 mons	3
5	Procurement	12 mons	4
6	Design	6 mons	5
7	Build - highway	12 mons	8FF
8	Build - roadside equipment	18 mons	6
9	Build - back office	6 mons	8FF
10	Test	6 mons	7FF+1 mon
11	Distribute tags	6 mons	12SS-3 mons
12	Go-live	0 mons	10



Environment

The border of Connecticut with New York on Interstate 95 is in a portion of coastal Connecticut often referred to as the 'Gold Coast' due to its relative wealth. It is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. The border of Connecticut at I-84 near Danbury is a mixture of medium density suburban uses with several large undeveloped properties or vacant properties proposed for redevelopment. The border of Connecticut with Rhode Island on I-95 is much less densely developed. The border of Connecticut with Massachusetts on Interstates 84 and 91 and with Rhode Island on I-395 are largely low-density residential and rural.

Concept B is expected to have some minor adverse impacts associated with the diversion of traffic onto local roads at the border tolls. The nature of these impacts could include the following, as highlighted in Table 8.8 and Figure 8.3.

- **Water Quality –** Some potential for exposure to hazardous materials and degradation of stormwater runoff with additional local traffic.

- **Air Quality –** Some increase in congestion on local roads; large numbers of motorists may travel fairly short distances on local roads to avoid paying border tolls. Volatile organic compounds (VOC), a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. Carbon monoxide emissions increase as well.

- **Community Disruption –** Added traffic congestion on local roads can result in barriers to ease of access to residences and/or businesses along diversion routes, increased traffic noise, and conflicts with the pedestrian-scale, aesthetic setting.

- **Bicycle and Pedestrian Travel –** Additional motor vehicles on the diversion routes may have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns for them.

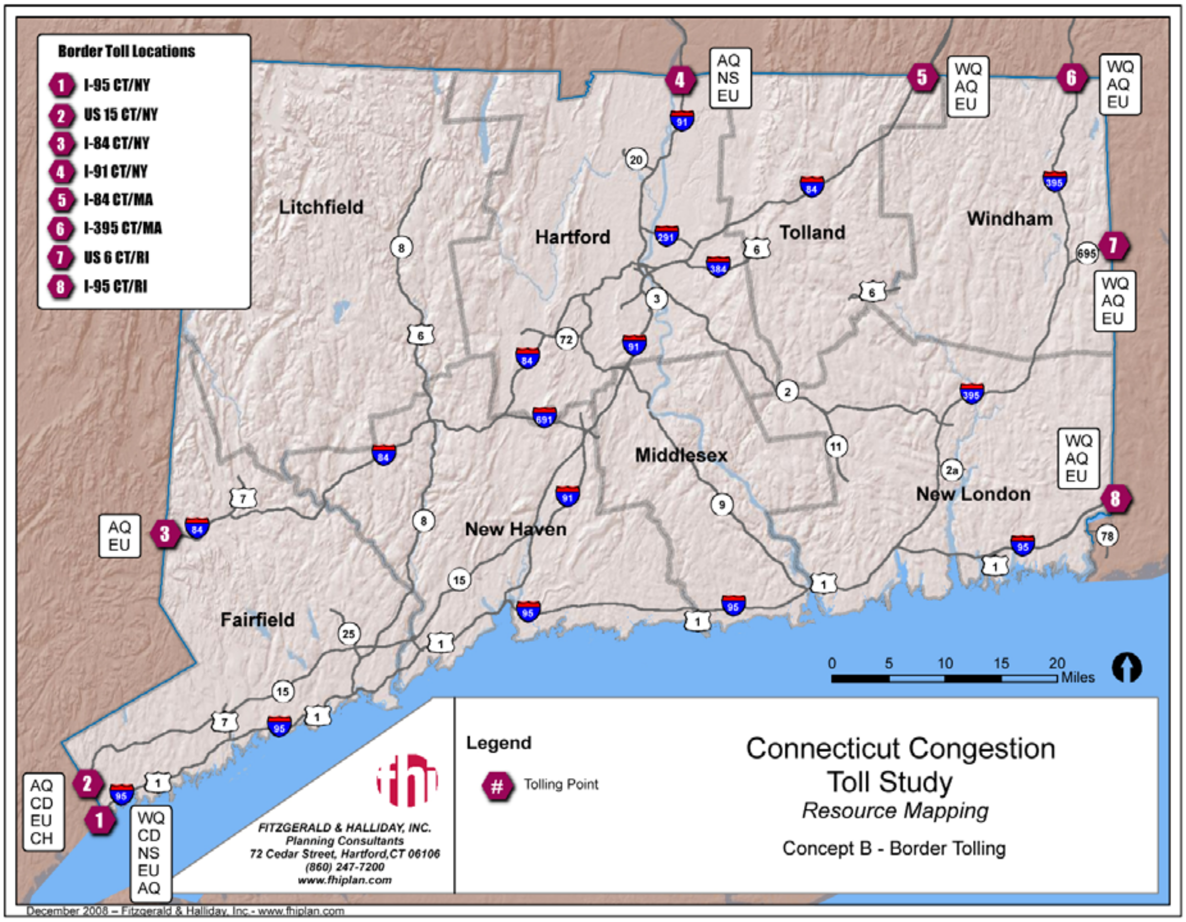
- **Noise –** Additional traffic can elevate noise levels locally somewhat.

- **Energy Use –** The average speed of travel decreases for vehicles traveling on local roads while increases for vehicles traveling on limited-access highways. However, if there are delays on local roads due to added congestion, fuel consumption may increase.

Table 8.8 Environmental Impact Summary
Concept B – Border Tolling

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	1 = Byram River 5 = Mashapaug Pond 6 = Little Pond 7 = Bog Meadow Reservoir/ Alva Chase Reservoir
Air Quality (AQ)	Yes	Minor Adverse	All diversion routes
Social/Community			
Community Disruption (CD)	Yes	Minor Adverse	1 = Route 1 (Commercial) 2 = North Ridge Road (Residential) 4 = Route 5 (Residential)
Bicycle and Pedestrian (BP)	Yes	Minor Adverse	Motorist diversions onto arterials
Noise (NS)	Yes	Minor Adverse	1 =Greenwich (New Lebanon School) 4 = Enfield (Bright Horizons Child Center)
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes
Environmental Justice (EJ)	No		
Cultural/Historic (CH)	Yes	Minor	Route 15 (Merritt Parkway)

Figure 8.3 Environmental Impact Locations
Concept B – Border Tolling



Economics

The main issues associated with the economic consequences of these concepts are the level of tolls, the level of existing congestion, whether the tolling would reduce congestion, and how the toll funds would be used. Unfortunately, this type of toll is very ineffective in dealing with congestion, while it can create congestion in new areas due to the diversion of traffic.

This concept provides little or no congestion relief (in and of itself), the tolls would be perceived as high relative to the benefit (or lack thereof) that it would produce, and spatial competition issues would be very serious. Communities nearby the border would feel that the costs of living, doing business, shopping, and other activities would have been artificially increased with no offsetting public or private benefit. The potential for significant interstate freight impacts due to these tolls would be particularly important, although interstate revenue sharing arrangements could mitigate those concerns somewhat.

A key to the overall economic benefit of the tolling concept – for local residents, for employers and major shippers and others who cross the border on a regular basis – is not the collection of the toll itself but what the State does with those revenues to improve transportation (or other) conditions in the corridor.

Equity

A $1 toll in each direction ($10/week for a regular border-crossing commuter, for example) is not projected to divert a substantial number of vehicles, while a $5 toll ($50/week) clearly would, especially for this type of toll, which is easier to avoid than a corridor-long, mileage-based tolling.

- **Geographic Distribution of Travelers –** By definition, border tolls impact a significant interstate component, raising serious economic and political issues. However, many of the highways involved carry substantial amounts of local and subregional trips. Localities near the border tolling location would likely feel burdened by this "tax" on their area of the State. Further, travelers with origins or destinations near the border would clearly be most likely to divert more around these toll locations than longer-distance highway travelers with less knowledge of local roadways.

- **Distribution of Auto Travel Markets –** All travel markets would be involved and sensitive to the local toll burden aspect of this concept.

- **Likely Truck Markets Involved –** The more rural area crossings (e.g., I-395 at Massachusetts border, U.S. Route 6 at Rhode Island border, I-84 at Massachusetts border) would have more of a longer-haul truck focus (although overall highway volumes are low), while those within or close to urbanized areas – I-91 at Massachusetts border (Springfield, Massachusetts), I-95 at Rhode Island border (Providence), etc. – have more of a mixture of local and subregional truck traffic. (Connecticut Route 15, as a parkway, would not directly impact truck traffic.)

- **Time Savings –** The goal of this concept is not to substantially reduce congestion but to raise revenues. All highway lanes in both directions at each crossing would be tolled, with the primary time versus toll issue being the additional travel time associated with lower-speed and often longer diversion routes. Travelers would potentially be faced with either paying a toll but with little travel-time benefit or avoid the toll by taking a longer, potentially less reliable route – i.e., a "lose-lose" situation. Any travel-time savings would result from the reinvestment in the revenue in some other worthy transportation project.

- **Potential Low-/Moderate-Income Concentration –** This issue would vary considerably across the State, with the higher-income areas along the New York border (Greenwich, Ridgefield) to average to somewhat lower than average income among some communities at or near the Massachusetts and Rhode Island border crossings. With no clear offsetting benefits, a key issue for lower-income groups would be whether other forms of taxation or user changes (fuel tax, sales tax, etc.) would be reduced to offset these new changes. A greater equity issue would be where the revenue generated by these tolls is applied in the future. Some of these border crossings are relatively uncongested, and thus it is likely that nearby residents and businesses would pay the tolls, but the benefits (revenue) would be spent elsewhere in the State.

- **Available Alternative Routes –** The major issue is whether convenient routes with available capacity would be available, especially for travelers with origins and destinations near the crossing (e.g., travelers heading to/from Thompsonville using I-91 to access points in Massachusetts). In some areas, the routes also are heavily congested and not appropriate destinations for substantial additional traffic, especially truck traffic.

- **Available and Potential New/Expanded Transit Service –** As discussed above under transit service issues, at a few border areas – e.g., I-95 at New York crossing and (to a lesser extent) I-84 at New York crossing – substantial services are available which could be potentially expanded using toll revenues to handle diverted travelers. However, the majority of these border areas have very limited transit with equally limited options for effective new services.

Safety

The main safety issues associated with this concept is the diversion of highway traffic, especially, trucks, along local routes and communities like Byram and Port Chester near the I-95 and Route 15 New York state borders, small communities near the I-95 Rhode Island border, residences and other uses along Routes 193 and 12 near the I-395 Massachusetts border, etc. One of the more significant possible safety issues would be at those locations where diverted traffic initially leaves and later reenters the highways, concentrating traffic on those ramps and the connecting intersections and local roadways.

8.6 Financial Analysis of Concept B – Border Tolling at Major Highways

Since this concept involves tolling existing highways with no specific road improvements, revenues are well in excess of all costs under all toll levels (Table 8.9). With a $1.00 automobile toll (higher for trucks), the present value of the 30-year revenue stream is estimated at almost $4.0 billion; after accounting for the initial cost of toll collection, the revenue available for projects would be almost $3.7 billion. According to current Federal rules, any toll revenue collected on an Interstate highway would have to be spent for the rehabilitation or improvement of that highway. However, most of the highways are long corridors which cross the State, and presumably the money could be spent anywhere along the corridor.

Table 8.9 Financial Analysis of Concept B – Border Tolling at Major Highways

Financial Summary (Millions of 2008 Dollars) Concept B: Border Tolling	Automobile Toll $1.00	$3.00	$5.00
Present Value of Net Toll Revenue	3950.6	9358.3	18,830.4
Initial Capital Cost of Toll Collection System	220.2	207.0	189.8
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,730.5**	**9,151.3**	**18,640.6**

Table 8.10 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project B. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept and all three toll levels, no annual revenue shortfalls are projected throughout the 30-year analysis period. Significant toll collection capital costs are projected every eight years for Project B for major toll collection infrastructure replacement. One such replacement cycles falls in 2030 and it is reflected in the recurring capital costs for that year. The large cost in 2015 reflects the initial purchase of a huge number of tags (an anticipated 1.1 million accounts versus about 4,000 accounts for Concept A, for example), reflecting the essentially statewide nature of this concept.

Table 8.10 Annual Toll Revenue and Expense Estimates Concept B – Border Tolling at Major Highways *(Millions of Year-of-Expenditure Dollars)*

Toll Level 1 – $1.00 In 2008$				Annual Costs			
Year	Passenger Car Toll	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$1.23	$1.59	$269.0	$13.5	69.6	74.3	111.7
2020	$1.43	$1.83	$323.0	$16.2	71.7	6.7	228.5
2025	$1.65	$2.08	$386.4	$19.3	69.6	6.6	290.8
2030	$1.92	$2.47	$487.0	$24.4	66.7	21.0	375.0
2035	$2.22	$2.87	$654.5	$32.7	80.5	0.0	541.3
2040	$2.58	$3.32	$879.7	$44.0	97.7	3.6	734.4

Table 8.10 Annual Toll Revenue and Expense Estimates Concept B – Border Tolling at Major Highways (continued)
(Millions of Year-of-Expenditure Dollars)

Toll Level 2 – $3.00 in 2008 Dollars				Annual Costs			
Year	Passenger Car Toll	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$3.69	$3.75	$588.6	$29.4	75.1	69.2	414.9
2020	$4.28	$4.27	$694.1	$34.7	79.0	5.9	574.6
2025	$4.96	$4.78	$813.5	$40.7	78.1	5.8	688.9
2030	$5.75	$5.79	$1,039.6	$52.0	78.4	28.7	880.6
2035	$6.66	$6.71	$1,397.2	$69.9	103.9	6.9	1,216.5
2040	$7.73	$7.78	$1,877.7	$93.9	136.9	4.6	1,642.3
Toll Level 3 – $5.00 in 2008 Dollars				**Annual Costs**			
Year	**Passenger Car Toll**	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue**
2015	$6.15	$7.91	$1,105.1	$55.3	86.0	64.0	899.8
2020	$7.13	$9.10	$1,320.9	$66.0	93.4	5.6	1,155.9
2025	$8.26	$10.32	$1,571.8	$78.6	94.0	5.6	1,393.5
2030	$9.58	$12.34	$1,992.0	$99.6	92.8	21.0	1,778.6
2035	$11.11	$14.31	$2,677.1	$133.9	116.6	0.0	2,426.6
2040	$12.88	$16.58	$3,597.8	$179.9	147.4	2.1	3,268.4

9.0 Concept C – Toll Trucks on Limited Access Highways

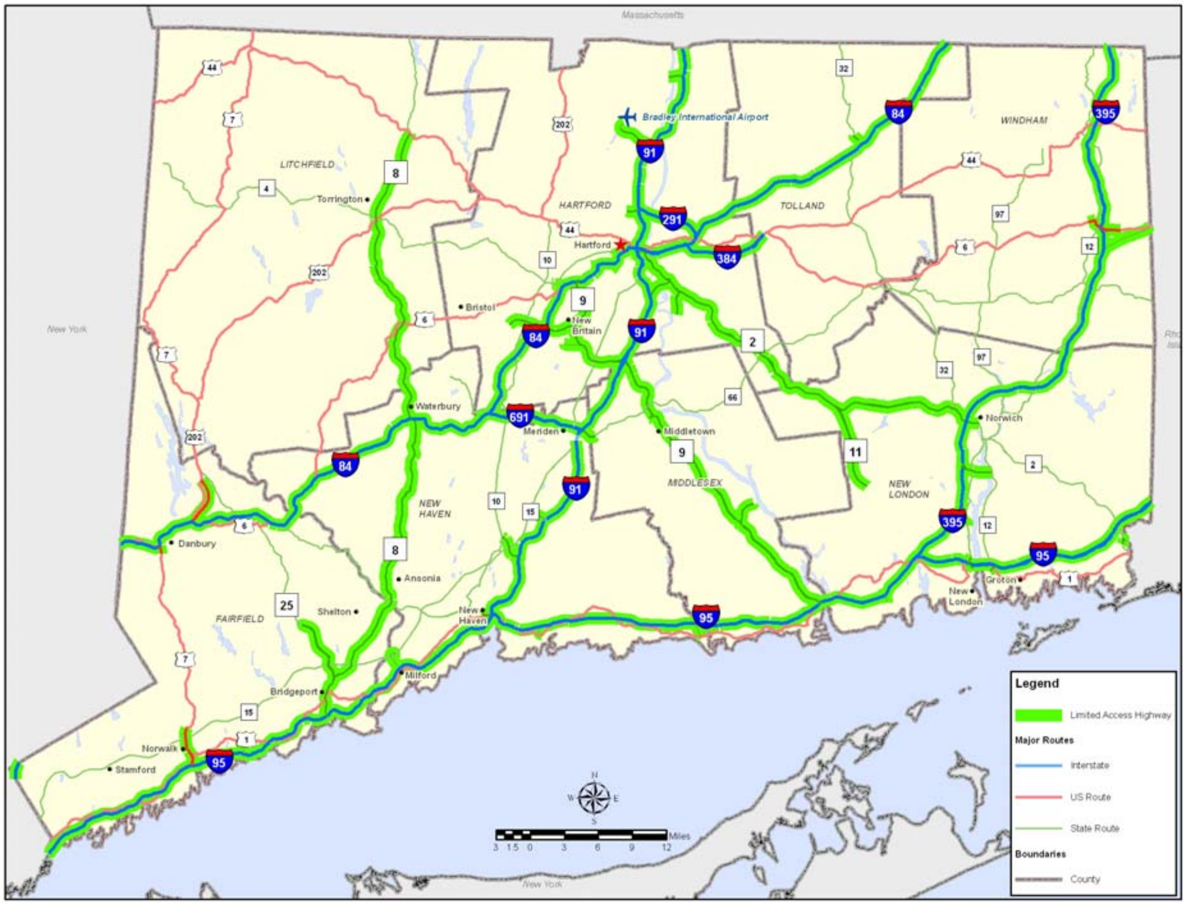
Overview and Project Description

This concept studies the implementation of mileage-based tolls for trucks only on all limited access highways in the State of Connecticut, which are (Figure 9.1):

- Interstate 95 from New York state line to Rhode Island state line;
- Interstate 84 from New York state line to Massachusetts state line;
- Interstate 395 up to Massachusetts state line;
- Interstate 91 up to Massachusetts state line;
- Interstate 691;
- Interstate 291;
- Route 2 (limited access portions only);
- Route 8 (limited access portions only); and
- Route 9 (limited access portions only).

The other limited access highway in the State – Route 15 – is not included due to its cars-only parkway status. We assumed that all highways would be tolled simultaneously at the same levels throughout the day. Toll rates also would vary by the various classifications of trucks, which for the purpose of this study were grouped under three types – vans, single-unit trucks and tractor trailers.

Figure 9.1 Concept C – Toll Trucks on Limited Access Highways



■ 9.1 Institutional and Legal

The current models for tolling trucks on all limited access facilities are Germany and Austria. Located in central Europe, their highways receive considerable use by trucks en route to other European destinations. Truck-only tolling is a way for these countries to fund road maintenance. The Austrian system uses overhead gantries and transponders to collect tolls, and all trucks must register. In Germany, a GPS-based system is used, supplemented by equipment on overhead gantries that have gear oriented to enforcement.

Washington State recently studied the possibility of tolling all truck miles on highways in that state. The objective in Washington was to collect revenue to more closely match the money spent on highway maintenance due to truck traffic and to divert some truck traffic to rail; the analysis showed that the first objective could probably be met, but that diversion to rail was less likely.[34] In addition, the infrastructure and administrative costs would likely be prohibitive and the feasibility of having truck drivers sign up for such a program that applies to only one state would be questionable. In the long term, however, the report noted that the spread of telematics technologies to the trucking industry may make the idea feasible at some point in the future, especially in a multistate or national system.

It is important to note that while passenger cars can easily avoid paying road user fees in the form of the motor fuel tax in Connecticut by not purchasing fuel in the State, trucks pay motor fuel tax regardless of where they purchase fuel. This tax transfer is accomplished through the International Fuel Tax Agreement (IFTA). This raises an important policy question of why trucks should be singled out to pay tolls.

Tolling trucks on existing highways that use Federal money would require Federal permission, as with other tolling concepts on existing highways. Under current laws, all revenue would need to be used on the highway where it was collected. Although the laws do not specifically exclude tolling a single class of vehicle, there might be other legal challenges surrounding equal protection issues.

9.2 Technology and Deployment

Construction

If utilizing a tag-based approach, no major construction is anticipated for this concept other than installation of tolling gantries. If GPS were used, it would require extensive investment in roadside equipment to cater to trucks without OBUs and to check compliance for OBU-equipped trucks.

Toll Collection Concept

Tracking entrance and exit for all trips on all limited access highways will require tolling points between each pair of interchanges. If this concept were something that Connecticut wanted to pursue, an alternative, less costly approach might be to only toll certain segments that catered to long-distance movements, meaning that the number of gantries could be reduced. Another alternative would be to use GPS. These concepts are discussed below.

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[34] Washington State Comprehensive Tolling Study, "*Background Paper No. 9: Illustrative Examples,*" Final Report Volume 2, [http://www.wstc.wa.gov/Tolling/FR1_WS%20Toll%20Study_Vol2_Paper09.pdf], 20 September 2006.

Technology and Roadside Components

Given the difficulties with identifying trucks (e.g., nonstandard license plate placement, and potentially different plates front and rear) and identifying the party responsible for the toll (i.e., the driver or the trailer owner), the most effective approach may be to mandate or strongly encourage use of transponders, with the use of video for compliance. Gantries would be required at all toll collection points, with a means of classification to only toll trucks and potentially charge different tolls based on truck characteristics, such as number of axles or total weight. Image capture technology would need to be optimized toward truck-specific capture – with front and rear cameras also required.

GPS would allow accurate tolling of trucks based upon distance driven, but the program would need to procure, personalize, and distribute GPS OBUs, as well as ensuring robust roadside and back office technology was in place to administer the system. Because a large number of out-of-state trucks pass through Connecticut, it may be impractical to mandate usage of this technology.

The only other deployment of GPS technology for trucking is the German Toll Collect system. Infrequent or one-off truck trips through the country for vehicles without a GPS OBU require truck operators to visit a kiosk, plan their actual route, and make payment. Detailed analysis of the trucking population will be needed to determine the applicability of this technology to Connecticut.

If GPS were adopted roadside detection equipment would still be required for non-equipped vehicles, along with substantial compliance equipment such as mobile image capture.

Payment Types

Given that this concept deals with commercial vehicles, it is likely that accounts will be the most common method of paying for tolls. Video billing could be used (with appropriate surcharges), but given the potentially high degree of leakage for trucks (caused by non-standard license plate placement, differing license plates front and rear and ownership of the tractor unit versus the operator) it is perhaps better suited to compliance only.

Demand for anonymous accounts is likely to be very low. Most agencies currently do not support anonymous accounts for truck users due to the higher tolls and the potential to generate a significant negative balance before the account status is communicated to the tolling points to cause video images to be captured. One-off payments might be used by the genuine "drive through" user; however, this could prove complex to declare depending on the nature of the toll. Advanced kiosks with a trip planning and toll calculation feature should be considered to support this payment method.

Toll Policy

This concept is best suited to static tolling, which could vary by time of day to try to discourage rush-hour usage.

Toll Program Operations

The operations of truck-only tolling on limited access highways under a tag or GPS scenario would be similar to that handling all vehicle types on these highways except that the volume would be considerably less. If tags were mandated for all trucks, the convenience of the back office and front office to administer their procurement, personalization, and distribution would need to be such that all users are able to obtain tags before they use the tolled roads.

The walk-in and transponder distribution centers could be coordinated with truck facilities such as truck stops and weigh-stations to maximize penetration.

Interoperable Programs

Given Connecticut's proximity to the E-ZPass network, customer benefit, and program cost savings would arise from adopting system interoperability with the E-ZPass network.

■ 9.3 Potential PPP Approaches

Germany has implemented a satellite-based truck tolling system designed, built, and operated by a private consortium of DaimlerChrysler AG, Deutsche Telekom AG and Cofiroute. Whether Connecticut advanced a GPS-based or ETC transponder-based truck tolling system through the E-ZPass IAG, either system could be constructed and maintained through a PPP such as a DBOM, just as the previous two concepts. Using a PPP approach would be particularly valuable for the State, as it would encourage technological and customer service innovation by the private sector.

However, mandatory truck only tolling would create serious issues about public acceptance and political support, which are necessary for successful PPPs. The litigation and political risk of such an approach could be a deterrent for private bidders, and DBOM contract terms would have to include termination for convenience provisions that allow the private developer to gain a reasonable return on its investment if a truck tolling system is ended by a future legislature. Most truck-only toll lanes under study in the United States are not mandatory, and so this kind of mandatory truck-only tolling scheme also would need an extensive legal analysis dealing with Federal interstate commerce preemption provisions or other possible legal challenges. Clear legal authority would be a prerequisite for any PPP procurement.

9.4 Privacy

The customers in this concept will be trucking companies and truck owner operators. Their identity, journey, and financial information will still be need to be safeguarded; however, their business concerns may lead to a greater desire for convenience at the expense of taking advantage of the features that provide the most rigorous privacy protection. For example, it is anticipated that many trucking companies will be interested in consolidating toll payments into single accounts rather than making one-off payments.

Companies also are concerned about their commercial movements being available to competitors. This concern would be addressed by even the most rudimentary privacy policies. The facility will need to ensure clear policies exist on third-party access to any information. Trucks that use the tolled highways are disclosing route journey information. Trucking companies already are required to submit regulatory information to various state and Federal organizations, including mileage traveled in each state as part of the IFTA fuel tax program, as well as being required to stop at weigh stations and provide a variety of data to enforcement officials. This industry does not, therefore, operate on the road system with an expectation of complete anonymity.

9.5 Technical Analysis of Concept C – Toll Trucks on Limited Access Highways

Transportation Impacts

Traffic data including average daily traffic (ADT) for locations along the highways were obtained from the Connecticut Department of Transportation (ConnDOT). From these data, weighted average daily traffic (ADT) figures were estimated along the length of each study segment of these highways. Vehicle classification data were obtained from ConnDOT for all of the highways, although in some instances this information had to be extrapolated from similar roadways within the State for which data were available.

Two short interstate segments completely within Connecticut – I-691 and I-291 – and three secondary highway corridors – Routes 2, 8, and 9 – were combined and analyzed as two additional highway segments. Some of the individual highways were split into two segments to reflect the often significant difference in traffic levels and patterns along these corridors. The corridor splits are as follows:

- Interstate 95: New York state line to New Haven and New Haven to Rhode Island state line;
- Interstate 84: New York state line to Hartford and Hartford to Massachusetts state line; and
- Interstate 91 New Haven to Hartford and Hartford to Massachusetts state line.

The analysis looks at "direct" and "diversion" routes. The selected diversion routes are the shortest travel distance between the end points of the study corridor along routes within reasonable proximity to the respective corridors, providing a potentially viable option for diverted traffic.

Table 9.1 shows the lengths of the study corridors and their respective diversion routes.

Table 9.1 Study Highways and Alternate Diversion Routes
Concept C – Toll Trucks on Limited Access Highways

Highway	Highway Length (Miles)	Diversion Routes	Diversion Length (Miles)
I-95 New York-New Haven	50.73	U.S. 1	49.00
I-95 New Haven-Rhode Island	60.84	Combination of CT 80, CT 148, and CT 2	67.00
I-84 New York-Hartford	66.90	U.S. 6	68.00
I-84 Hartford- Massachusetts	31.00	Combination of CT 159, CT 140, and CT 190	46.00
I-91 New Haven- Hartford	40.98	Combination of Hartford Turnpike, CT 150 and U.S. 5	36.00
I-91 Hartford – Massachusetts	17.02	Combination of CT 159 and U.S. 5	19.50
I-395	54.69	Combination of Grassy Hill Road, Chesterfield Road, New London Turnpike, Canterbury Turnpike, CT 169, U.S. 6, CT 12, and CT 21	53.00
I-691 and I-291	15.32	Combination of Meriden-Waterbury Turnpike, West main Street and East Main Street	17.50
Route 15[a]	63.00	Combination of U.S. 1, CT 57, CT 136, CT 59, CT 34, CT 42, and CT 70	68.00
Route 2, 8, 9	166.28	Route 2-Combination of Fitchville Road, Norwich Avenue, Old Hartford Road, South Main Street, North Main Street, New London Turnpike, Main Street (Glastonbury)	178.00
		Route 8-Combination of Washington Av, Noble Av, Huntington Turnpike, Bridgeport Av, CT 714, CT 34, CT 188, CT 64, CT 64, CT 63, U.S. 6, CT 222, CT 4, and CT 183	
		Route 9-Combination of CT 372, CT 3, Saybrook Road, and CT 154	

[a] Route 15 does not allow commercial vehicles, and was not included in the analysis of truck tolling for Concept C. However, it was included in Concept G-1, tolling all vehicles on all limited access highways.

The diversion routes are generally of approximately similar lengths and in some instances are actually somewhat shorter than the highway route. In reality, there would be myriad diversion routes used, especially by local employees and residents who better understand the local roadway system, but these routes were used for purposes of this simplified analysis.

Toll Structure and Levels

We analyzed three different levels of per-mile rates for each category of truck (Table 9.2).

Table 9.2 Per Mile Tolls for Different Vehicle Classes
Concept C – Toll Trucks on Limited Access Highways

	Vans	Single Unit Trucks	Tractor Trailers
Toll Level 1	$0.06	$0.10	$0.20
Toll Level 2	$0.09	$0.15	$0.30
Toll Level 3	$0.12	$0.20	$0.40

The analysis of the likely reaction of truck drivers to these toll levels was based on a ratio of: 1) the toll charges paid to travel a certain distance on the highway; and 2) the estimated monetary value of the extra travel time required to reach the same destination using an alternate route. We assumed a single value of time for vans, single-unit trucks (SUT), and tractor-trailers (TT) for all corridors, based on a study recently conducted by CS in Vancouver, British Columbia. We considered average trip lengths for each class of vehicle (with TTs having by far the longest average trip length), based on truck travel data for an area of California with a mix of highways, arterials and local roadways roughly similar to these study corridors. Though the diversion model uses average trip length to establish the level of diversion, we used the estimated total VMT for each truck classification along each of the individual study corridors.

We estimated traffic volumes for 2015 and 2030 based on future trend lines established in 2008 by ConnDOT's Bureau of Policy and Planning. Current speeds for the study corridor and the diversion routes were obtained by averaging values obtained from multiple directional and interactive mapping web sites and data on hourly and daily traffic levels and volume-to-capacity (V/C) ratios for these corridors. The speeds for future analysis years were lowered using Speed-flow curves to reflect the growth of the traffic by those years. We assumed that no significant improvements would occur to the roadways in these corridors (either the highway or the diversion routes).

Existing Traffic Characteristics in Study Corridors

Traffic data obtained from ConnDOT and other sources shows that volume of trucks on the three major interstates – I-95, I-84, and I-91 – accounts for almost 84 percent of all trucks on all of the State's limited access highways. The overwhelming majority of the tractor trailers (91 percent) also are found on these three highways. Overall, vans account for approximately 45 percent of all the trucks on these study corridors, while SUTs and TTs account for 18 percent and 37 percent, respectively.

Diversion to Non-tolled Roads

Low speeds on the diversion routes and the relatively high value of time for trucks means that relatively few trucks would be expected to divert to the non-tolled roads, even at the higher toll rates. Tables 9.3 and 9.4 summarize the total trips that divert to the non-tolled roads and also express the numbers as a percentage of the original traffic volumes. The largest diversion – 928 vehicles per day in 2015 and 1,056 in 2030 – is seen in the I-95 corridor between New York State and New Haven. This translates to approximately 90 to 100 vehicles per hour (both directions combined), with diversion rates generally in the two to three percent range.

Table 9.3 Diverted Vehicles by Toll Levels: 2015
Concept C – Toll Trucks on Limited Access Highways

	2015					
	Toll Level 1		Toll Level 2		Toll Level 3	
Study Corridors	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**
I-84 New York to Hartford	502	2.29%	657	3.00%	657	3.00%
I-84 Hartford to Massachusetts	206	1.26%	400	2.44%	420	2.57%
I-95 New York to New Haven	801	2.19%	928	2.53%	1,098	3.00%
I-95 New Haven to Rhode Island	389	2.00%	455	2.34%	583	3.00%
I-91 New Haven to Hartford	659	3.00%	659	3.00%	775	3.53%
I-91 Hartford to Massachusetts	638	2.15%	889	3.00%	889	3.00%
I-691 and I-291	113	1.27%	203	2.27%	227	2.53%
I-395	225	2.22%	305	3.00%	305	3.00%
Route 2, 8, 9	143	2.06%	159	2.29%	209	3.00%

Table 9.4 Truck Tolling Only- Diverted Vehicles by Toll Levels: 2030
Concept C – Toll Trucks on Limited Access Highways

	2030					
	Toll Level 1		Toll Level 2		Toll Level 3	
Study Corridors	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**
I-84 New York to Hartford	572	2.29%	749	3.00%	749	3.00%
I-84 Hartford to Massachusetts	235	1.26%	455	2.44%	478	2.57%
I-95 New York to New Haven	912	2.19%	1,056	2.53%	1,251	3.00%
I-95 New Haven to Rhode Island	443	2.00%	518	2.34%	664	3.00%
I-91 New Haven to Hartford	751	3.00%	751	3.00%	882	3.53%
I-91 Hartford to Massachusetts	727	2.15%	1,012	3.00%	1,012	3.00%
I-691 and I-291	129	1.27%	231	2.27%	259	2.53%
I-395	257	2.22%	347	3.00%	347	3.00%
Route 2, 8, 9	163	2.06%	181	2.29%	238	3.00%

Impact on Highway and Local Roadway Traffic Operations

Truck-only tolling on all limited access facilities enables Connecticut to collect revenue from freight shippers traveling through and within the State. The projected diversion numbers indicated above – rarely more than 100 to 200 trucks in both directions leaving the highway in the peak hours – would not appear to create substantial traffic issues for the projected diversion routes and the communities along them, since the diversions would be spread over the entire length of the highway segments, rather than at a single point. For example, the following are the approximate number of diverted trucks in 2015 in the peak hours within the AM and PM commuter peak hours:

- I-84 – New York to Hartford: 60 to 70 trucks would be diverted;
- I-84 – Hartford to Massachusetts: 40 trucks would be diverted;
- I-95 – New York to New Haven: 93 trucks would be diverted;
- I–95 – New Haven to Rhode Island: 45 trucks would be diverted;
- I-91 – Hartford to Massachusetts: 89 trucks would be diverted;
- I-395: 31 trucks would be diverted;
- Routes 8/9/2: 16 trucks would be diverted; and
- I-691/I-291: 20 trucks would be diverted.

Given the small number of trucks diverted in these corridors, there will be no significant traffic impact on the diversion roadways. For example, the section of I-95 from the New York border to New Haven is 46 miles long; with an expected diversion of 93 trucks spread over that length, no single location will be significantly impacted. However, much of this is a matter of perception, particularly when large trucks are involved. Even though the number of TTs projected to divert from I-95, for example, would be in the 15 to 20 range in the peak hour (both directions combined), the vision of these types of trucks, no matter what the number, rumbling through communities along Route 1 raises concerns that go beyond level of service and capacity.

Overall Impacts on VMT and VHT

The diversion effects discussed above are likely to result in modest changes in VMT – sometimes up and sometimes down, depending on the corridor – because the diversion routes typically cover about the same distance as the primary route. However, VHT is expected to increase by a much higher degree signifying slow travel speeds of the diverted vehicles on the alternate routes. Table 9.5 summarizes the change in VMT and VHT at each toll level in the years 2015 and 2030. The data represent volumes and conditions in both directions (e.g., northbound and southbound on I-95), and only represents the limited access highways and their alternative routes – not the entire State.

Table 9.5 Corridor Traffic Operational Impacts at Toll Level 2 in 2015 and 2030

Concept C – Toll Trucks on Limited Access Highways

I-84 New York State Line to Hartford								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	1,466,096	1,466,930	834	0.06%	1,669,720	1,670,544	824	0.05%
VHT	29,322	30,370	1,048	3.57%	37,105	38,538	1,433	3.86%
Average Speed	50.00	48.30	-1.70	-3.40%	45.00	43.35	-1.65	-3.67%

I-84 Hartford to Massachusetts State Line								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	507,018	513,315	6,297	1.24%	577,437	584,262	6,825	1.18%
VHT	10,140	10,653	512	5.05%	12,832	13,565	733	5.71%
Average Speed	50.00	48.19	-1.81	-3.63%	45.00	43.07	-1.93	-4.29%

Table 9.5 Corridor Traffic Operational Impacts at Toll Level 2 in 2015 and 2030 (continued)

Concept C – Toll Trucks on Limited Access Highways

I-95 New York State Line to New Haven								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	1,857,105	1,855,205	-1,900	-0.10%	2,115,036	2,113,209	-1,827	-0.09%
VHT	41,269	42,722	1,453	3.52%	52,876	54,987	2,111	3.99%
Average Speed	45.00	43.43	-1.57	-3.50%	40.00	38.43	-1.57	-3.92%

I-95 New Haven to Rhode Island State Line								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	1,182,644	1,186,236	3,592	0.30%	1,346,900	1,350,094	3,194	0.24%
VHT	21,503	22,420	918	4.27%	26,938	28,351	1,412	5.24%
Average Speed	55.00	52.91	-2.09	-3.80%	50.00	47.62	-2.38	-4.76%

I-395 to Massachusetts State Line								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	555,193	554,634	-559	-0.10%	632,303	631,717	-586	-0.09%
VHT	10,094	10,467	372	3.69%	12,646	13,186	540	4.27%
Average Speed	55.00	52.99	-2.01	-3.65%	50.00	47.91	-2.09	-4.18%

I-91 New Haven to Hartford								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	900,619	896,185	-4,433	-0.49%	1,025,704	1,021,965	-3,739	-0.36%
VHT	18,012	18,565	552	3.07%	22,793	23,461	668	2.93%
Average Speed	50.00	48.27	-1.73	-3.45%	45.00	43.56	-1.44	-3.20%

I-91 Hartford to Massachusetts State Line								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	504,134	506,338	2,204	0.44%	574,153	576,663	2,510	0.44%
VHT	10,083	10,473	391	3.87%	12,759	13,363	604	4.73%
Average Speed	50.00	48.35	-1.65	-3.31%	45.00	43.15	-1.85	-4.10%

Table 9.5 Corridor Traffic Operational Impacts at Toll Level 2 in 2015 and 2030 (continued)

Concept C – Toll Trucks on Limited Access Highways

I-691 and I-291								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	137,268	137,854	586	0.43%	156,333	156,838	504	0.32%
VHT	3,050	3,194	144	4.71%	3,908	4,090	181	4.64%
Average Speed	45.00	43.16	-1.84	-4.09%	40.00	38.35	-1.65	-4.12%
Route 2, Route 8, and Route 9								
	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	No Build	Build	Change	Percent Change	No Build	Build	Change	Percent Change
VMT	1,156,202	1,158,647	2,445	0.21%	1,316,785	1,318,906	2,121	0.16%
VHT	25,693	26,610	917	3.57%	32,920	34,062	1,143	3.47%
Average Speed	45.00	43.54	-1.46	-3.24%	40.00	38.72	-1.28	-3.20%

Transit Impacts

This truck-only tolling scheme would have little impact on transit operations, which could not provide alternative services for diverted truckers and which would not benefit from changes in highway or local roadway operations.

Toll Revenue Estimates

Annual toll revenue under Toll Levels 1, 2, and 3 in 2015 would be approximately $346 million, $512 million and $680 million, respectively. The equivalent figures for 2030 would be approximately $394 million, $583 million, and $794 million, respectively (see Table 9.6.

Table 9.6 Toll Trips and Revenue Forecasts (in 2008 Dollars) for 2015 and 2030 by Study Corridors

Concept C – Toll Trucks on Limited Access Highways

Toll Level 1	2015		2030	
Study Corridors	**Toll Trips (Thousands)**	**Revenue (Millions)**	**Toll Trips (Thousands)**	**Revenue (Millions)**
I-84 New York to Hartford	7,815.4	$67.8	8,900.9	$77.2
I-84 Hartford to Massachusetts	5,894.4	$23.2	6,713.1	$26.4
I-95 New York to New Haven	13,069.2	$78.5	14,884.7	$89.4
I-95 New Haven to Rhode Island	6,953.3	$47.6	7,919.0	$54.3
I-91 New Haven to Hartford	7,781.1	$46.4	8,861.8	$52.9
I-91 Hartford to Massachusetts	10,578.4	$22.5	12,047.6	$25.7
I-691 and I-291	3,229.2	$5.3	3,677.4	$6.1
I-395	3,623.0	$20.3	4,126.3	$23.2
Route 2, 8, 9	2,485.7	$34.2	2,830.9	$39.0
Total	**61,429.5**	**$346.0**	**69,961.7**	**$394.1**
Toll Level 2	**2015**		**2030**	
Study Corridors	**Toll Trips (Thousands)**	**Revenue (Millions)**	**Toll Trips (Thousands)**	**Revenue (Millions)**
I-84 New York to Hartford	7,758.8	$101.1	8,836.7	$115.1
I-84 Hartford to Massachusetts	5,823.9	$34.3	6,632.8	$39.1
I-95 New York to New Haven	13,023.2	$117.3	14,832.1	$133.5
I-95 New Haven to Rhode Island	6,928.8	$71.0	7,891.3	$80.9
I-91 New Haven to Hartford	7,781.1	$69.7	8,861.8	$79.3
I-91 Hartford to Massachusetts	10,486.8	$29.4	11,943.5	$33.5
I-691 and I-291	3,196.3	$7.9	3,640.1	$9.0
I-395	3,594.2	$30.3	4,093.5	$34.5
Route 2, 8, 9	2,479.8	$51.2	2,824.4	$58.3
Total	**61,072.9**	**$512.1**	**69,556.2**	**$583.2**
Toll Level 3	**2015**		**2030**	
Study Corridors	**Toll Trips (Thousands)**	**Revenue (Millions)**	**Toll Trips (Thousands)**	**Revenue (Millions)**
I-84 New York to Hartford	7,758.8	$134.8	8,836.7	$153.5
I-84 Hartford to Massachusetts	5,816.6	$45.6	6,624.4	$70.1
I-95 New York to New Haven	12,960.8	$156.0	14,761.0	$177.6
I-95 New Haven to Rhode Island	6,882.1	$94.3	7,838.0	$107.4
I-91 New Haven to Hartford	7,738.7	$92.2	8,813.7	$105.0
I-91 Hartford to Massachusetts	10,486.8	$39.2	11,943.5	$44.7
I-691 and I-291	3,187.5	$10.5	3,630.3	$12.0
I-395	3,594.2	$40.4	4,093.5	$46.0
Route 2, 8, 9	2,461.9	$67.9	2,803.9	$77.3
Total	**60,887.5**	**$680.8**	**69,344.9**	**$793.6**

Implementation Requirements

This concept requires instrumenting an extensive roadway tolling system in excess of 585 miles. Using the assumption that all trucks will pay a toll for using these highways results in the need to deploy 710 tolling points to cover all segments of the highway in both directions. Furthermore, each tolling point would need to cover all lanes of traffic as lane restrictions would be difficult to enforce at all these points. Since tolling is only to be applied to trucks, effective classification equipment would need to be installed at each location. This concept would likely not use dynamic pricing so that traffic monitoring equipment and dynamic message signs for toll rates are not required, although it is likely that some dynamic messaging signs would be installed to convey other information to drivers. CCTV cameras would not be required for traffic monitoring but would be used to monitor tolling equipment. Since the project is not associated with the requirement to improve traffic flow, no additional roadway assistance facilities would be required. Allowance has been made for additional enforcement staff to provide toll evasion deterrence along the extended length of these facilities. Since equipment will be distributed along the length of the roadways, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The back office for this concept is equivalent to an existing small- to medium-size operation. It is anticipated that there would be a fairly high-level of account participation, including leveraging current E-ZPass tag holders from other states. This results in a smaller percentage of video toll processing than in some of the other concepts. This concept would not require retail channels to provide payment options as users will largely be businesses. However, two walk-in centers have been included to provide customer service and account management support.

Toll Collection Costs

Table 9.7 identifies the total costs to implement and operate the truck only toll concept over 30 years under the different proposed toll rates.

Table 9.7 Life-Cycle Toll Collection Costs (Millions)
Concept C – Toll Trucks on Limited Access Highways

Scenario	Total Capital Cost	Total O&M Cost	Total
Toll Rate 1	$2,890.6	$1,938.2	**$4,828.8**
Toll Rate 2	$2,890.2	$2,051.3	**$4,941.4**
Toll Rate 3	$2,889.9	$2,178.1	**$5,068.0**

The capital cost for this project is driven by the large number of tolling points that need to be installed to toll every segment of the limited access highways. Less than 3 percent of the capital is to cover tag purchases over the 30 years. The ongoing operations costs are also dominated by the toll equipment maintenance, which make up over 56 percent of the ongoing costs. However, the cost of financial transaction processing is also significant at 12 percent of O&M. The back-office operation is commensurate with a medium size operation at about 16 percent of O&M costs.

The principal changes for toll rate 2 are a small change to the number of accounts and tags that are needed as well as a significant increase in revenue processing costs (up to over 16.5 percent of O&M) for credit card companies due to the increased revenue.

For toll rate 3 the principal changes over toll rate 1 are a small change to the number of accounts and tags that are needed as well as a significant increase in revenue processing costs (up to 21 percent of O&M) for credit card companies due to the increased revenue.

Implementation Strategy

This concept tolls only trucks which have a strong lobby group and are closely linked to other trade organizations. If this concept were to move forward, the consensus building component will likely take some time to work out agreements on tolling concepts and use of revenue.

Typically, when delivering a project of this scale, deployment risk can be reduced by rolling out section by section rather than adopting a 'big-bang' delivery. Under this approach, the program would be structured into a number of design-build-test-deliver phases, each learning lessons from the previous phase; in particular, it is likely that later delivery phases can be reduced in duration as efficiencies are realized. The number of phases, and the time between them to learn from the previous phase, will vary according to the amount of delivery risk the agency is prepared to accept. Design efforts in the first phase should be used to set the standards to be applied in later phases.

Even though the delivery is phased, it is likely a single procurement will be conducted for all phases to allow for the continuity between phases and to promote the ability to learn lessons and achieve the improvements due to greater experience.

The scale of the project will increase the design, build, and test task durations and with over 600 tolling points requiring installation, it is clear this construction could dominate the critical path unless appropriate time savings can be gained. Given the size of the program, the existing toll industry would be challenged to provide the resources for a rapid deployment. Potentially, the program could create a new business for the sole purpose of constructing these tolling points, which would allow its staff to be solely focused on this work rather than face competing demands on its time from other clients. Adopting this approach also might yield time savings through training focused on the specific construction required for this job. Nevertheless, it is unlikely that 600 tolling points could be erected in fewer than five years.

It is likely a small amount of roadway construction will be required along the tolled roads, such as enforcement pull-offs and drainage, although given the large geographical coverage this construction is not trivial.

Accordingly, the tasks to implement this concept, and their likely durations, are noted below in Table 9.8:

Table 9.8 Illustrative Construction Durations
Concept C – Toll Trucks on Limited Access Highways

Task	Duration
Further Studies and Consensus Building	48 months
Studies Sufficient for Funding	18 months
Legislation and Funding	36 months
Assemble Program Staff	9 months
Procurement	24 months
Design	42 months over 3 phases
Build – Highway	36 months over 3 phases
Build – Roadside Equipment	60 months over 3 phases
Build – Back-Office	12 months
Test	18 months over 3 phases
Distribute Tags	6 months
Go-Live	3 milestones

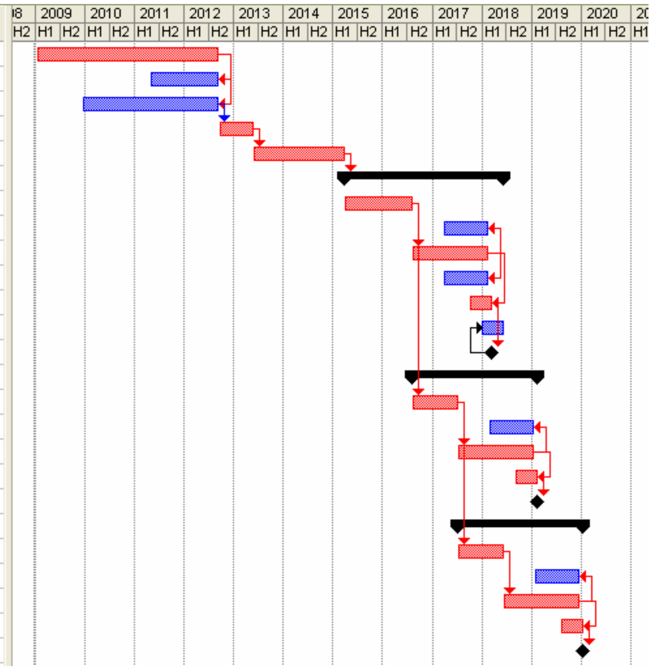
Implementation Schedule

There are many ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability. One such arrangement is detailed in the Gantt chart in Figure 9.2 below; this format allows key dependencies to be highlighted and the critical path[35] to be identified (in red).

[35] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

Figure 9.2 Illustrative Implementation Schedule
Concept C – Toll Trucks on Limited Access Highways

	Task Name	Duration	Predecessors
1	Further studies and consensus building	48 mons	
2	Studies sufficient for funding	18 mons	1FF
3	Legislation and funding	36 mons	1FF
4	Assemble program staff	9 mons	3
5	Procurement	24 mons	4
6	**Phase 1**	**42 mons**	**5**
7	Design	18 mons	
8	Build - highway	12 mons	9FF
9	Build - roadside equipment	20 mons	7
10	Build - back office	12 mons	9FF
11	Test	6 mons	9FF+1 mon
12	Distribute tags	6 mons	13SS-3 mons
13	Go-live 1	0 mons	11
14	**Phase 2**	**33 mons**	
15	Design	12 mons	7
16	Build - highway	12 mons	17FF
17	Build - roadside equipment	20 mons	15
18	Test	6 mons	17FF+1 mon
19	Go-live 2	0 mons	18
20	**Phase 3**	**33 mons**	
21	Design	12 mons	15
22	Build - highway	12 mons	23FF
23	Build - roadside equipment	20 mons	21
24	Test	6 mons	23FF+1 mon
25	Go-live 3	0 mons	24



Under a phased approach, there are in fact critical paths for each delivery phase go-live milestone, with the overall critical path length determined by the total duration of its constituent paths. Full implementation by 2020 is projected.

Environmental

Alternative C would impact all of the limited access highways in Connecticut. A number of diversion routes are expected to be used by trucks with tolling of those highways. Consequently, the impacts of this alternative can be considered to be statewide but vary somewhat by highway. The map for this Alternative, therefore, labels the limited access highway alternatives as 1 through 11, with 1 through 7 referring to the Interstates and 8 through 11 referring to the Connecticut state routes. The impacts are summarized by magnitude as follows.

Alternative C would only have beneficial impacts in terms of air quality along the limited access highway. It is anticipated that traffic movement will be somewhat more free-flowing with Alternative C. Consequently, vehicle hours of travel and vehicle hours of delay will both decrease. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions along the limited access highways.

Alternative C is expected to have a minor adverse impact to:

- **Air Quality –** The diversion routes with Alternative C are generally the same distance as the highway routes, but the speeds are considerably slower. Volatile organic compounds (VOC), a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. In addition, if there are delays along the diversion routes in part due to added traffic, this could increase overall vehicle emissions somewhat.

- **Water Quality –** Approximately 97 major water bodies could have increased exposure to hazardous materials and degraded stormwater runoff. Less traveled local roads are often not as well maintained as the major highways and, due to their age, do not have contemporary stormwater treatment facilities along their length. As those roads receive more traffic, there is greater potential for hazardous waste spills and stormwater runoff contaminated with petroleum products to impact unprotected streams, rivers, and wetlands or groundwater.

- **Energy Use/Conservation –** The average travel speed would be slower for trucks on local roads than the limited-access highway they divert from, and in particular there will be more stops, starts and idling, causing an increase in fuel consumption.

- **Environmental Justice –** Tolls in the vicinity of disadvantaged populations may discourage highway use and cause trucks to divert onto local streets. Added traffic congestion in a neighborhood with an environmental justice population has the potential to expose them to a higher burden of community impacts.

Alternative C is expected to have potentially significant impacts to:

- **Community Disruption –** Several of the diversion routes also are the 'Main Street' for communities through which they travel. The addition of traffic through these community centers will adversely affect quality of life by inhibiting pedestrian access, reducing pedestrian safety, and altering sense of place. This is particularly true for the smaller towns and villages where the 'Main Street' serves as the central gathering place for the community. In particular, diversions from I-95 in southwestern Connecticut would occur in what is often referred to as the 'Gold Coast' due to its relative wealth. It is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. Additional truck traffic through these centers such as Greenwich, Fairfield, Darien, New Canaan, and Westport would conflict with the pedestrian-scale character of these communities' residents experience of quality of life.

- **Bicycles and Pedestrian Travel –** Portions of the diversion routes serve as designated cross-state bicycle routes. Traffic diverted to those routes reduces safety and can hinder travel for bicyclists. Where trucks are diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel.

- **Noise –** Trucks are a particular source of noise associated with traffic. As trucks are added to local roads, the noise levels can be expected to increase. There are a significant number of noise sensitive receptors along the anticipated diversion routes. In particular, several of the diversion routes pass through residential enclaves in southwestern Connecticut, north and west of Hartford, and in the suburban rings around Norwich, New London, and Windham.

These impacts are summarized in Table 9.9 and shown in Figure 9.3.

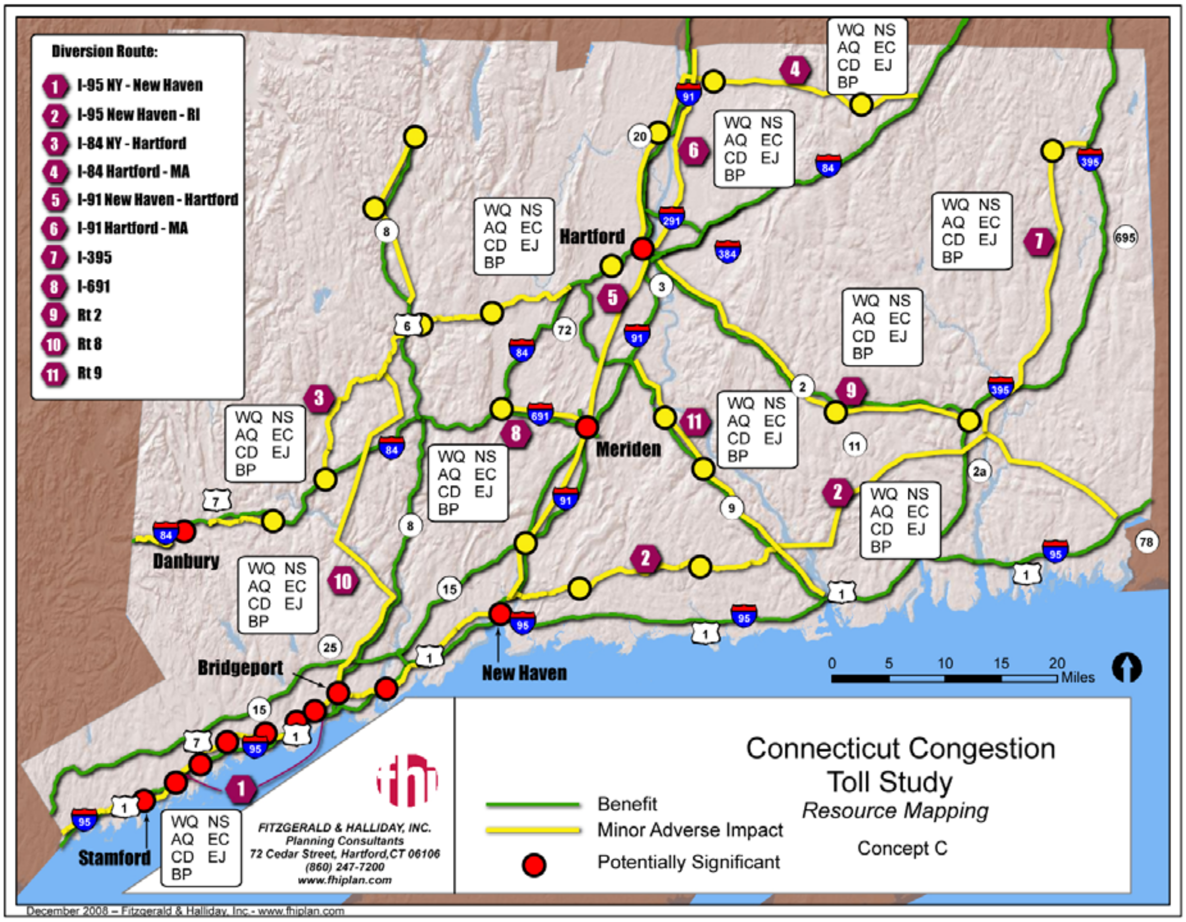
Table 9.9 Summary of Environmental Impacts
Concept C – Toll Trucks on Limited Access Highways

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	Approximately 97 major water bodies could have increased exposure to hazardous materials and degraded stormwater runoff
Air Quality (AQ)	Yes	Minor Adverse	Benefit to Limited Access Highways Minor Adverse Impact to all diversion routes
Social/Community			
Community Disruption (CD) – includes quality of life deterioration, economic development impacts, and community character impacts	Yes	Potentially Significant	Gold Coast Town Centers 1) – heavily developed/commercial Urban Centers (1, 2, 3, 5) – higher density, increased conflicts Numerous suburban and rural community centers (all routes) where diversion route is the 'Main Street'
Bicycle and Pedestrian (BP)	Yes	Potentially Significant	Motorist diversions onto arterials, portions of which are cross-state bicycle routes, including: Route 1 (Stamford, Darien, Stratford, and Milford), Route 148 (Chester), Route 6 (Woodbury, Southbury), Route 190 (Stafford Springs, Union), Route 169 (Canterbury, Brooklyn), CT 136 (Darien, Norwalk, and Westport), Route 57 (Weston), Route 6 (Thomaston), CT 154 (Chester), and CT 3 (Middletown, Cromwell).

Table 9.9 Summary of Environmental Impacts (continued)
Concept C – Toll Trucks on Limited Access Highways

Resource	Potential Impact	Impact Description	
		Magnitude	Location
Social/Community (continued)			
Noise (NS)		Potentially Significant	Over all diversion routes there is increased truck noise exposure to 532 sensitive land uses. Locations with heavy receptor concentrations are located in segments (1 – SW CT, 6 – Hartford north, and 2, 9, 7 – in Norwich)
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes have the potential for increased fuel consumption due to longer trips
Environmental Justice (EJ)	Yes	Minor Adverse	Numerous EJ populations along diversion segment (1), including Stamford, Norwalk, Bridgeport and New Haven Segments (3, 5, 9) include EJ population in Greater Hartford area Segment 3) has EJ issues in Danbury area
Cultural/Historic (CH)	No		

Figure 9.3 Environmental Impact Locations
Concept C – Toll Trucks on Limited Access Highways



Economics

Since the concept's main objective is not to achieve substantial congestion relief along these corridors, tolls will represent an additional cost to truckers, either through direct toll payments or through slower stop-and-go travel on diversion routes, raising substantial economic concerns. Therefore, if a certain highway segment has significant congestion and high truck volumes, but the flat-toll approach does not substantially address this issue, the offsetting benefits for businesses, shippers, and trucking interests are hard to see in the short term. The western portions of both I-95 and I-84 fall into this category. Extensive use of the highway for local and subregional trips – a typical pattern in highway segments in more urbanized areas – combined with a lack of suitable alternative routes also can pose an economic problem for local-market businesses and for communities along the likely diversion routes.

By itself, then, tolling trucks on existing highways is likely to have significantly adverse economic consequences. These consequences can potentially be mitigated, or even reversed if the revenues collected are used to improve facilities, services and programs that help trucking, whether in improved highways, expanded truck stops and parking or similar actions.

Equity

The main equity issues relating to Concept C include:

- **Geographic Distribution of Travelers –** Due to the comprehensive nature of this concept, truck traffic in virtually all areas of the State would be affected by this tolling plan.
- **Likely Truck Markets Involved –** Virtually all truck markets, from local van-based delivery and service operations to long-haul interstate freight movements, would face these proposed charges. The major interstate truck routes – I-91, I-84, and especially I-95 – have a larger share of the longer-haul truck market, while secondary highways (e.g., CT Route 8) would be more regional and local in nature. At the same time, I-95 carries a substantial amount of local truck traffic as well. The eventual level and mix of tolls would reflect the State's policy on which groups of trucks should be using the highway and which should use the local and arterial network, with relevant consequences to both networks.
- **Time Savings in Tolled versus Untolled Lanes –** Truckers who remain on the highways will experience time savings over non-tolled routes, but they will pay more than they do now. This is fundamentally different from a traditional new toll road or a tolled express lane, where new capacity is provided for a price, and users can stay with their previous choices (for no toll), or pay more for improved service. This sets up a potential "lose-lose" situation, at least until the new revenue is invested in improved transportation systems.
- **Potential Low-/Moderate-Income Concentration –** This would most likely not be a major issue under this concept, due to its broad statewide coverage except to the extent trucks diverted through such neighborhoods.
- **Available Alternative Routes –** In most instances, there is some form of alternate route for trucks to use. However, the key questions are: 1) the time penalty on these routes relative to the highway; and 2) the capacity of the route to absorb more truck traffic, especially larger trucks, from capacity, safety, and environmental perspectives. These issues are particularly important for longer-haul larger single-unit and tractor trailer trucks, which by design are intended to be on the highways that are better designed to handle them.

Safety

The concept of tolling trucks on limited access highways in the State may have serious implications for safety (real or perceived) on the alternate routes they are forced or willing to take. Since route directness and timing of deliveries and service appointments are crucial for truck drivers, truck tolls on highways may result in a disproportionate volumes of the diverted trucks using specific truck routes during those times of the day when trucking operations are at the highest levels (generally from early morning to midafternoon).

Trucks are larger, heavier vehicles and require larger turning radii, and consume more roadway capacity. As such, increased truck volumes on the alternate truck routes may increase not only the propensity for certain types of crashes to occur, but also could increase the severity of the crashes, potentially resulting in more fatalities and injuries. Although the relatively modest number of diversions would limit congestion increases, serious safety issues can be raised by only a few trucks per hour when they are large highway-appropriate vehicles.

While local jurisdictions may have specific truck routing regulations, truck drivers may risk traveling along non-truck routes to compensate for additional travel time and distance, especially at night when enforcement may not be as rigid. This could result in potential noise, safety, and quality of life issues, particularly in suburban and rural neighborhoods.

For example, in southwestern Connecticut, Route 1 (in some sections) currently is used as a bypass route to I-95 for both automobiles and trucks. Tolling of trucks on I-95 can be expected to result in heavier truck volumes along Route 1, and increased truck travel along some already congested sections of Route 1. During the midday peak periods when significant amounts of traffic is generated by the retail and commercial uses along Route 1, even a small increase in truck traffic would have only a moderate impact on traffic congestion, but may contribute more substantially to the potential for crashes. Roadways connecting Route 1 and I-95 may experience similar issues. The same issues would be raised on the diversion routes along each of the major truck corridors – e.g., Route 6 along I-84 near the New York State border, Route 80, 148 and similar routes along I-84 between Hartford and the Massachusetts border, etc.

■ 9.6 Financial Analysis of Concept C – Toll Trucks on Limited Access Highways

Concept C would result in significant new revenue – from $5 billion to over $12 billion depending on the toll rate, 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 23 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). After accounting for collection costs, the life cycle value of this concept that could be applied to projects would be from $3.7 to $10.9 billion. As with Concept B, tolls on Interstate highways would be restricted to improving those highways.

Table 9.10 Financial Analysis of Concept C – Toll Trucks on Limited Access Highways

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	4,891.9	8,229.1	12,087.5
Initial Capital Cost of Toll Collection System	1,384.0	1,383.6	1,383.4
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,507.9**	**6,915.5**	**10,704.1**

Table 9.11 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project C. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept, no revenue shortfalls are projected throughout the 30-year analysis period for Toll Level 3. Annual shortfalls are projected for Project C under Toll Level 1 in year 2030, but large surpluses in other years are sufficient to offset these losses. Significant toll collection capital costs are projected every eight years for Project C for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 9.11 Annual Toll Revenue and Expense Estimates Concept C – Toll Trucks on Limited Access Highways

(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.30/Mile in 2008 Dollars				Annual Costs			
Year	Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.37	$7.22	$425.5	$21.3	88.2	1.1	314.9
2020	$0.43	$8.36	$515.2	$25.8	93.8	1.2	394.4
2025	$0.50	$9.69	$623.7	$31.2	105.1	1.1	486.3
2030	$0.57	$11.24	$755.1	$37.8	118.4	1,070.4	(471.4)
2035	$0.67	$13.03	$920.0	$46.0	139.1	0.6	734.3
2040	$0.77	$15.10	$1,120.9	$56.0	163.5	0.4	901.0

Table 9.11 Annual Toll Revenue and Expense Estimates Concept C – Toll Trucks on Limited Access Highways (continued)

(Millions of Year-of-Expenditure Dollars)

Toll Level 2 – $0.45/Mile in 2008 Dollars				Annual Costs			
Year	Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.55	$10.74	$629.8	$31.5	92.7	1.1	504.6
2020	$0.64	$12.45	$762.5	$38.1	99.0	1.2	624.2
2025	$0.74	$14.44	$923.1	$46.2	111.1	1.1	764.7
2030	$0.86	$16.75	$1,117.5	$55.9	125.3	1,070.4	(134.1)
2035	$1.00	$19.42	$1,361.6	$68.1	147.6	0.6	1,145.4
2040	$1.16	$22.51	$1,659.0	$83.0	173.8	0.4	1,401.9
Toll Level 3 – $0.60/Mile In 2008$				**Annual Costs**			
Year	Per Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.74	$14.60	$857.0	$42.9	97.7	1.1	715.3
2020	$0.86	$16.94	$1,037.5	$51.9	104.9	1.2	879.6
2025	$0.99	$19.65	$1,256.1	$62.8	117.8	1.1	1,074.3
2030	$1.15	$22.80	$1,520.6	$76.0	133.1	1,070.4	241.1
2035	$1.33	$26.44	$1,852.7	$92.6	157.1	0.6	1,602.4
2040	$1.55	$30.64	$2,257.4	$112.9	185.4	0.4	1,958.7

10.0 Concept D – HOV to HOT Lane Conversion

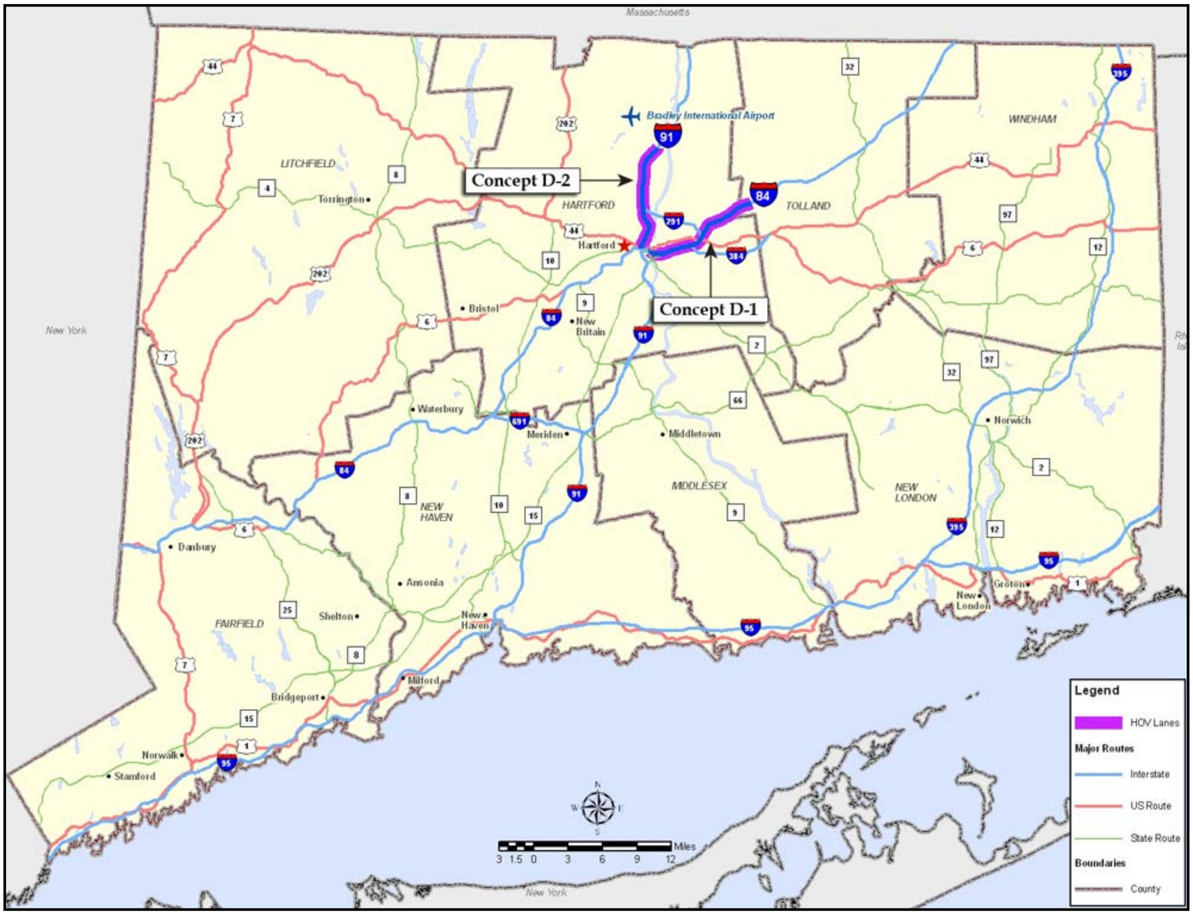
Overview

The simplest toll project to implement is the conversion of High-Occupancy Vehicle (HOV) lanes to High-Occupancy Toll (HOT) lanes. HOT lanes allow for SOV drivers to buy into the lane by paying a toll while HOVs can still use the lane toll free. The end result is maximizing HOT lane utilization and the possibility for better efficiency in the general purpose roadway lanes as well. HOT lane revenues are typically low relative to other types of toll projects because much of the available HOT lane capacity is given away for free to HOVs. The most recent HOV to HOT conversions took place on I-394 in Minneapolis in 2005, on I-25 in Denver in 2006, and on I-95 in Miami on December 5, 2008.

For this study, we considered converting the existing single-lane HOV lanes in Connecticut to HOT lanes (Figure 10.1):

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

Figure 10.1 Concept D – HOV to HOT Lane Conversion



Project Descriptions

In 1989, High-Occupancy Vehicle (HOV) lanes opened east of Hartford along I-84 and I-384 and were extended into Hartford in 2000. The HOV facility along I-84 and I-384 is approximately 22.1 lane-miles with one HOV lane provided in each direction of travel (10.1 miles eastbound and 12.0 miles westbound). In 1993, HOV lanes were opened on I-91 north of Hartford. The HOV facility along I-91 is approximately 14.7 lane-miles with one HOV lane provided in each direction of travel (7.5 miles northbound and 7.2 miles southbound).

Three general purpose lanes in each direction parallel the I-91 HOV lanes. Access to and egress from the I-91 HOV lane is provided at these locations (Figure 10.2):

- Southbound access:
  - General purpose lanes in Windsor (less than a mile south of the Bradley International Airport access road);
  - Direct on-ramp from Route 75;

  - Direct on-ramp from Bloomfield Avenue; and
  - Direct on-ramp from I-291/Route 218.

- Southbound egress:
  - Near Jennings Road to the general purpose lanes; and
  - Direct off-ramp to Leibert Road.

- Northbound access:
  - General purpose lanes near Jennings Road; and
  - Direct on-ramp from Leibert Road.

- Northbound egress:
  - Direct off-ramp to I-291/Route 218;
  - Direct off-ramp to Bloomfield Avenue;
  - Direct off-ramp to Route 75; and
  - General purpose lanes in Windsor (less than a mile south of the Bradley International Airport access road).

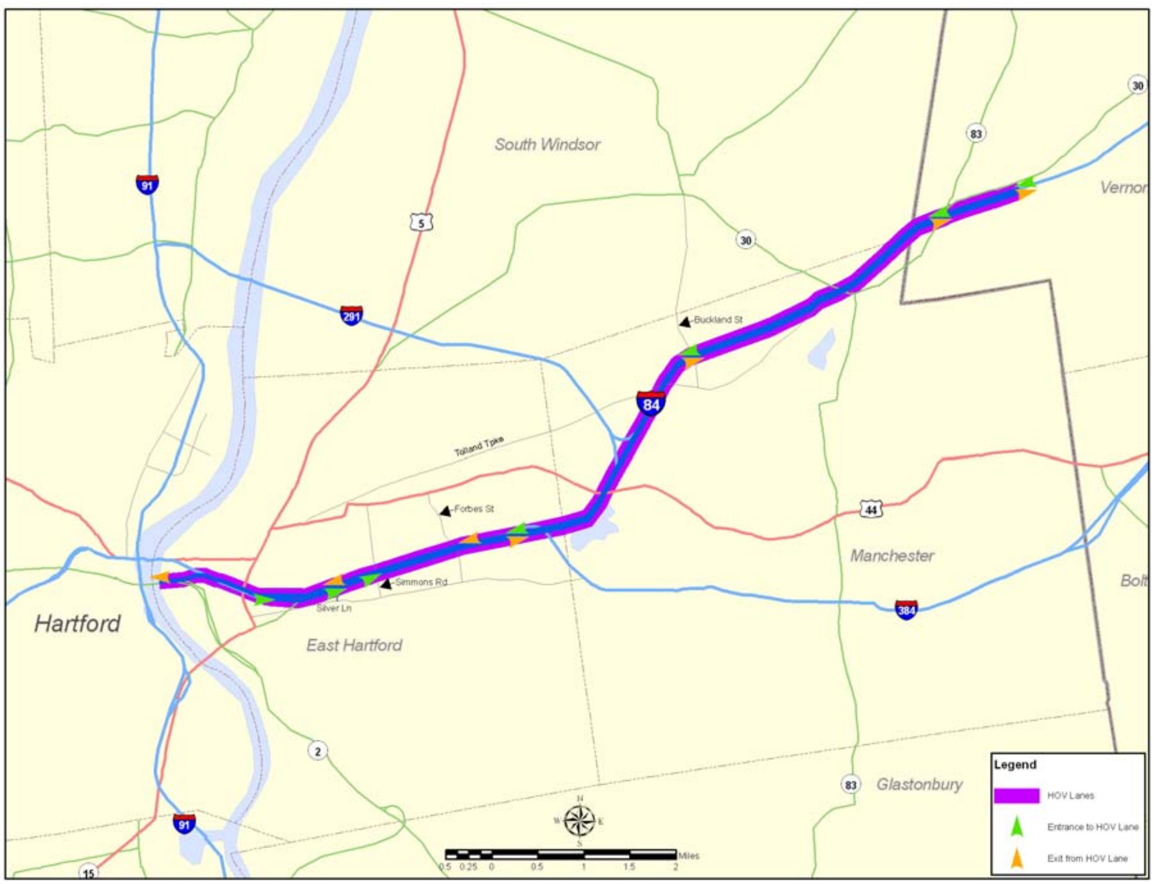
Figure 10.2 Existing I-91 HOV Lanes

Three general purpose lanes in each direction parallel the I-84 HOV lanes, except in the section between the I-384/I-84 merge and Wilbur Cross Parkway (Route 15) where five general purpose lanes are provided. Access to and egress from the I-84 HOV lane is provided at these locations (Figure 10.3):

- Westbound access:
  - General purpose lanes in Vernon;
  - Direct on-ramp from Route 30;
  - Direct on-ramp from Buckland Street; and
  - Direct on-ramp from I-384 HOV.
- Westbound egress:
  - General purpose lanes east of Forbes Street under pass;
  - Direct off-ramp to Silver Lane;
  - General purpose lanes near Route 2 interchange; and
  - General purpose lanes at Founders Bridge.

- Eastbound access:
  - General purpose lanes west of Route 15;
  - Direct on-ramp from Silver Lane; and
  - General purpose lanes west of Simmons Road underpass.
- Eastbound egress:
  - Direct off-ramp to I-384 HOV;
  - Direct off-ramp to Buckland Street;
  - Direct off-ramp to Route 30; and
  - General purpose lanes in Vernon.

Figure 10.3 Existing HOV Lanes on I-84



Converting the Existing HOV Lanes to HOT Lanes

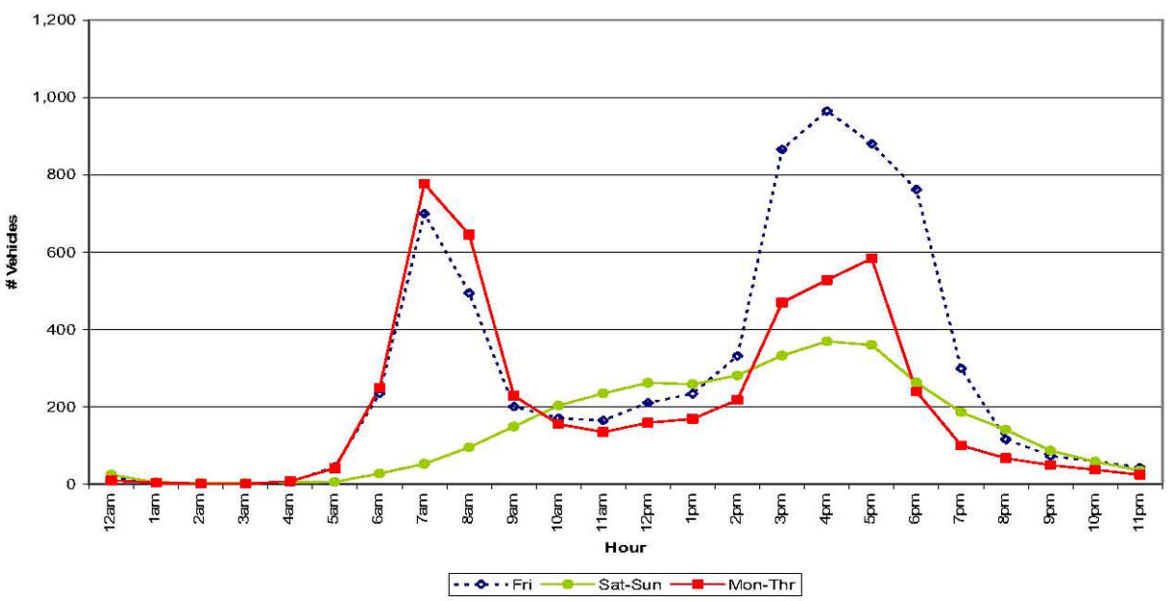
The existing HOV lanes on both I-91 and I-84 are ideally suited to easy conversion to HOT lanes. They have limited on and off points (as opposed to continuous access/egress), and the on-ramps are relatively clustered at the beginning of the inbound and outbound ends of the HOV lanes, with the off-ramps relatively clustered at the end. This makes setting up the toll collection system relatively easy.

Traffic Characteristics

ConnDOT's Bureau of Policy and Planning (BPP) has been monitoring the usage of these HOV facilities since 1989 through annual on-site counts.[36] In 1993, the HOV requirement was changed from three to two occupants per vehicle, which coincided with the opening of the I-91 HOV lanes.

Figures 10-4 through 10-7 show average hourly HOV lane volumes for I-91 and I-84 respectively in both directions, as reported in ConnDOT's 2008 HOV report. As shown, I-91 southbound has two distinct peaks during the a.m. and p.m. commuter periods, reaching a volume of almost 1,000 vehicles per hour in the Friday p.m. peak. Northbound volume is much more heavily peaked in the p.m. period only. The bidirectional nature of peak traffic on I-91 particularly southbound is advantageous in generating sufficient demand to fill up the HOT lane with SOV paying customers. I-84 has more of a typical one-directional peaking pattern.

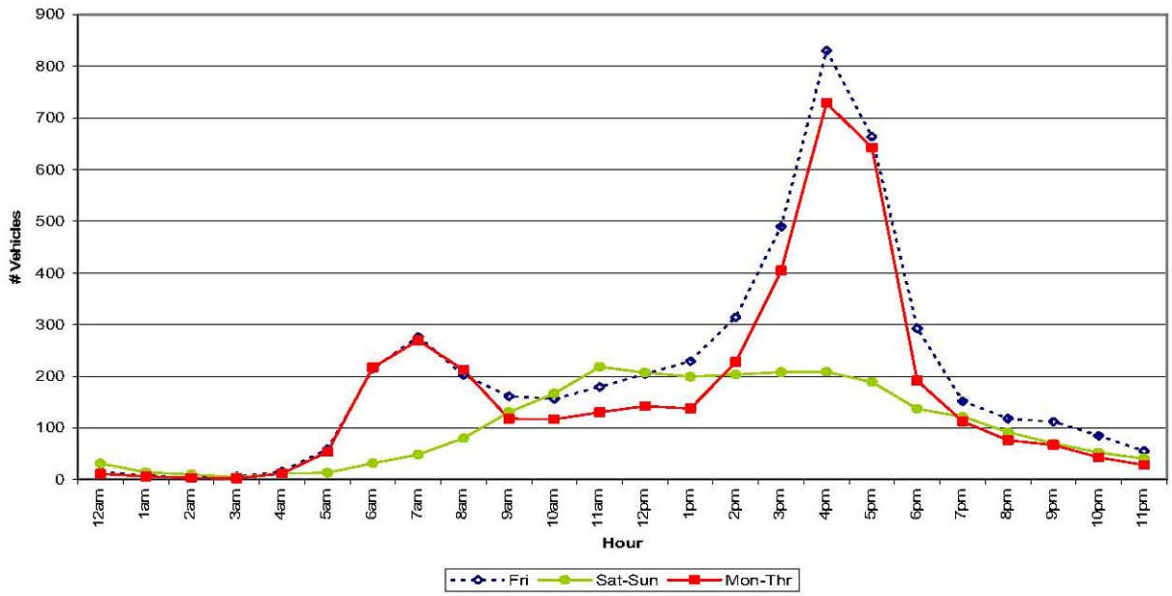
Figure 10.4 Average Hourly Distribution of Vehicles
I-91 Southbound HOV Lane Between Exits 33 and 34



Source: ConnDOT 2008 HOV Report, data collected in 2008.
Note: Motorcycles and violators are not included in the data.

[36] http://www.ct.gov/dot/lib/dot/documents/dpolicy/HovRpt.pdf.

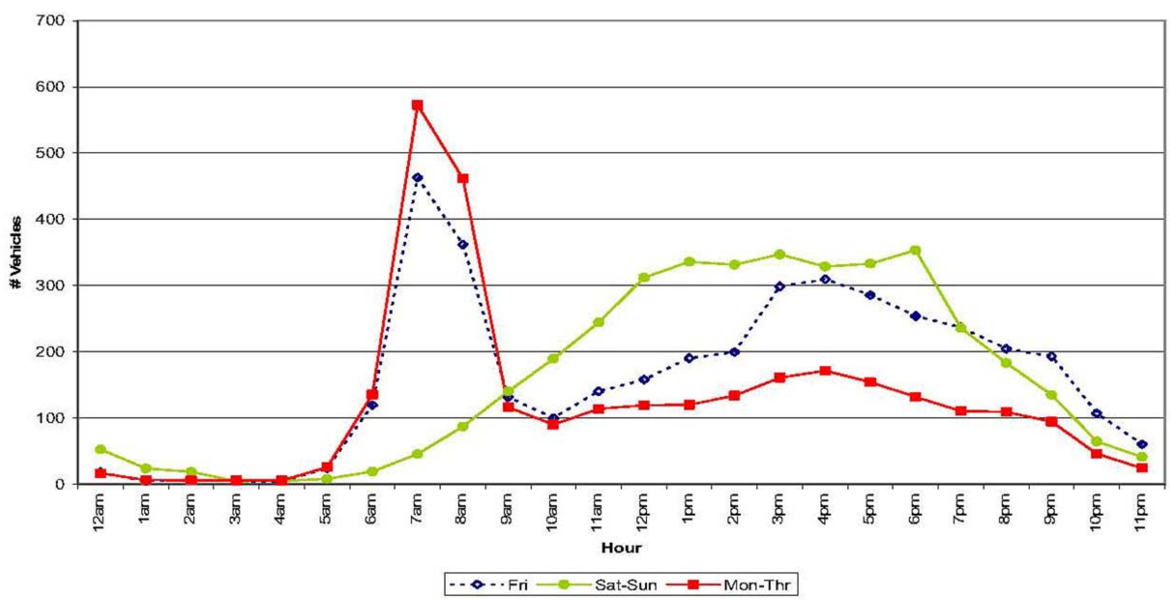
Figure 10.5 Average Hourly Distribution of Vehicles
I-91 Northbound HOV Lane Between Exits 33 and 34



Source: ConnDOT 2008 HOV Report, data collected in 2008.

Note: Motorcycles and violators are not included in the data.

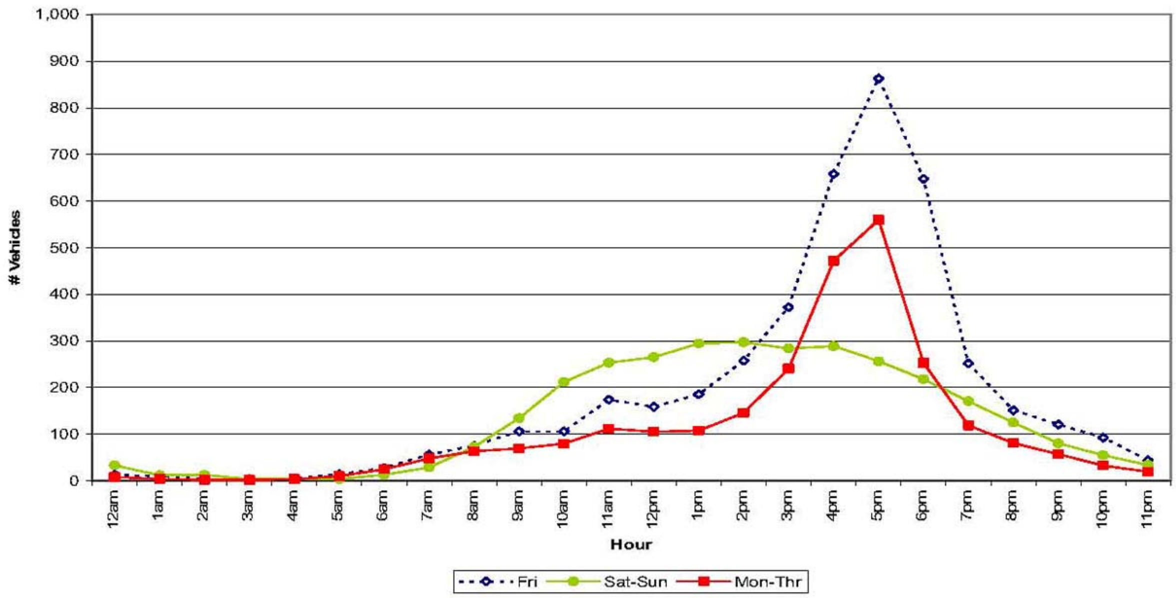
Figure 10.6 Average Hourly Distribution of Vehicles
I-84 Westbound HOV Lane East of HOV On Ramp from I-384



Source: ConnDOT 2008 HOV Report, data collected in 2008.

Note: Motorcycles and violators are not included in the data.

Figure 10.7 Average Hourly Distribution of Vehicles
I-84 Eastbound HOV Lane East of HOV Off Ramp from I-384



Source: ConnDOT 2008 HOV Report, data collected in 2008.

Note: Motorcycles and violators are not included in the data.

Table 10.1 presents the HOV lane traffic at their corresponding peak load points on the I-91 and I-84 HOV lanes. The HOV lanes get the most usage during Fridays on both facilities. On I-91, HOV lane usage is lowest on weekends, while the HOV lane on I-84 has its lowest usage on an average weekday.

Table 10.1 HOV Lane Average Daily Vehicles at Peak Load Point: 2007
I-91 and I-84

Direction	I-91 HOV Lane			I-84 HOV Lane		
(I-91/I-84)	Weekday	Friday	Weekend	Weekday	Friday	Weekend
SB/WB	5,232	7,019	4,141	4,013	5,661	5,230
NB/EB	4,364	5,552	3,111	3,462	5,434	4,153
Total	9,596	12,571	7,252	7,475	11,095	9,383

Source: ConnDOT.

Note: Peak load point on I-91 HOV lane is between Exit 33 and 34. Peak load point on I-84 is west of I-384 merge.

Table 10.2 displays the average daily traffic in the general-purpose lanes and the HOV lane at the HOV lane peak load points on I-91 and I-84. On I-91, the HOV lane traffic accounts for 6.7 percent of the average daily demand across all lanes. In terms of capacity across this section, the HOV lane is 25 percent of the total capacity. This indicates that there is a significant amount of available capacity that can be sold to SOV traffic. A similar relationship is shown for I-84, although the HOV lane represents a smaller percentage of total capacity (5.4 percent) near this location on I-84 since there are five general-purpose lanes at the HOV lane peak load location.

Table 10.2 2007 Average Daily Vehicles at Peak Load Points
I-91 and I-84 GP and HOV Lane

	I-91	Percent Share	I-84	Percent Share
General Purpose Lanes	129,900	93.3%	148,300	94.6%
HOV Lane	9,300	6.7%	8,500	5.4%
Total	139,200	100.0%	156,800	100.0%

Source: ConnDOT.

Note: ADTs are at peak load point on I-91 HOV lane between Exit 33 and 34 and on I-84 is west of I-384 merge. GP ADTs are 2006 levels.

Analysis Methodology

The attractiveness of an HOV lane comes from the travel-time advantage that it can provide over the general-purpose lanes during congested periods. Since the time saving advantage of the HOT lane is typically only significant during several hours of the day, we analyzed traffic flows for the following time periods, based on traffic count data provided by ConnDOT:

- AM1: 6:00 a.m. to 7:00 a.m.;
- AM2: 7:00 a.m. to 9:00 a.m.;
- MD: 9:00 a.m. to 3:00 p.m.;
- PM1: 3:00 p.m. to 4:00 p.m.;
- PM2: 4:00 p.m. to 6:00 p.m.;
- PM3: 6:00 p.m. to 7:00 p.m.; and
- NT: 7:00 p.m. to 6:00 a.m.

We obtained the travel demand model used by the Capitol Region Council of Governments (CRCOG) to estimate growth in future corridor demand. This growth in demand was applied to the 2007 time period levels of demand to create baseline traffic demand levels for 2015 and 2030.

Using this information, we developed a spreadsheet market share model to estimate the amount of SOV traffic by time period and by direction that would use the HOT lane at various toll rates. HOV traffic is assumed to continue to use the HOT lane toll free. Toll rates for SOV traffic were chosen at levels that aimed to maximize revenue wherever possible, but also limiting usage of the HOT lane to 1,650 vehicles per hour so as to maintain free flow conditions for HOVs and buses. Another policy option could be to maximize usage of the facility, bounded by a minimum toll and limiting usage to 1,650 vehicles per hour per lane in the HOT lane. In some instances, maximizing usage also will maximize revenue, but not in all cases.

■ 10.1 Institutional and Legal

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.[37] This means that all that is required is a toll agreement between the FHWA, ConnDOT, and the operating agency in Connecticut. At this point, ConnDOT has not pursued this option. There is no limit to the number of agreements that can be Federally approved. States that wish to create new HOT lanes, or to convert existing HOV lanes into HOT lanes, need to submit an Expression of Interest to the local FHWA division office.

■ 10.2 Technology and Deployment

This concept has very similar considerations to Concept A, except as described in the following sections.

Construction

This concept can utilize existing lane configuration and separation and should not require major construction. The biggest challenge with HOV to HOT lane conversions is usually restricting access to the tolled lanes, but in Connecticut, there already is restricted access and good separation between the lanes.

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[37] Federal Highway Administration, *High Occupancy Vehicle (HOV) Facilities, SAFETEA-LU Section 1121 (23 USC 166)*, [http://ops.fhwa.dot.gov/tolling_pricing/hov_facilities.htm], 8 October 2008.

One way for drivers to declare their high-occupancy status is to provide separate toll point lanes for HOVs and non-HOVs, with tolls only charged in the non-HOV lane while occupancy is verified in the other lane by police officers observing traffic flowing across the toll collection point. This requires traffic to divide appropriately in advance of the toll point and requires sufficient toll payment lanes to support the throughput of traffic under varying non-HOV proportions. Selection of this HOV detection/declaration option may, therefore, require some construction to expand the lane width at the toll points. Other methods, such as the use of roving police officers with enforcement readers would remove the need for these separate lanes, but in this case the system would benefit from the provision of dedicated enforcement facilities.

Technology and Roadside Components

All current HOT deployments require transponders for the paying vehicles. Some also require HOVs to be equipped with transponders. These tags are encoded as HOV or HOT and allow the system to quickly determine whether the vehicle should pay a toll or not. This is often supported by manual, spot compliance checks by law enforcement officers.

If vehicles are detected by their license plate only (under video billing), the system will have difficulty in determining whether a toll should be charged unless the program requires users to preregister their license plate as HOV or HOT.

Roadside equipment would involve standard toll gantries with antennas, readers, and cameras. Typically, trucks are not permitted to use HOT lanes, and so this concept does not require classification equipment. At least in the short term, it is unlikely that vehicle-occupancy detection equipment could be installed roadside because that technology has not yet been proven to work effectively. There is considerable research going on that may change this in the future.

Toll Program Operation

Since the I-84 and I-91 projects are focused on the Hartford area, and the expected toll payers would mostly be commuters, walk-in, retail channels, and customer kiosks need only be focused in the Hartford region. Since this is an optional toll scheme, other similar deployments handle customer interaction via mail, telephone, and web rather than through walk-in centers.

■ 10.3 Potential PPP Approaches

Texas, Minnesota, and Virginia are implementing managed lane projects through PPPs, involving reconstruction of general purpose lanes supported by limited public funding contributions, or implementation of an HOT lane within an existing corridor. Managed lane tolling applications generally are priced at higher per-mile toll rates than typical commuter toll roads, and also are priced variably (time of day) or dynamically (rates which are based on congestion in the managed or general purpose lanes).

Depending on estimated toll revenues, 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. The public sector also needs to consider how geometrics, traffic control devices, HOV vehicle use, and HOV enforcement are altered to provide a more closed tolling system (where everyone pays); otherwise, revenue potential for the managed lane developer may be limited or difficult to estimate. In either case, the private sector is likely to price that revenue/enforcement risk accordingly.

■ 10.4 Privacy

Operationally, this concept is similar to Concept A and so the privacy issues mirror that concept. However, one additional privacy issue for HOT/HOV lanes is that future systems may use HOV enforcement cameras (e.g., infrared cameras, still under development) to count the number of occupants. This introduces a further privacy concern because additional images are taken of the driver and the occupants, so clear guidelines should be introduced to protect this data. Users that do choose to use the tolled lane are disclosing route journey information.

■ 10.5 Technical Analysis of Project D-1 – Interstate 84 HOT Lane

Transportation Impacts

I-84 has the heaviest demand westbound in the morning and eastbound in the afternoon. In the westbound direction during the 7:00 a.m. to 9:00 a.m. period, we estimate there will be 3,000 vehicles in the HOT lane with a corresponding volume of 12,700 vehicles in the general-purpose lanes (Table 10.3). Of the 3,000 HOT lane users, we estimated about 1,400 would be SOV toll payers at a toll of $1 for a full-length trip. A similar pattern is found in the eastbound direction during the 4:00 p.m. to 6:00 p.m. period. More than 50 percent of the estimated usage would occur during these two periods. For an average weekday, we estimate that more than 12,000 vehicles would use the HOT lane from 6:00 a.m. to 7:00 p.m., with about 5,000 of those vehicles paying a toll.

Table 10.3 Forecast Average Weekday Volumes at Peak Load Point: 2015
Project D-1 – Interstate 84 HOT Lane

	2015 Westbound					2015 Eastbound				
		HOT Lane Traffic					HOT Lane Traffic			
Time Period	**GP Traffic**	**HOV**	**SOV**	**Total**	**SOV Toll**	**GP Traffic**	**HOV**	**SOV**	**Total**	**SOV Toll**
6:00 a.m.-7:00 a.m.	5,500	245	205	5,950	$0.75	2,700	25	50	2,775	$0.50
7:00 a.m.-9:00 a.m.	12,700	1,591	1,409	15,700	$1.00	7,400	100	100	7,600	$0.50
9:00 a.m.-3:00 p.m.	27,200	1,005	195	28,400	$0.50	27,100	924	276	28,300	$0.50
3:00 p.m.-4:00 p.m.	4,900	234	66	5,200	$0.60	6,400	387	813	7,600	$0.75
4:00 p.m.-6:00 p.m.	9,600	492	108	10,200	$0.60	14,500	1,469	1,531	17,500	$1.45
6:00 p.m.-7:00 p.m.	4,300	150	50	4,500	$0.50	5,700	312	288	6,300	$0.75
7:00 p.m.-6:00 a.m.	18,700	-	-	18,700	-	19,100	-	-	19,100	-
Total Day	**82,900**	**3,717**	**2,033**	**88,650**	**-**	**82,900**	**3,217**	**3,058**	**89,175**	**-**

Note: SOV toll rate shown is for a full length trip.

We also analyzed the impact of the HOT lane on corridor traffic (Table 10.4). We expect that the overall average speed in the corridor would improve by 4.4 miles per hour during the peak periods, and by 2.0 miles per hour over the entire day. These speed improvements would bring about a reduction in vehicle hours of delay of 34.4 percent during the peak periods, and 29.9 percent over the entire day. Time periods other than 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. experience little congestion and, therefore, the HOT lanes have limited impacts on the operation of the overall corridor during these times.

Table 10.4 Corridor Traffic Operational Impacts: Average Weekday in 2015
Project D-1 – Interstate 84 HOT Lane

	Peak Period (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.)			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT	338,442	338,442	0	0.0%
VHT	6,817	6,264	-553	-8.1%
Average Speed	49.7	54.0	4.4	8.8%
Vehicle Hours of Delay	1,610	1,057	-553	-34.4%

Table 10.4 Corridor Traffic Operational Impacts: Average Weekday in 2015 (continued)
Project D-1 – Interstate 84 HOT Lane

	Total Day			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT	1,206,616	1,206,616	0	0.0%
VHT	20,910	20,209	-701	-3.4%
Average Speed	57.7	59.7	2.0	3.5%
Vehicle Hours of Delay	2,347	1,646	-701	-29.9%

Transit Impacts

CTTransit offers several express bus routes on I-84 both east and west of Hartford. Services offered on two routes (3 and 17) extend as far east as Rockville and Vernon and as far west as Cheshire. Many CTTransit local bus routes also are operated along this corridor throughout the greater Hartford region from Plainville to Vernon. Express services are frequent during the peak periods and focus primarily on the Capitol area and Asylum Hill.

Private carriers, including Peter Pan/Arrow Line and Collins Bus Service, also operate express services east of Hartford in the I-84 corridor, thus providing additional capacity and commuting options from Vernon, Willimantic, Mansfield, Columbia, Andover, Coventry, and Bolton.

While the shift from HOV to HOT lanes in this corridor would not provoke a significant change in driving habits, the express bus network into Hartford is rich and provides for alternatives to driving in several corridors. East of Hartford, CTTransit serves four park-and-ride lots in the I-84 corridor to facilitate express bus commuting. Since toll rates will be set so as to maintain free flow speeds in the HOT lanes, there should be no impact on bus travel times.

Toll Revenue Estimates

Annual toll revenue of $0.9 million and $2.0 million is estimated for the I-84 HOT lane for 2015 and 2030, respectively (Table 10.5) in 2008 dollars.

Table 10.5 Forecast HOT Lane Annual Toll Revenue: 2008 Dollars
Project D-1 – Interstate 84 HOT Lane

Year	Annual Toll Revenue
2015	$935,000
2030	$2,030,000

Implementation Requirements

The two projects in this concept individually cover over 11 and 8 miles of roadway and aim to provide a reliable level of service to travelers opting to use the express lanes. We assumed that entrance and exit points will correspond to the existing freeway entrance and exits and that all travelers using the HOT lanes will be charged. Because all traffic passes through a single point on the HOT lane, only a single tolling point is required in each direction of travel.

HOT lanes are normally limited to passenger vehicles and so this project would not require deployment of extensive classification equipment to determine vehicle class for differential tolls, although some equipment may be required to detect separate vehicles passing beneath the gantries. However, to optimize use of the lanes, dynamic pricing would be used requiring deployment of an extensive traffic sensor network, CCTV cameras for viewing vehicle flow and dynamic message signs to communicate the current toll rate. Since there will be a requirement to clear incidents quickly, this concept would require deployment of additional roadside assistance trucks and personnel. Since equipment will be distributed along the length of this roadway, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The back-office needs for this project are fairly modest due to the relatively small number of transactions and, therefore, the low number of accounts required even for the combination of both projects. We would expect that all users will be required to have tags, which cuts down on the level of video processing required but slightly increases the number of accounts anticipated. Given these limitations, the back-office would be of minimal size and, for most years, the pricing uses a minimum annual cost for running such an operation rather than a per account charge. Given the low volume of accounts and that use of the tolled facility is optional; this concept does not require any walk-in centers. Due to the small geographic area covered by the projects, only a small number of retail channels are anticipated to support account payment through partnership with a store chain.

Toll Collection Costs

Table 10.6 identifies the total costs to implement and operate the new toll express lanes projects over 30 years for the individual and combined projects.

Table 10.6 Life-Cycle Toll Collection Costs (Millions) Concept D: HOT to HOV Lane Conversion

Scenario	Total Capital Cost	Total O&M Cost	Total
Project D-1: I-84 – East of Hartford	$19.5	$72.5	**$91.9**
Project D-2: I-91 – North of Hartford	$25.3	$76.1	**$101.4**
All Projects Combined, D-1 and D-2	$41.8	$94.3	**$136.1**

Capital cost for these projects is reduced because only a single tolling point is required for each direction of travel (rather than a tolling point every segment as per other concepts). About 12 percent of the capital is to cover tag purchases over the 30 years. As stated above, for these projects the back-office operating costs are calculated using the minimum cost to run a dedicated back office to process the transactions but still contribute about 44 percent of the O&M costs. The toll equipment maintenance costs make up about 21 percent of the ongoing costs. Due to the fairly small size of the program, overall management labor makes up a significant percentage of the cost at 15 percent of the ongoing costs. Roadside service and law enforcement costs are estimated at about 6 percent of the O&M costs. In the combined project, the back office becomes large enough toward the end of the 30 years to exceed the minimum operating cost and be priced on a per account basis. Credit card processing revenue costs are an extremely small percentage in this concept (<2 percent) due to the low amount of revenue being processed.

Implementation Strategy

There already is an established network of HOV lanes in Connecticut, so the further studies to examine converting these to HOT lanes should be reasonably straightforward. Legislation is required for this conversion, but not at the Federal level. However, a toll agreement is needed with FHWA which may extend the approval process. As with Concept A, drivers using this roadway are not forced to pay the toll (they can choose a non-tolled lane), so consensus building may be shorter than would be expected if the toll was unavoidable.

HOT lanes have been implemented in many other places in the United States, from which experience can be derived. Industry estimates suggest two tolling points can be constructed per month for a project of this nature, which results in a roadside construction duration of approximately 6 to 12 months. It is likely a small amount of roadway construction will be required along the tolled roads, such as enforcement plazas and drainage.

Accordingly, the tasks to implement this concept, and their likely durations, are noted below in Table 10.7:

Table 10.7 Illustrative Implementation Durations
Project D-1 – Interstate 84 HOT Lane

Task	Duration
Further Studies and Consensus Building	24 months
Studies Sufficient for Funding	12 months
Legislation and Funding	24 months
Assemble Program Staff	9 months
Procurement	12 months
Design	6 months
Build – Highway	12 months
Build – Roadside Equipment	12 months
Build – Back-Office	6 months
Test	3 months
Distribute Tags	6 months
Go-Live	0

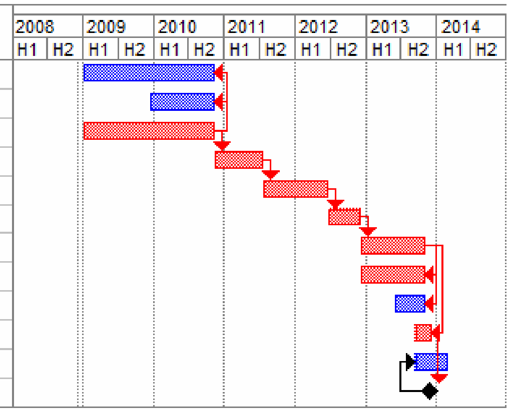
Implementation Schedule

There are many ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability.

One such arrangement is detailed in the Gantt chart in Figure 10.8 below; this format allows key dependencies to be highlighted and the critical path[38] to be identified (in red). Under this schedule the project could be completed by 2014.

Figure 10.8 Illustrative Implementation Schedule
Project D-1 – Interstate 84 HOT Lane

ID	Task Name	Duration	Predecessors
1	Further studies and consensus building	24 mons	3FF
2	Studies sufficient for funding	12 mons	3FF
3	Legislation and funding	24 mons	
4	Assemble program staff	9 mons	3
5	Procurement	12 mons	4
6	Design	6 mons	5
7	Build - highway	12 mons	6
8	Build - roadside equipment	12 mons	7FF
9	Build - back office	6 mons	7FF
10	Test	3 mons	7FF+1 mon
11	Distribute tags	6 mons	12SS-3 mons
12	Go-live	0 mons	10



Environmental

Project D-1 would be located exclusively in the northeastern portion of the Hartford metropolitan area. This is a highly developed urban area transitioning to more suburban character northeast of Hartford. Project D-1 is expected to have no adverse impacts to environmental resources. There will be no diversion of traffic to local roads and there will be minimal change to traffic flow patterns on the affected highways.

Project D-1 is expected to have a beneficial effect on the Hartford metropolitan area in terms of the following as shown in Table 10.8 and Figure 10.9:

- **Air Quality –** While vehicle miles of travel remains constant among the projects, vehicle hours of travel, and vehicle hours of delay will both decrease with Project D-1. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions.

- **Energy Use and Conservation –** Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be

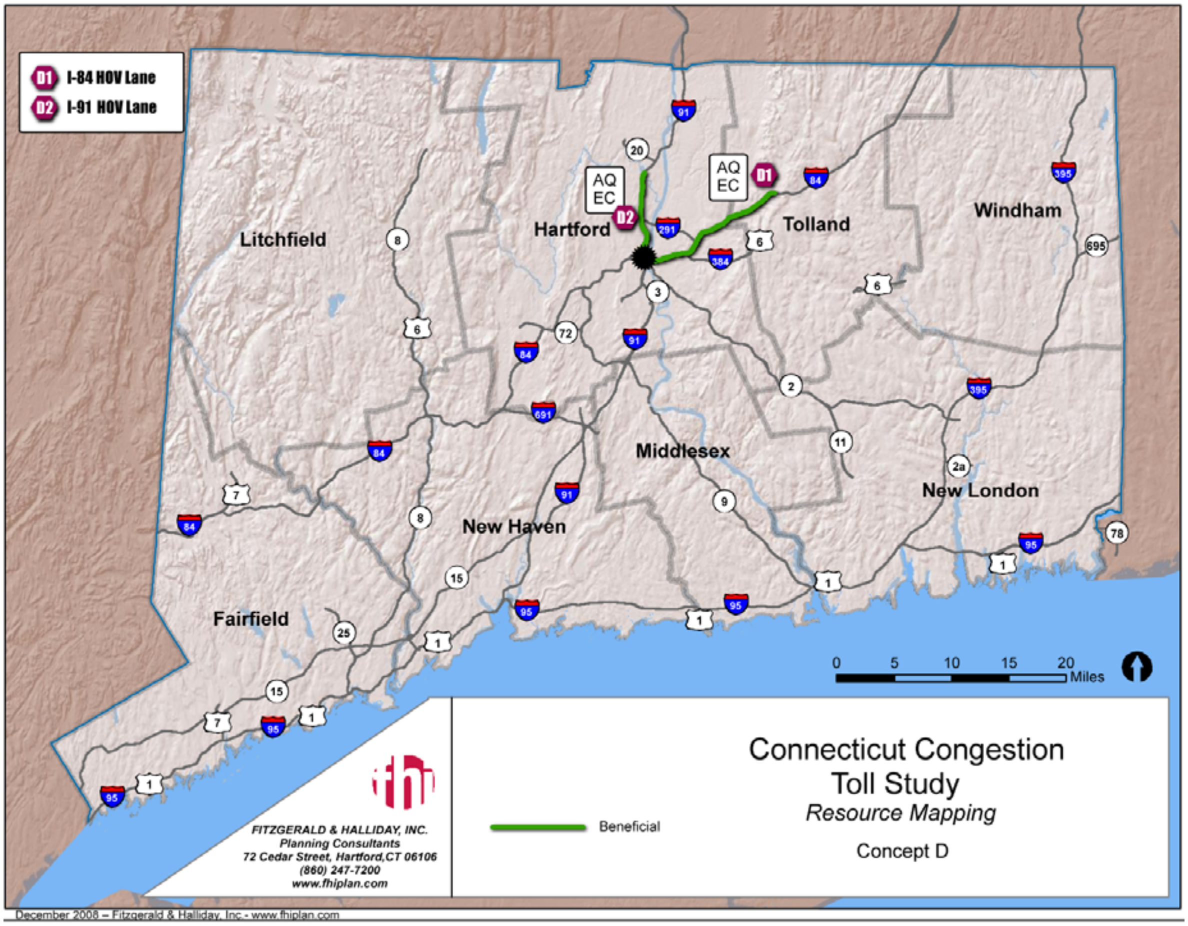
[38] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

expected to be consumed due to vehicles sitting in traffic, yet speeds will not increase to a degree that would result in an overall drop in miles-per-gallon achieved.

Table 10.8 Environmental Impact Summary
Project D-1 – Interstate 84 HOT Lane

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Natural			
Water Quality (WQ)	No		
Air Quality (AQ)	Yes	Beneficial	D1 – I-84-Hartford to Exit 64 (Vernon)
Social/Community			
Community Disruption (CD)	No		
Bicycle and Pedestrian (BP)	No		
Noise (NS)	No		
Energy Use/Conservation (EC)	Yes	Beneficial	D1 = I-84-Hartford to Exit 64 (Vernon)
Environmental Justice (EJ)	No		
Cultural/Historic (CH)	No		

Figure 10.9 Environmental Impact Locations
Project D-1 – Interstate 84 HOT Lane



Economics

As the proposal merely expands the options available to all travelers in terms of their ability to take advantage of a higher-speed option, this concept is not expected to raise any significant economic issues. The travel-time benefits of using the lane are always available for those days, for example, when one is running late, has an important appointment, or other personal or business reasons for using the lane. The extent to which the toll revenue could be used to support expanded transit services would effectively expand the market reach of these services, thereby increasing the economic strength of the Greater Hartford Area.

Equity

As the proposal merely expands the options available to all travelers in terms of their ability to take advantage of a higher-speed option, this concept is not expected to raise any significant horizontal or vertical equity issues or concerns. Studies have shown that the income levels in the cars in these types of HOT express lanes is considerably more mixed than implied by the often-stated "Lexus lane" name attributed to such facilities. The travel-time benefits of using the lane are always available for those days when any given individual needs to use them.

Safety

Conversion of existing HOV lanes to HOT express lanes would result in similar safety and operational issues as Concept A above. For enforcing occupancy requirements, HOT lanes also may require accommodating ***enforcement areas*** along the facility for which adequate pull in-pull out sites must be designed. These enforcement areas may be within the median area or on the outside shoulder areas depending on the geometric configuration of the highway.

In addition, HOT lanes are designed to promote driver safety. Closed-circuit video cameras and traffic sensors would continuously monitor the HOT lane and identify incidents and accidents within seconds. Incident response crews will be deployed to manage incidents quickly, in cooperation with first responders and emergency service providers. Electronic signs will alert motorists of incidents ahead.

10.6 Technical Analysis of Project D-2 – Interstate 91 HOT Lane

Transportation Impacts

The hourly demand profile for I-91 also suggests commuting travel patterns where the heaviest demand is southbound in the morning and northbound in the afternoon, but unlike I-84, there also is significant reverse commute travel during the AM and PM peak periods, respectively. In the southbound direction during the 7:00 a.m. to 9:00 a.m. period, we estimate 2,700 vehicles in the HOT lane with a corresponding volume of 8,600 vehicles in the general purpose lanes (Table 10.9). Of the 2,700 HOT lane users, we estimate about 1,100 would be SOV toll payers at a toll of $0.85 for a full length trip. A similar pattern is found in the northbound direction during the 4:00 p.m. to 6:00 p.m. time period. For an average weekday, it is estimated that 21,450 vehicles would utilized the HOT lane from 6:00 a.m. to 7:00 p.m., with about 12,000 of those vehicles paying a toll.

Table 10.9 Forecast Average Weekday Volumes at Peak Load Point: 2015
Project D-2 – Interstate 91 HOT Lane

	2015 Southbound					2015 Northbound				
		HOT Lane Traffic					HOT Lane Traffic			
Time Period	**GP Traffic**	**HOV**	**SOV**	**Total**	**SOV Toll**	**GP Traffic**	**HOV**	**SOV**	**Total**	**SOV Toll**
6:00 a.m.-7:00 a.m.	4,100	280	620	5,000	$0.55	4,000	229	521	4,750	$0.60
7:00 a.m.-9:00 a.m.	8,600	1,583	1,117	11,300	$0.85	8,600	513	1,587	10,700	$0.75
9:00 a.m.-3:00 p.m.	23,300	1,223	1,477	26,000	$0.50	22,800	1,011	1,689	25,500	$0.50
3:00 p.m.-4:00 p.m.	4,400	612	738	5,750	$0.70	4,800	446	754	6,000	$1.00
4:00 p.m.-6:00 p.m.	8,800	1,297	1,403	11,500	$0.85	9,400	1,541	1,459	12,400	$1.00
6:00 p.m.-7:00 p.m.	3,990	253	347	4,500	$0.60	3,900	334	416	4,650	$0.55
7:00 p.m.-6:00 a.m.	17,400	-	-	17,400	-	17,500	-	-	17,500	-
Total Day	70,500	5,248	5,702	81,450	-	71,000	4,074	6,426	81,500	-

Note: SOV toll rate shown is for a full length trip.

Estimates of operating conditions in the general purpose lanes and the express lanes were summarized for No Build (HOV lanes exist as they do today) and Build conditions (HOV lanes converted to HOT lane operation). Table 10.10 provides a summary of the overall corridor for the peak periods and total day. The overall average speed of the corridor is estimated to be improved by nearly seven miles per hour during the peak periods, and by 4 miles per hour over the entire day. A significant reduction in vehicle hours of delay is estimated to occur throughout the day. Operational improvements to I-91 under HOT lane operations are estimated to occur over more hours of the day than on I-84. This can be attributed to I-91 showing less directionality during peak periods than the I-84 corridor, and relatively significant traffic levels during shoulder time periods. This would seem to indicate that travel characteristics of the I-91 corridor make it a better candidate for conversion of the HOV lane.

Table 10.10 HOT Lane Corridor Operational Impacts: 2015
Project D-2 – Interstate 91 HOT Lane

	Peak Period (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.)			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT	324,904	324,904	0	0.0%
VHT	7,414	6,419	-995	-13.4%
Average Speed	43.8	50.6	6.8	15.5%
Vehicle Hours of Delay	2,416	1,420	-995	-41.2%
	Total Day			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT	1,151,677	1,151,677	0	0.0%
VHT	21,953	20,320	-1,633	-7.4%
Average Speed	52.5	56.7	4.2	8.0%
Vehicle Hours of Delay	4,235	2,602	-1,633	-38.6%

Transit Impacts

In the I-91 corridor north of Hartford, express bus services are provided by CTTransit, including two primary routes and three park-and-ride lots. The service extends north to Windsor, Windsor Locks, and Enfield.

Available capacity in the I-91 corridor is similar to that of the I-84 corridor in that modest diversions from the highway to transit as a result of tolling would be accommodated by the existing network. Furthermore, service could be expanded in terms of frequency and geographic scope with additional funding resources generated through the tolling HOT lane tolling mechanism. No degradation of transit service travel time should be expected.

Toll Revenue Estimates

We estimate $2.0 million and 4.1 million in toll revenue for the I-91 HOT lane for 2015 and 2030, respectively (Table 10.11). All revenue is assumed to be in year 2008 dollars. These revenue estimates are about twice the amount estimated for the I-84 corridor.

Table 10.11 Forecast Annual Toll Revenue: 2008 Dollars
Project D-2 – Interstate 91 HOT Lane

Year	Annual Toll Revenue
2015	$2,024,000
2030	$4,133,000

Implementation Requirements

Implementation requirements are the same as those for Project D-1.

Implementation Strategy

Implementation strategy and schedule is similar to Project D-1.

Environmental

Alternative D-2 also would be located exclusively in the northern portion of the Hartford metropolitan area. This is a highly developed urban area transitioning to more suburban character north of Hartford. Alternative D-2 is expected to have no adverse impacts to environmental resources. There will be no diversion of traffic to local roads and there will be minimal change to traffic flow patterns on the affected highways. Impacts are summarized in Table 10.12 and shown in Figure 10.10.

Alternative D-2 is expected to have a beneficial effect on the Hartford metropolitan area in terms of:

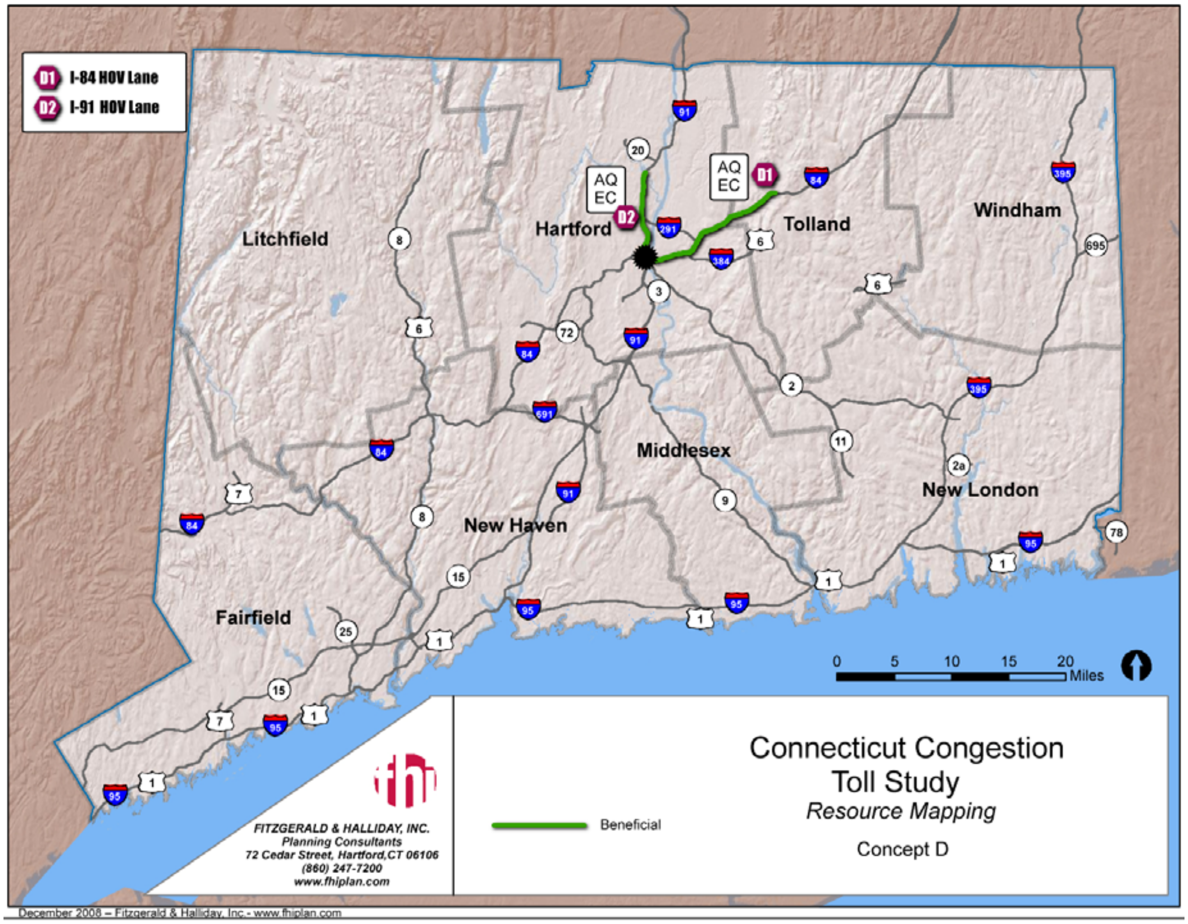
- **Air Quality –** While vehicle miles of travel remains constant among the alternatives, vehicle hours of travel and vehicle hours of delay both decrease with Alternative D-2. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions.

- **Energy Use and Conservation –** Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be expected to be consumed due to vehicles sitting in traffic yet speeds will not increase to a degree that would result in an overall drop in miles-per-gallon achieved.

Table 10.12 Summary of Environmental Impacts
Project D-2 – I-84 HOT Lane

Resource	Potential Impact	Impact Description	
		Magnitude	Location
Natural			
Water Quality (WQ)	No		
Air Quality (AQ)	Yes	Beneficial	D2 – I-91-Hartford to Route 75
Social/Community			
Community Disruption (CD)	No		
Bicycle and Pedestrian (BP)	No		
Noise (NS)	No		
Energy Use/Conservation (EC)	Yes	Beneficial	D2 – I-91-Hartford to Route 75
Environmental Justice (EJ)	No		
Cultural/Historic (CH)	No		

Figure 10.10 Environmental Impact Locations
Project D-2 – Interstate 91 HOT Lane



Economics

All economic impacts are identical to those discussed under D-1.

Equity

All equity issues are identical to those discussed under D-1.

Safety

All safety issues are identical to those discussed under D-1.

10.7 Technical Analysis of Project D-3 – Combined HOT Lanes

Toll Revenue Estimates

Annual revenue estimates for the I-91 and I-84 HOT lanes were added together, reflecting the potential implementation of both projects (Table 10.13). Total revenue is estimated to be $2.9 million and $6.2 million for 2015 and 2030, respectively in 2008 dollars.

Table 10.13 Forecast HOT Lane Annual Toll Revenue: 2008 Dollars
Project D-3 – Combined HOT Lanes

Year	Annual Toll Revenue
2015	$2,959,000
2030	$6,163,000

Implementation Requirements

Implementation requirements are identical to the individual HOT lane conversions.

Implementation Strategy

Strategy and schedule are similar in nature to project D-1, except that implementing both projects in this concept may increase the duration of the further studies, design and build time due to greater geographical coverage, and the larger number of tolling sites required, although some time saved may be realized through efficiencies of scale and conducting construction work in parallel.

Environmental

Alternative D-3 is expected to have the combined effects of Alternatives D-1 and D-2. The cumulative effect of these two alternatives is expected to be an overall beneficial impact to air quality and energy use/consumption in Hartford metropolitan region.

Economics

All economic impacts are identical to those discussed under D-1.

Equity

All equity issues are identical to those discussed under D-1.

Safety

All safety issues are identical to those discussed under D-1.

10.8 Financial Analysis of Concept D – HOV to HOT Lane Conversion

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 (Table 10.14). 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 $17.7 million over a 30-year period, and fall just $1.3 million shy of covering the capital cost of toll collection. This could warrant a second look in a more detailed study.

Table 10.14 Financial Analysis of Concept D – HOV to HOT Lane Conversion

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	(16.9)	17.7
Initial Capital Cost of Toll Collection System	13.4	19.0
Total Highway Construction Costs	0	0
Life-Cycle Surplus/(Shortfall)	**(30.3)**	**(1.3)**

Table 10.15 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for Project D-1. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Positive net revenues for Project D-1 are not generated until after 2030. Significant toll collection capital costs are projected every eight years for Project D-1 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 10.15 Annual Toll Revenue and Expense Estimates Concept D-1 – I-84 HOV to HOT Lane Conversion
(Millions of Year-of-Expenditure Dollars)

			Annual Costs			
Year	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.84	$1.1	$0.1	3.0	0.1	(2.1)
2020	$1.09	$1.7	$0.1	3.3	0.2	(1.8)
2025	$1.40	$2.6	$0.1	3.8	0.2	(1.5)
2030	$1.80	$3.9	$0.2	4.4	4.6	(5.3)
2035	$2.30	$5.5	$0.3	5.1	0.1	0.0
2040	$2.94	$7.7	$0.4	5.9	0.1	1.3

Table 10.16 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for Project D-2. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Positive net revenues for Project D-2 are not generated until after 2024, and additional shortfalls are projected for 2030, when significant recurring toll collection capital costs are projected. Significant toll collection capital costs are projected every eight years for Project D-2 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 10.16 Annual Toll Revenue and Expense Estimates
Concept D-2 – I-91 HOV to HOT Lane Conversion
(Millions of Year-of-Expenditure Dollars)

			Annual Costs			
Year	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.77	$2.5	$0.1	3.4	0.3	(1.4)
2020	$1.00	$3.7	$0.2	3.4	0.3	(0.3)
2025	$1.29	$5.4	$0.3	3.9	0.3	0.8
2030	$1.68	$7.9	$0.4	4.5	4.1	(1.1)
2035	$2.14	$11.2	$0.6	5.3	0.2	5.1
2040	$2.74	$15.8	$0.8	6.3	0.1	8.6

11.0 Concept E – Convert Highway Shoulders to HOT Lanes

Project Description and Overview

A High-Occupancy Toll (HOT) lane is an example of a "managed lane" – i.e., one in which the lane's usage by time of day, type of vehicle, etc. are managed to increase the highway's overall efficiency. A HOT lane is a High-Occupancy Vehicle (HOV) lane that allows vehicles with lower than HOV-level occupancy to access the lane with the payment of a toll. HOT lanes when implemented as part of a highway expansion are generally implemented as a means of improving the efficiency of the overall highway (moving more people per lane) while raising revenue to help finance the highway expansion. In some instances (such as Concept D), existing HOV lanes are proposed for conversion to HOT lanes to improve the highway lane's utilization and effectively selling unused lane capacity. In general, for HOT lanes to be successful, the following assumption should be present:

- HOT lanes should be incorporated into existing or planned HOV lanes where possible; and
- There must be recurring congestion in the highway segment in which the HOT lane is proposed, as the HOT lanes would offer drivers the choice to avoid congestion and reduce travel time by paying a HOT lane toll.

HOT lanes should not be created by taking away an exiting general traffic lane.

To date, HOT lanes have generally not been self-supporting – i.e., they do not generate sufficient revenue to cover their capital and operating costs.[39]

Concept E would involve the conversion of an existing highway shoulder to a concurrent-flow (i.e., in the same direction of travel as the other lanes) HOT lane for a portion of the day when there is congestion in the corridor. In some proposals, buses and HOVs (i.e., cars or vans with 3+ passengers) would be able to use the shoulder HOT lane for free, although a variety of usage and tolling policies for such a lane are possible.

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[39] *State of the Practice for Managed Use Lane Projects*, Prepared by TTI for NYSDOT, May 2008.

The shoulder HOT lane would not be physically separated from the other freeway lanes (e.g., by a concrete barrier), but instead use pavement markings, delineators and signage wherever possible to reinforce and indicate the separation of the general use lanes and the shoulder HOT lane. However, it must be noted that driving on the shoulder takes some getting used to. As a result, there could be adverse safety and operational implications of converting a shoulder to HOT lane use. In addition, it is usually necessary to construct pull-off areas to where breakdowns and incidents can be moved, but the use of shoulders will nevertheless often result in an increase in the impact of incidents on traffic flow. As in any transportation strategy, safety is paramount for managed lanes. Research has suggested that with the implementation and operation of an HOV or HOT lane, crashes should not increase and that the crash rate should be lower in the HOV lane than on the freeway main lanes. However, creation of the HOV/HOT lane facility can be problematic if it requires the narrowing or elimination of main traffic lanes or shoulders especially for older highways which already are often substandard in terms of their geometry or their ability to handle existing traffic.[40],[41]

Potential Candidate Highway Segments for Shoulder HOT Lanes

The highway segments within Connecticut that would be potential candidates for conversion of a shoulder to a HOT lane would be (see Figure 11.1):

- Sections of I-95 between Bridgeport and the NY state line;
- Sections of I-84 and I-91 within the Greater Hartford area; and
- Sections of CT Route 15 roughly between Bridgeport and the NY state line.

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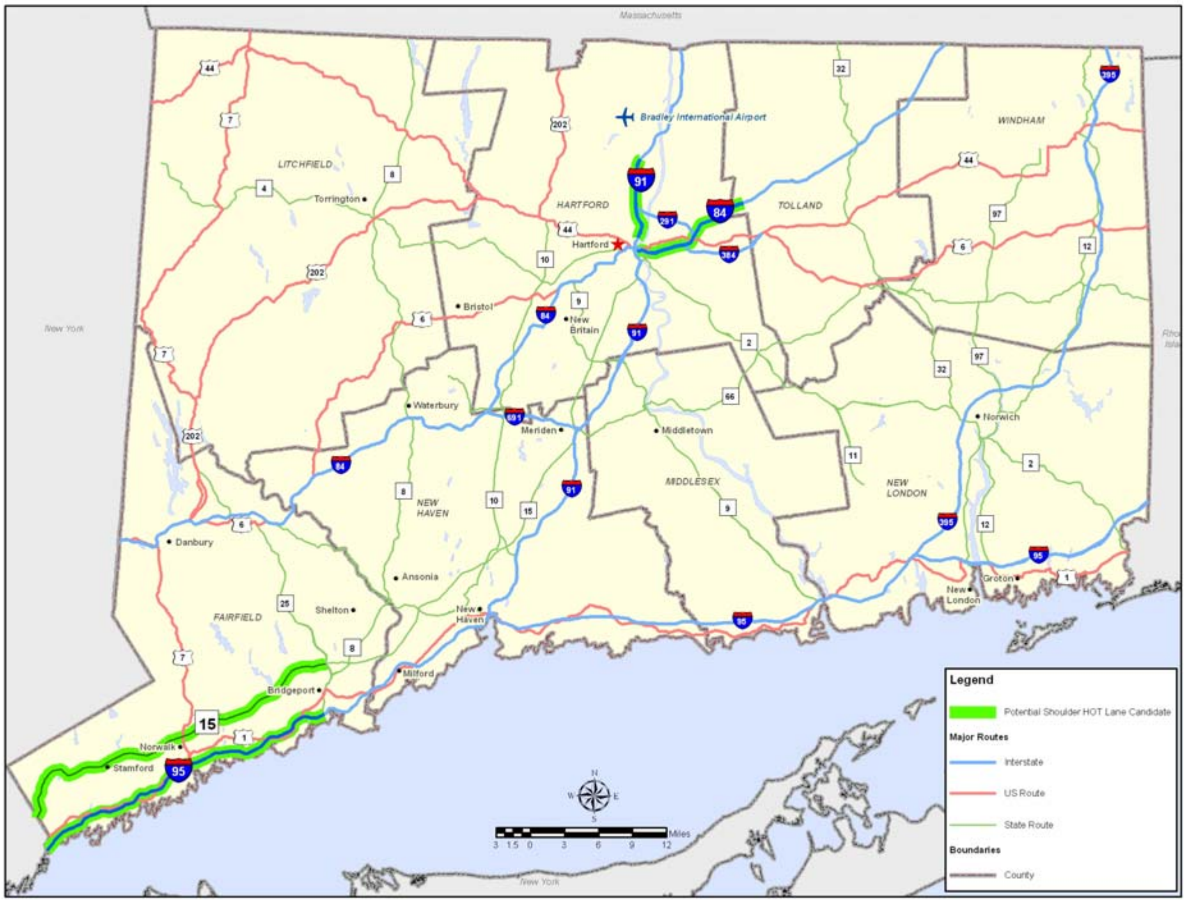
[40] *Performance Measure Initiative*, National Transportation Operations Coalition, Final Report, Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., 2005.

[41] *Current State-of-the-Practice for Managed Lanes,* Prepared by TTI.

Figure 11.1 Concept E – Convert Highway Shoulders to HOT Lanes



■ 11.1 Institutional and Legal

If Connecticut were to examine converting existing shoulders to HOT lanes, this could be accomplished through the Express Lanes Demonstration Program. The program allows for tolling to finance added Interstate capacity for the purposes of reducing congestion and conversion of shoulders would likely qualify. Conversion of shoulders to HOT lanes on any highways not constructed with Federal money would not require Federal approval. One benefit of this program is that income generated in excess of that needed to maintain the highway facility also can be used for other transportation projects, including transit.

There are no specific design standards for HOT lanes but the agreement with the Federal government does require that the State establish a program to address what types of vehicles will be allowed and which will be tolled (e.g., those not meeting the minimum occupancy requirements to use an HOV lane). Variable tolls also must be used to manage demand and violations must be enforced.

■ 11.2 Technology and Deployment

This concept has very similar considerations to Concepts A and D, except as described in the following section.

Construction

Because this concept converts existing shoulders to HOT lanes, extensive lane separation is required. This might include paint or physical separation methods. Furthermore, it is highly likely that an upgrade of the shoulder surface will be required to allow traffic to use it at highway speeds.

■ 11.3 Potential PPP Approaches

From a PPP perspective, Concept E is no different from Concept D, except that revenue production from a shoulder-running HOT lane is likely to be less than for a conventional HOT lane because the free-flow speeds would be slower. Lower revenue would mean less interest from private investors for a project with revenue risk. However, PPP without revenue risk would still be potentially viable.

■ 11.4 Privacy

Operationally this concept is similar to Concept D, and so the privacy issues mirror that concept. Users that do choose to use the tolled lane are disclosing route journey information.

11.5 Technical Analysis of Concept E – Convert Highway Shoulders to HOT Lanes

When Would Creating a HOT Lane on a Highway Shoulder be Possible

There are a number of considerations that need to be addressed to identify if this concept could be considered for any of the highway corridors within Connecticut.[42] It would be desirable for a managed lane, such as an HOV or HOT lane, to be 12-feet wide. In addition, it would be desirable for there to be an additional 4 feet of lateral clearance to any obstructions. Where these dimensions are not achievable, reduced dimensions of 11 feet for lane width and 2 feet for lateral clearance may be considered.

To allow for various vehicles (e.g., buses, trucks, cars) to use the managed lane, it would be desirable for there to be 16.5 feet of vertical clearance. Where this dimension is not achievable, a reduced dimension of 14.5 feet for vertical clearance may be considered. These horizontal and vertical dimensions for the HOT lane would need to be available for the entire length of the corridor in which the concept is being considered. It would be undesirable to have a situation where, due to bridge abutments or other constraints that reduce the available width, the lane would not be continuous. Any situation where it would be necessary to terminate the HOT lane until the necessary dimensions are again available would compound safety and operational concerns as drivers merge out of and into the HOT and general purpose lanes.

It may be envisioned that this treatment could be considered only for the left or inside shoulder of the highway in question. Usage of the right or outer shoulder would create conflicts and operational problems at ramp entry and exit locations where merging and diverging movements occur. In addition, the usage of either shoulder would remove it from being used to clear incidents and crashes from the through travel lanes. Shoulder usage for a HOT lane also would impede access to or from an incident scene by emergency responders.

It also must be noted that HOT enforcement is typically performed from the shoulder abutting the HOT lane. If the shoulder itself is used as the HOT lane, the question is raised as to how enforcement will be performed. High-speed enforcement area design usually involves spacing multiple areas periodically along facilities that have multiple at-grade access locations or are lacking continuous shoulders wide enough for enforcement. These areas are usually designed for monitoring traffic and apprehending violators.

I-84 and I-91 north of Hartford already have HOV lanes, and their conversion to HOT lane use has been separately analyzed in this report. Therefore, no further consideration of these options is provided here.

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[42] *Managed Lanes Handbook,* Prepared by TTI for the Texas Department of Transportation (TxDOT), October 2005.

CT Route 15 (Merit Parkway) is a narrow, generally two-lane parkway with often tight geometry, substandard interchange design, little or no paved shoulders, and overpass widths that would preclude the provision of an additional lane. The lanes also are not suitable for use by buses. Overall, these conditions preclude the creation of shoulder HOT lanes along the Merit Parkway.

Geometric limitations also exist within the often congested section of I-95 in southwestern Connecticut. The continuous availability of at least 15 feet of horizontal width and 14.5 feet of vertical clearance, especially along the highway's inner shoulder, is rarely available for a sufficiently long stretch to make such a plan effective or financially attractive. Without these conditions being met, any such shoulder conversion would create unsafe conditions for HOT lane users, as well as those in adjacent general purpose lanes. It would be physically possible to expand the overall highway sufficiently to create the necessary conditions for shoulder HOT lane operation. However, the required amount of highway reconstruction, property takings, and related costs would be extensive, and would likely lead to adverse impacts (e.g., property takings, extensive and disruptive construction periods, etc.) within those communities in which these highway widenings would occur.

Proposals Elsewhere for HOT Lane Installation on Highway Shoulders

As part of Federal Highway Administration's Urban Partnership Program, Minnesota DOT is progressing a project in the Twin Cities Metropolitan Area to convert narrow bus-only shoulder lanes along the northbound portion of Interstate 35W between 46th Street and downtown Minneapolis to wider, priced dynamic shoulder lanes (PDSL). The former bus-only lane also will be moved from the right-most (i.e., outer) shoulder to the left-most (i.e., inner) portion of the roadway to minimize conflict with entering vehicles. Buses and high-occupancy vehicles will operate at no charge in the PDSL, with access allowed during peak times to single-occupant vehicles whose drivers are willing to pay the toll. Prices would vary with the level of congestion in the PDSL to ensure the free-flow traffic conditions in that lane that are necessary for it to be attractive to potential users.[43] Further information provided by Minnesota DOT indicated that the total shoulder width for this 2.5-mile section will be between 15.5 and 17.5 feet wide, including an 11- to 12-foot wide shoulder lane, a 2-foot buffer between the left-most travel lane and the shoulder lane, and a 2.5- to 3.5-foot inside buffer.

Conclusion: Potential HOT Lanes on Existing Highway Shoulders

The example from Minneapolis shows that if there is sufficient horizontal and vertical clearance along a highway segment to meet the minimum requirements for a shoulder

[43] FHWA Tolling and Pricing Program web site: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/projects/involving_tolls/priced_lanes/express_toll_lanes/mn_pricedymshldlanes.htm.

HOT lane, then such a plan could provide substantial additional vehicle and person-moving capacity to that corridor at a relatively modest price. However, review of conditions along potential highways in Connecticut indicates that there is only one potential highway corridor where this could be remotely feasible – sections of I-95 between Bridgeport and the New York state line – but where there are serious barriers as well:

- The minimum clearances for HOT lane operation generally do not exist, making it impossible 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[44,45], 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.

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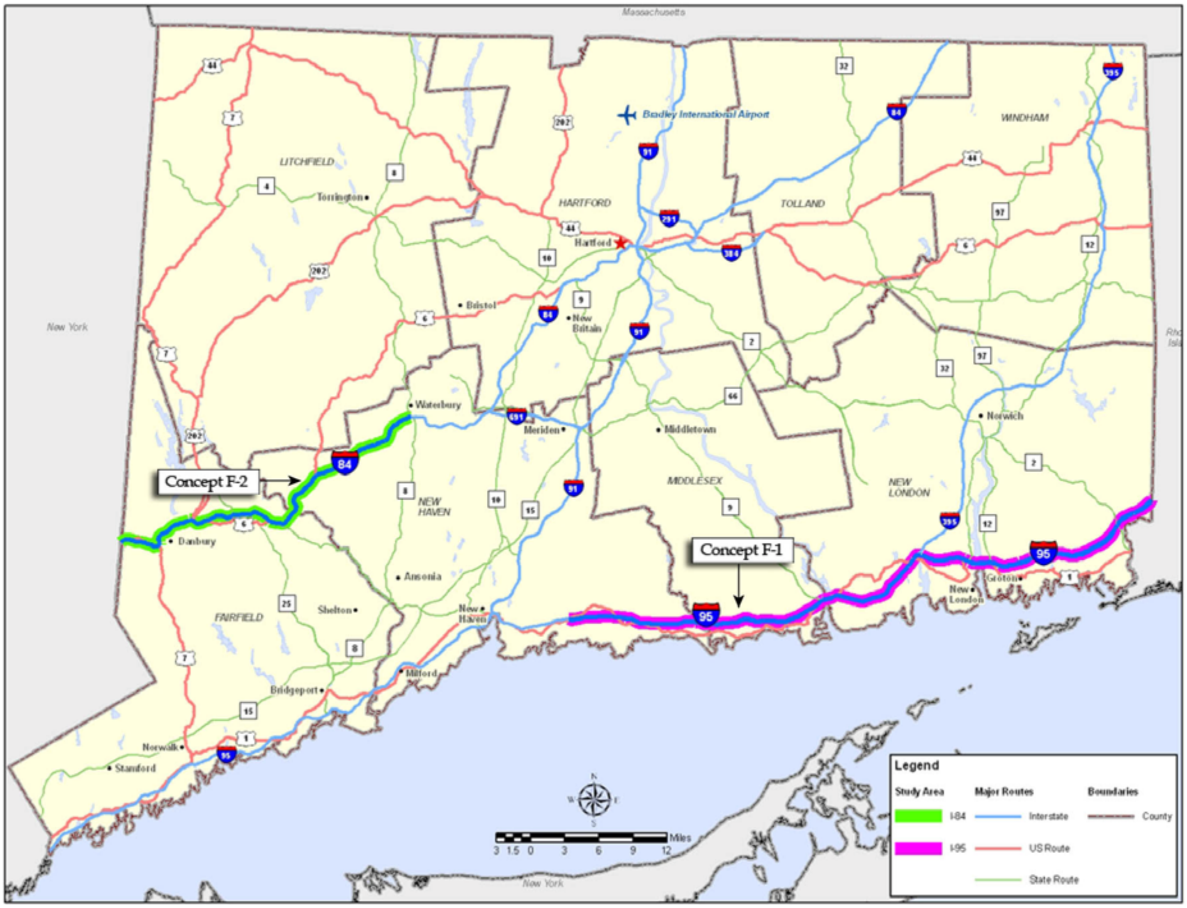
[44] *Evaluation of Shoulder Lanes, Incident Management, and Ramp Metering – I-95 from Exit 8 to Exit 18.* ConnDot (2004).

[45] Fitzgerald & Halliday, Inc. I-95 Commuter Shoulders Operational Analysis (Exits 8 to 18), December 2004.

12.0 Concept F – Toll Individual Highways Needing New Capacity

This concept examines the same two highway corridors analyzed in Section 7.0 for new tolled express lanes – I-95 between Branford and the Rhode Island state line and I-84 between Waterbury and the New York state line (see Figure 12.1). However, in this concept, instead of adding a tolled express lane, the two corridors would be reconstructed with an additional general purpose lane in each direction, and the entire corridor would be tolled. Studies have shown that while drivers are very resistant to tolling previously free highways, they are more willing to pay tolls if they can see the connection between the tolls and a significant improvement in highway operations. The additional general purpose lanes would be intended to achieve that improvement.

Figure 12.1 Concept F – Toll Individual Highways Needing New Capacity



Project Description

The I-95 corridor has been most recently studied in a 2004 report[46] prepared for ConnDOT that provided an assessment of the transportation-related deficiencies and needs in this corridor and an evaluation of potential improvement concepts. A 1999 study[47] by ConnDOT's Bureau of Policy and Planning identified the need for additional capacity on I-95. That study recommended further analysis to assess the feasibility of providing a third travel lane in all two-lane sections of I-95 between Branford and the Rhode Island state line.

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[46] I-95 Corridor Feasibility Study – Branford to Rhode Island, Final Report. Prepared for the Connecticut Department of Transportation. Prepared by Clough, Harbour & Associates LLP. December 2004.

[47] The Southeastern Connecticut Corridor Study.

A 2001 report[48] prepared for ConnDOT on the I-84 corridor provided an assessment of the transportation-related deficiencies and needs in this corridor and an evaluation of potential improvement concepts. The 2001 study focused on approximately 13 miles of this corridor from Interchange 18 in Waterbury to the Housatonic River. Among the various transportation strategies considered was the addition of a general purpose lane in each direction, increasing the cross-section to three lanes in each direction along this stretch of I-84.

Traffic Characteristics

The 1999 study of I-95 found that the most severe congestion occurs on Friday through Sunday in the summer months. Traffic along this corridor is a combination of commuter traffic and recreational traffic heading to and from attractions in the southeast region of Connecticut and adjacent areas of Rhode Island and Cape Cod. These attractions include Hammonasset State Beach, Mystic Marine Life Aquarium, Mystic Seaport, Rocky Neck State Park, Harkness Memorial, Mohegan Sun Casino, Foxwoods Resort Casino, Rhode Island beaches and Cape Cod.

The 2001 study of I-84 by ConnDOT and the Council of Governments of Central Naugatuck Valley identified peak hour traffic congestion and safety deficiencies along Interstate 84 between the Housatonic River in Southbury and Interchange 23 in Waterbury.

Methodology

For I-95, average daily traffic (ADT) estimates for years 2000 and 2025 between each interchange from Branford to the Rhode Island border were taken from the 2004 study report. Year 2015 traffic was developed through interpolation between 2000 and 2025. Year 2015 was chosen for an opening year analysis. Average daily traffic along U.S. 1 (which generally parallels I-95) also was summarized from ConnDOT's 2006 traffic volume log report[49] to establish the baseline of VMT and VHT estimates along U.S. 1 before applying diversion impacts from tolling I-95. We estimated VMT on U.S. 1 for 2015 by using I-95 forecast growth rates.

For I-84, average daily traffic (ADT) estimates for years 2015 between each interchange from Waterbury to the New York state line were forecasted by starting with ConnDOT's

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[48] I-84 West of Waterbury Needs and Deficiencies Study – Final Report. Prepared for the Connecticut Department of Transportation. Prepared by Wilbur Smith Associates. November 2001.

[49] State of Connecticut Department of Transportation. 2006 Traffic Volumes State-Maintained Highway Network (Traffic Log). Prepared by Division of Systems Information, Bureau of Policy and Planning, in cooperation with U.S. Department of Transportation – Federal Highway Administration.

2007 traffic log report[50] and factoring to 2015 levels by using ConnDOT's 2007 Congestion Screening and Monitoring Report which provides a growth forecast for I-84. Average daily traffic along assumed alternate routes also was summarized from ConnDOT's 2007 traffic log report to establish the baseline of VMT and VHT estimates along these roadways before applying diversion impacts from tolling I-95. Baseline alternate route traffic for year 2015 was estimated by using I-84 forecast growth rates applied to 2007 volumes.

We developed a spreadsheet analysis tool based on the TRUCE model developed by the Federal Highway Administration[51] to estimate the amount of diversion from the tolled highway to alternative routes. We assumed that 85 percent of the diverted traffic would choose to use the nearest arterial alternative, with the remaining 15 percent using more minor routes, forming carpools, reducing trips, and shifting to transit. We compared the time savings benefit of staying on the highway compared to using the best alternative for an average 10-mile trip.

We tested three per-mile toll rates: 10, 20, 30 cents. The lower end of that scale is in the general range of the older intercity turnpikes in the northeast. The midrange is at the level of urban toll expressways built within the last 20 years, and the higher end is a level in use on a few highways that use congestion pricing in urban areas or congested corridors. Average daily revenue was calculated by multiplying the remaining tolled VMT by the corresponding per-mile toll rate. Daily estimates of revenue were then annualized.

■ 12.1 Institutional and Legal

Roads that are paid for predominantly with Federal funds must be free from tolls of all kinds; this has been a Federal rule for over 80 years. One notable exception was a provision in the 1978 Surface Transportation Act that allowed toll roads on the Interstate Highway System to receive Federal money earmarked for resurfacing, restoring, rehabilitating, and reconstructing. In order to qualify, the State had to remove all tolls once the costs associated with construction, debt service, and toll removal had been raised from tolls. At this point, the mileage on the former toll road would be factored into the State's apportionment formula for Federal resurfacing money. In 1983, Connecticut became one of the few states to execute this agreement when it removed tolls from the Connecticut Turnpike.[52] The portion of I-95 from Branford to New London is part of the

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[50] State of Connecticut Department of Transportation. 2007 Traffic Volumes State-Maintained Highway Network (Traffic Log). Prepared by Division of Systems Information, Bureau of Policy and Planning, in cooperation with U.S. Department of Transportation – Federal Highway Administration.

[51] Federal Highway Administration, TRUCE 3.0, available at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/tools/truce_model_guide.htm.

[52] Agreement No. 3.07-08(83) between the State of Connecticut and the United States Department of Transportation, Federal Highway Administration., August 30, 1983.

former Connecticut Turnpike and is now considered as part of the State's apportionment formula. The toll removal agreement stated that, "When freed of tolls, the Connecticut Turnpike toll road subject to this Agreement on the Interstate and Primary Systems at the date of this Agreement, shall be treated the same as any other portions of the Interstate and Primary Systems which were constructed with Federal-aid." This implies that the former Connecticut Turnpike would be eligible for some of the toll demonstration projects that have been enacted since the toll removal.

For Interstates in need of reconstruction, the Interstate System Reconstruction and Rehabilitation Toll Pilot Program would apply. 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. Again, for highways that were not constructed with Federal funding, no Federal permission or coordination is required.

For any non-Interstate highway previously constructed with Federal funding and in need of reconstruction, a toll agreement with the Federal government may be executed if Federal money will not be used for the reconstruction. There is no limit to the number of such agreements. Federal maintenance funds may not be used on toll roads. The toll agreement must require that all toll revenue is first used for any of the following: debt service, reasonable return on private investment, and operation and maintenance, including reconstructing, resurfacing, restoring, and rehabilitating work. The agreement also may include a provision for revenues generated in excess of that needed for the above purposes. Revenues could be used for highway and transit purposes, as outlined in Title 23, if the State annually certifies that the toll facility is being adequately maintained. Whether the toll facility will become free once the debt is retired or whether tolls will continue indefinitely is a matter for the State to decide. There are no Federal regulations about the amount of tolls that can be charged. This is governed only by state and local laws. Currently, Connecticut prohibits the collection of any tolls in the State so any legislation reauthorizing tolling could stipulate toll amounts or the toll policy.[53]

■ 12.2 Technology and Deployment

Construction

Since this concept is tied to capacity expansion or reconstruction, all toll-related construction can be achieved as part of the highway improvement. This can include combining of

[53] Federal Highway Administration. *Title 23 United States Code (23 U.S.C.) Section 129 Toll Agreements.* [http://ops.fhwa.dot.gov/tolling_pricing/toll_agreements.htm], 8 October 2008.

gantries for signage and toll collection and installation of fiber optics in the right-of-way to support the tolling system needs.

Toll Collection Concept

We have assumed that all vehicle miles traveled on the improved highway would be tolled. This will require an extensive network of toll collection equipment, discussed below. A potentially less costly approach would be to allow some toll-free travel, akin to the old Connecticut Turnpike. An analysis of the revenue productivity of different tolling locations and amounts could be done to optimize the relationship between costs of collection and revenue. However, since this is a retrofit of an existing toll-free highway, tolling some movements and not others would likely face stiff opposition from those that would have to pay tolls.

Technology and Roadside Components

Since this concept would be a limited to one or two highways, this concept is suitable for the application of transponder and video payment, rather than a more extensive GPS approach. Toll gantries will need to be placed to cover all lanes and, depending on the toll system selected, on either all entrances and exits (closed) or a large number of segments (open). Classification equipment will need to be installed to enable tolling by vehicle type.

Payment Type

Since this concept tolls existing highways, it would be difficult to restrict usage to transponder users, so some mechanism of addressing infrequent users will be needed. This would likely be video tolling with appropriate billing and collection mechanisms, potentially combined with transponders.

Toll Policy

This concept is not suitable for dynamic tolling since no real-time choice is available for the traveler. Static tolling can vary by time and day to encourage peak spreading, and also vary by vehicle type, such car, truck, or motorcycle.

Toll Program Operation

Limited coverage toll lanes suggest that walk-in, retail channels, and customer kiosks need only be focused close to the tolled areas. The scope of the operation will be highly dependent on the length of the tolled facilities and the origins and destinations of the regular users.

Interoperable Programs

Given Connecticut's proximity to the E-ZPass network, customer benefit, and program cost savings would arise from adopting system interoperability with the E-ZPass network.

12.3 Potential PPP Approaches

Tolling an existing highway segment in order to finance complete reconstruction or to add new capacity, would essentially function as a toll road in a corridor with established traffic patterns. This kind of project would be less risky than a greenfield project. What traffic and revenue risk that might be caused from diversions may be partially offset by added traffic levels from added capacity. If an entire roadway is being tolled, toll revenues may be sufficient to pay for all or most of the construction costs and all operating and maintenance expenses. This revenue stream may attract private sector interest in a long-term concession like a DBOM or DBFO.

A more likely PPP structure might be more along the lines of a design-build, or DBOM, where the private involvement is to ensure project delivery and keeping the project available for public use, rather than revenue risk. Depending on the net revenue estimates, proposal selection could be awarded on the lowest possible public financing needed. This would presume sufficient levels of public support and Federal waivers for tolling an existing roadway.

12.4 Privacy

The privacy concerns with this concept will depend on whether a limited number or all lanes are tolled, because a limited number will offer easy alternatives for drivers, while all lanes will mean the disclosure of personal information is hard to avoid for some drivers unless they take a different road completely – which is not an equivalent option. Therefore, should the concept utilize tolling of all lanes, anonymous accounts and/or one-off payments should be supported. Users that do choose to use the tolled lane are disclosing route journey information.

12.5 Technical Analysis of Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

Transportation Impacts

Three sections of I-95 were analyzed independently:

1. Branford to the Connecticut River;
2. Connecticut River to the Thames River; and
3. Thames River to the Rhode Island state line.

Along the entire length, we analyzed U.S. 1 as the best alternative route. We developed estimates of VMT, VHT, average speed, and hours of delay for No Build and Build conditions. No Build conditions assume the current configuration of I-95 would remain – two lanes in each direction. The Build condition assumed widening to three lanes in each direction and tolls would be charged for all trips.[54]

At a toll rate of 10 cents per mile, we estimate that about 5 percent of I-95 traffic would choose not to pay the toll (Table 12.1). Assuming 85 percent of that diverted traffic would go to U.S. 1 would result in a 25 percent increase in VMT along U.S. 1. Under this scenario, the overall average speed of the corridor is forecast to be slightly improved and a significant reduction in corridor hours of delay is estimated to occur. However, as toll rates increase to 20 and 30 cents per mile, the negative impact to U.S. 1 operating speeds is significant and results in an overall corridor impact that is unfavorable, as overall average speeds are reduced and a substantial increase in vehicle hours of delay is realized (Table 12.2 and 12.3).

There is a key point that should be identified from these findings. The idea of tolling this Interstate is for the purpose of funding the improvements needed in the long term to accommodate traffic growth and reduce congestion during seasonal traffic. 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

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[54] Although our analysis assumed that all trips would be tolled, there may be a good reason for two exceptions – the crossings of the Connecticut and Thames rivers. In both cases, U.S. 1 uses the I-95 Bridge, which would mean that there would be no toll-free alternative for the river crossing. If the state believed it were important to maintain a toll-free alternative, then these segments of highway might be left toll free.

for the improvements, while minimizing and/or mitigating the potential diversion to U.S. 1 would seem to be the ideal solution.

Table 12.1 Traffic Operations Changes: 10 Cents per Mile
Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-95	4,680,000	4,439,331	-240,669	-5.1%
Route 1	814,000	1,018,569	204,569	25.1%
Total	5,494,000	5,457,900	-36,100	-0.7%
VHT				
I-95	78,149	68,297	-9,851	-12.6%
Route 1	25,777	36,253	10,477	40.6%
Total	103,925	104,551	625	0.6%
Average Speed				
I-95	59.9	65.0	5.1	8.5%
Route 1	31.6	28.1	-3.5	-11.0%
Overall	52.9	52.2	-0.7	-1.3%
Vehicle Hours of Delay				
I-95	6,149	0	-6,149	-100.0%
Route 1	2,520	7,151	4,632	183.8%
Total	8,668	7,151	-1,517	-17.5%
Toll Trips	0	443,933	-	-
Toll Revenue	$0	$443,933	-	-
Per Mile Toll Rate	$0	$0.10	-	-

Table 12.2 Traffic Operations Changes: 20 Cents per Mile

Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-95	4,680,000	4,029,892	-650,108	-13.9%
Route 1	814,000	1,366,592	552,592	67.9%
Total	5,494,000	5,396,484	-97,516	-1.8%
VHT				
I-95	78,149	61,998	-16,150	-20.7%
Route 1	25,777	67,240	41,463	160.9%
Total	103,925	129,238	25,313	24.4%
Average Speed				
I-95	59.9	65.0	5.1	8.5%
Route 1	31.6	20.3	-11.3	-35.6%
Overall	52.9	41.8	-11.1	-21.0%
Vehicle Hours of Delay				
I-95	6,149	0	-6,149	-100.0%
Route 1	2,520	28,195	25,675	1,019.0%
Total	8,668	28,195	19,526	225.3%
Toll Trips	0	402,989	-	-
Toll Revenue	$0	$805,978	-	-
Per Mile Toll Rate	$0	$0.20	-	-

Table 12.3 Traffic Operations Changes: 30 Cents per Mile
Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-95	4,680,000	3,547,319	-1,132,681	-24.2%
Route 1	814,000	1,776,779	962,779	118.3%
Total	5,494,000	5,324,098	-169,902	-3.1%
VHT				
I-95	78,149	54,574	-23,575	-30.2%
Route 1	25,777	155,421	129,644	503.0%
Total	103,925	209,995	106,070	102.1%
Average Speed				
I-95	59.9	65.0	5.1	8.5%
Route 1	31.6	11.4	-20.1	-63.8%
Overall	52.9	25.4	-27.5	-52.0%
Vehicle Hours of Delay				
I-95	6,149	0	-6,149	-100.0%
Route 1	2,520	104,656	102,136	4,053.8%
Total	8,668	104,656	95,987	1,107.3%
Toll Trips	0	354,732	-	-
Toll Revenue	$0	$1,064,196	-	-
Per Mile Toll Rate	$0	$0.30	-	-

Transit Impacts

Tolling concepts most likely to prompt diversions of trips from automobiles to transit are those that involve tolling of all existing lane capacity rather than tolling only HOV/HOT lanes that represent added system capacity (e.g., shoulder lanes or new construction).

CTTransit's New Haven Division operates local and interregional fixed route service along this corridor. To the east of New Haven, one local bus route is operated parallel to the corridor into Branford. Estuary Transit District (ETD) also operates local shuttle service along the corridor from Madison to Old Saybrook. The S-Route, operated by DATTCO for CTTransit, is an interregional route that operates along Route 1, parallel to I-95, from New Haven to Old Saybrook.

While Metro-North Railroad commuter service terminates at New Haven, the Shoreline East commuter rail service is available in the I-95 corridor from New Haven east to New London. Longer distance trips would be accommodated by Amtrak.

The Southeast Area Transit Authority (SEAT) provides corridor bus service along I-95 from New London to North Stonington. SEAT also provides local service along the corridor from East Lyme to North Stonington.

In general, transit capacity in this region could accommodate trips diverted from automobiles, both for short local trips as well as long intercity trips from New London to New Haven, or municipalities in between. Depending on trip origins and destinations, some of these trips could be easily provided by bus transit or by Shoreline East trains. Train station parking lots along the Shoreline East would be likely to serve as park-and-ride lots, as would several lots along I-95.

Toll Revenue Estimates

At 10 cents per mile, tolling I-95 could be expected to generate about $183.1 million per year in 2015, rising to $219 million per year in 2030 (both in 2008 dollars – see Table 12.4). Revenues could increase from $332 million (20 cents/mile in 2015) to $525 million (30 cents/mile) in 2030, but at the expense of increasing congestion on Route 1 and other alternate routes.

Table 12.4 Annual Toll Revenue: 2008 Dollars
Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

Year	10 Cents per Mile	20 Cents per Mile	30 Cents per Mile
2015	$183,100,000	$332,426,000	$438,928,000
2030	$218,976,000	$397,560,000	$524,929,000

Implementation Requirements

The two projects in this concept individually cover over 58 and 32 miles of roadway and will require tolling across all lanes of the highways. For this level of analysis, it has been assumed that entrance and exit points will correspond to the existing freeway entrance and exits and that all travelers using all lanes will be charged. This will require about 62 and 34 tolling points respectively to cover both directions of traffic. Since tolling is applied to all vehicle types but at different rates, effective classification equipment would need to be installed at each location. This concept would likely not use dynamic pricing so that traffic monitoring equipment and dynamic message signs for toll rates are not required as part of this concept, although it is likely that some dynamic messaging signs would be installed to convey other information to drivers. CCTV cameras would not be required for traffic monitoring but would be used to monitor tolling equipment. Since the project is not associated with the requirement to improve traffic flow, no additional roadway assistance facilities would be required. Allowance has been made for additional enforcement staff to provide toll evasion deterrent along the extended length of these facilities. Since equipment will be distributed along the length of this roadway, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The large number of transactions associated with this concept indicates the need for a large back office operation comparable to some of the larger existing E-ZPass service centers. However, the connection with adjacent state borders will likely leverage some of the existing E-ZPass account holders from other states. Given that all traffic will be tolled and that long distance trips may be taken by a high number of users that do not make frequent trips, a fairly high-level of video transaction processing has also been estimated. Since travelers needing to use these facilities will not have much alternative other than to pay the toll, a fairly comprehensive customer service operation has been estimated involving a regional walk-in center for each facility and partnership with a grocery store type chain to provide payment locations.

Toll Collection Costs

Table 12.5 identifies the total costs to implement and operate the individual toll facility projects over 30 years under the different proposed toll rates.

Table 12.5 Life-Cycle Toll Collection Costs (Millions)
Concept F – Toll Individual Highways Needing New Capacity

Scenario		Total Capital Cost	Total O&M Cost	Total
Project F-1: I-95 – Branford to Rhode Island State Line	Toll Rate 1	$559.0	$1,313.0	**$1,871.9**
Project F-1: I-95 – Branford to Rhode Island State Line	Toll Rate 2	$530.4	$1,351.7	**$1,882.2**
Project F-1: I-95 – Branford to Rhode Island State Line	Toll Rate 3	$496.8	$1,339.3	**$1,836.1**
Project F-2: I-84 – Waterbury to New York State Line	Toll Rate 1	$306.3	$835.3	**$1,141.6**
Project F-2: I-84 – Waterbury to New York State Line	Toll Rate 2	$286.7	$829.1	**$1,115.9**
Project F-2: I-84 – Waterbury to New York State Line	Toll Rate 3	$273.1	$826.6	**$1,099.7**

Table 12.5 Life Cycle Toll Collection Costs (Millions, continued)
Concept F – Toll Individual Highways Needing New Capacity

Scenario		Total Capital Cost	Total O&M Cost	Total
Project F-3: All projects combined, F-1 and F-2	Toll Rate 1	$796.4	$1,877.5	**$2,673,905.7**
Project F-3: All projects combined, F-1 and F-2	Toll Rate 2	$759.3	$1,957.0	**$2,716.2**
Project F-3: All projects combined, F-1 and F-2	Toll Rate 3	$715.0	$1,955.9	**$2,670.9**

A large part of the capital costs for these projects is generated by the number of tags that need to be purchased over 30 years to support the anticipated account volume – 55 to 60 percent of the capital costs for most project/toll rate combinations. This also accounts for the decrease in capital cost as the toll rate increases. The number of tolling points that need to be installed to toll every segment of the proposed facilities also requires a significant capital investment. The O&M costs are largely driven by the cost to operate the back office which accounts for about 65 percent of the O&M costs in each case. The increased tolls for each toll rate result in an increase to the costs paid for financial transaction (credit card) processing from 11 percent at the lowest toll rate to 25 percent at the highest.

Implementation Strategy

This concept will toll an existing highway (with a capacity improvement), and users of these roads would not be able to avoid paying the toll, so the ability to build consensus with stakeholders, public and elected officials is likely to require considerable time. For Federally maintained roads, Federal approval would be required.

This project involves a relatively simple approach to tolling, which has been implemented throughout the United States and the world; this means the initial requirement is relatively simple and well-defined, which should result in shorter procurement activities. Furthermore, the geographical coverage is limited to only one stretch of road and so design and build activities should be reflected in shorter design and build durations. This project has a similar number of tolling points to Project A-1 and hence likely roadside construction durations might be 30 months. It is likely a small amount of roadway construction will be required along the tolled roads, such as enforcement pull-offs and drainage.

Accordingly the tasks to implement this concept, and their likely durations, are noted below in Table 12.6:

Table 12.6 Illustrative Implementation Durations
Concept F – Toll Individual Highways Needing New Capacity

Task	Duration
Further Studies and Consensus Building	36 months
Studies Sufficient for Funding	12 months
Legislation and Funding	36 months
Assemble Program Staff	9 months
Procurement	12 months
Design	9 months
Build – Highway	24 months
Build – Roadside Equipment	30 months
Build – Back-Office	9 months
Test	3 months
Distribute Tags	6 months
Go-Live	0 months

Implementation Schedule

There are many ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability.

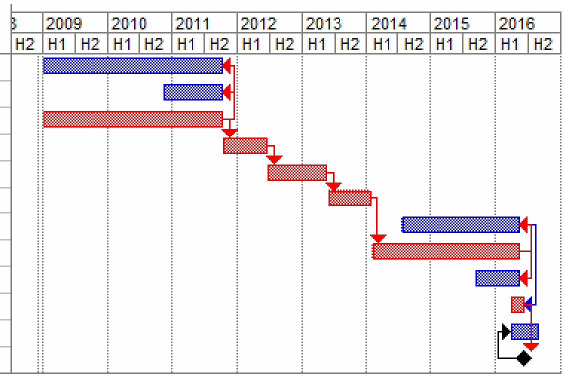
One such arrangement is detailed in the Gantt chart in Figure 12.2 below; this format allows key dependencies to be highlighted and the critical path[55] to be identified (in red). An implementation schedule of 2016 is estimated.

[55] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

Figure 12.2 Illustrative Implementation Schedule

Concept F – Toll Individual Highways Needing New Capacity

ID	Task Name	Duration	Predecessors
1	Further studies and consensus building	36 mons	3FF
2	Studies sufficient for funding	12 mons	3FF
3	Legislation and funding	36 mons	
4	Assemble program staff	9 mons	3
5	Procurement	12 mons	4
6	Design	9 mons	5
7	Build - highway	24 mons	8FF
8	Build - roadside equipment	30 mons	6
9	Build - back office	9 mons	8FF
10	Test	3 mons	7FF+1 mon
11	Distribute tags	6 mons	12SS-3 mons
12	Go-live	0 mons	10



Physical Infrastructure Capital Costs

The capital costs to improve the physical infrastructure of I-95, widening it from four to six lanes, from Branford to the Rhode Island line was originally estimated at $1,109,800,000 (2004 dollars) in the ConnDOT I-95 Corridor Feasibility Study. By inflating the original cost estimate to 2008 dollars according to the U.S. Bureau of Labor Statistics' Consumer Price Index a total capital cost for the physical infrastructure improvements is estimated to be **$1,248,010,941**.

Environmental

Alternative F-1 traverses coastal Connecticut in an area of sensitive natural resources many of which are linked, ecologically, with Long Island Sound. The area also has numerous historic village centers. This segment of I-95 is the subject of a number of ongoing widening and improvement projects. It is assumed that any impacts to resources for this alternative also will be identified as part of the formal environmental documentation process for those projects. As a part of the associated construction process, appropriate mitigation will be determined and implemented.

Impacts associated solely with this tolling alternative will relate exclusively to the diversion of traffic onto local roads. Consequently, the diversion of traffic to Route 1 has a heightened potential to adversely affect the corridor's sensitive resources.

This alternative is expected to have a minor adverse effect to the following factors as highlighted in Table 12.7 and Figure 12.3:

- **Water Quality –** Approximately 14 major water bodies could have increased exposure to degraded stormwater runoff and hazardous materials from additional traffic on Route 1.

- **Air Quality –** Motorists will divert from limited access highways to arterials to avoid paying tolls. Volatile organic compounds (VOC), a precursor to ozone, levels increase in this concept because the VOC emissions rate is higher for arterials than for freeways.

- **Noise –** Additional traffic can elevate noise levels locally somewhat adjacent to the local diversion routes.

- **Energy Use and Conservation –** The average speed of travel decreases for vehicles traveling on local roads while increasing for vehicles on limited-access highways. However, if there are delays on local roads due to added congestion, fuel consumption may increase.

- **Environmental Justice Populations –** Tolls in the vicinity of disadvantaged populations may discourage highway use and make travel more expensive and/or more inconvenient. Added traffic congestion in a neighborhood with an environmental justice population has a potential to expose them to a higher burden of community impacts.

- **Cultural/Historic Resources –** Route 1 serves as the 'Main Street' through a number of historic village centers. Added traffic there could have a minor adverse effect on the setting of important historic structures and sites.

This alternative is expected to have a potentially significant adverse effect to:

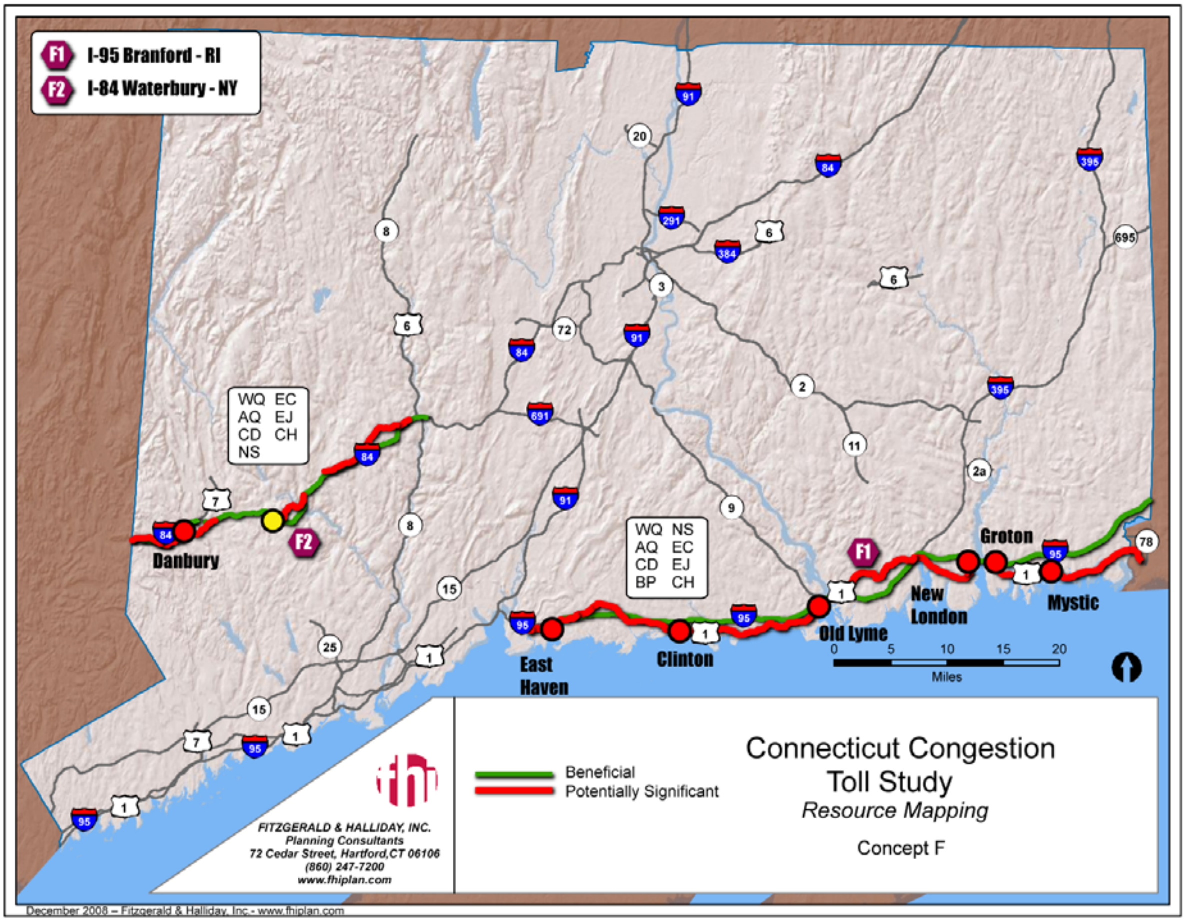
- **Bicycle and Pedestrian Travel –** Portions of Route 1 are a designated as a cross-state bicycle route. Traffic diverted to this route reduces safety and can hinder travel for bicyclists and pedestrians, particularly within the village centers where pedestrian activity is a key component of character and sense of place.

- **Community Disruption –** Route 1 is the 'Main Street' for Guilford, Madison, Clinton, Old Saybrook, East Lyme, Mystic, Stonington, and Waterford. The addition of traffic through these community centers will adversely affect quality of life in these centers by inhibiting pedestrian access, reducing pedestrian safety, and altering the quiet ambience, character, and sense of place.

Table 12.7 Environmental Impact Summary
Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	1 = Approximately 14 major water bodies could have increased exposure to degraded stormwater runoff hazardous materials
Air Quality (AQ)	Yes	Minor Adverse	• Benefit to Limited Access Highways; • Minor Adverse Impact to all diversion routes
Social/Community			
Community Disruption (CD)	Yes	Potentially Significant	1 = 8 historic villages/village centers many of which have Route 1 as their 'Main Street'
Bicycle and Pedestrian (BP)	Yes	Potentially Significant	Motorist diversions portions of cross-state bicycle routes, Route 1 (Guilford, Madison, Clinton, East Lyme, Waterford, New London, Groton, Mystic, and Stonington).
Noise (NS)	Yes	Minor Adverse	1 = 39 sensitive noise receptors
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes
Environmental Justice (EJ)	Yes	Minor Adverse	1 = Niantic and New London
Cultural/Historic (CH)	Yes	Minor Adverse	1 = 7 historic villages which have Route 1 as their 'Main Street'; Guilford, Madison, Clinton, Old Saybrook, East Lyme, Mystic, Stonington, Waterford

Figure 12.3 Environmental Impact Locations
Project F-1 – Toll All Lanes of I-95 – Branford to Rhode Island State Line to Fund Improvements



Economics

In this concept, all highway drivers would have to pay a toll. Therefore, all drivers will face either increased costs and improved travel times (resulting from the added capacity of the new lanes) or increased travel times if they chose to divert in order to avoid paying a toll. Relatively low, revenue-generating tolls with low impact on highway usage patterns would tend to mute whatever spatial competition issues would be raised by a moderately high tolling scheme. However, given the limited congestion on this route at least in the early years of tolled operation (with the notable exception of summer Fridays) means that most people most of the time would not be receiving significant benefits in terms of travel-time reductions in return for their tolls.

Equity

This section of I-95 is generally not congested for most of the highway's length most of the time, so using the toll revenue to expand capacity would not provide significant travel-time benefits for most travelers, the main exception being commuters and recreational travelers on summer Fridays. The frequent lack of meaningful travel-time benefits for tolled highway users would not be a critical equity issues given the relatively modest tolls involved; however, if this type of tolling were only done in this segment and not in comparable corridors across the State it could raise the typical "fairness" debate raised in such circumstances. The impact of tolls on low-/moderate-income travelers would be a relatively limited issue for this concept, as the communities along this section of I-95, with some exceptions, generally have higher than average income levels. However, the limited nature of the alternative routes and the lack of meaningful transit options (existing and likely new ones) could raise equity issues for this concept, given the greater dependence of lower-income residents on such services. Unlike Concept A-1, everyone wanting to use the highway would have to pay a toll.

Safety

For this project, all existing and planned highway lanes on the highway segment would be tolled. Introducing tolls in presently free highway corridors would result in some diversion of highway traffic onto alternate routes along the same corridor – U.S. 1 primarily in this case – which would put a moderate amount of diverted traffic along this route and other arterials and local roadways.

The alternative routes have considerably lower volumes than highways but much lower capacity and greater operational constraints. The key to minimizing safety issues on the diversion routes would be to maintain highway tolls such that extensive amounts of traffic, especially large trucks, would not be diverted, as the available alternate routes cannot handle these vehicles as safely as high-capacity limited access highways. The introduction of diverted traffic to small communities in the corridor would raise important safety issues in those areas particular in shopping areas, school zones, and similar sensitive locales.

Since this project involves the reconstruction of an existing highway, safety and operational issues on the highway itself and its interchanges would be addressed in the design process. It is expected that all truck climbing lanes would remain if existing and additional lanes were tolled. The potential for vehicles to divert in large number just upstream from the beginning of the tolled sections would raise safety issues at those interchanges and the adjacent local roadways and intersections. This may require improvements in those areas to increase capacity, ensure that trucks follow designated truck routes, and avoid sensitive areas, and similar actions to increase safety.

12.6 Technical Analysis of Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

Transportation Impacts

No Build conditions assumes the current configuration of I-84 would remain, while the Build condition assumes three lanes in each direction would be provided and tolled along I-84 from Waterbury to the New York state line. Three sections of I-84 were analyzed independently. These sections and their corresponding alternate routings are described below:

- I-84 New York to Newtown:
  - Alternate Route: U.S. 6 (from New York state line to U.S. 7 in Danbury), Lake Avenue, West Street, Liberty Street, Patriot Drive, White Street, Newtown Road, U.S. 6 (from Exit 8 on I-84 to Exit 10 on I-84);
- I-84 Newtown to Southbury:
  - Alternate Route: Church Hill Road (at I-84 Exit 10), Glen Road, River Road, Fish Hook Road, Main Street (Junction of U.S. 6/I-84 Exit 15);
- I-84 Southbury to Waterbury:
  - Alternate route: Old Waterbury Road, SR 188 (Southford Road), SR 64 (Middlebury Road), Chase Parkway (in Waterbury), and Highland Avenue (I-84 Exit 18).

At a toll rate of 10 cents per mile, we estimate that about 5.5 percent of I-84 traffic would choose not to pay the toll (Table 12.8). Assuming 85 percent of that diverted traffic would go to the alternate routes previously described would result in an estimated 29 percent increase in VMT along the alternate routes. Under this scenario, the overall average speed of the corridor is forecast to be slightly improved and a significant reduction in corridor hours of delay is estimated to occur. However, as toll rates increase to 20 and 30 cents per mile, the impact of diverted traffic to the local network results in an overall corridor impact that is unfavorable, as overall average speeds are reduced and a substantial increase in vehicle hours of delay is realized (Tables 12.9 and 12.10).

Table 12.8 Traffic Operations Changes: 10 Cents per Mile
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-84	2,783,938	2,630,366	-153,572	-5.5%
Alternate Route	447,294	577,830	130,536	29.2%
Total	3,231,232	3,208,196	-23,036	-0.7%
VHT				
I-84	46,380	40,467	-5,913	-12.7%
Alternate Route	13,951	20,525	6,574	47.1%
Total	60,331	60,992	661	1.1%
Average Speed				
I-84	60.0	65.0	5.0	8.3%
Alternate Route	32.1	28.2	-3.9	-12.2%
Overall	53.6	52.6	-1.0	-1.8%
Vehicle Hours of Delay				
I-84	3,550	0	-3,550	-100%
Alternate Route	1,171	4,016	2,844	243%
Total	4,721	4,016	-706	-15%
Toll Trips	0	263,037	-	-
Toll Revenue	$0	$263,037	-	-
Per Mile Toll Rate	$0	$0.10	-	-

Table 12.9 Traffic Operations Changes: 20 Cents per Mile
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-84	2,783,938	2,399,235	-384,703	-13.8%
Alternate Route	447,294	774,292	326,998	73.1%
Total	3,231,232	3,173,527	-57,705	-1.8%
VHT				
I-84	46,379.7	36,911.3	-9,468	-20.4%
Alternate Route	13,951.3	38,492.8	24,541	175.9%
Total	60,331	75,404	15,073	25.0%
Average Speed				
I-84	60.0	65.0	5.0	8.3%
Alternate Route	32.1	20.1	-11.9	-37.3%
Overall	53.6	42.1	-11.5	-21.4%
Vehicle Hours of Delay				
I-84	3,550	0	-3,550	-100%
Alternate Route	1,171	16,370	15,199	1,297%
Total	4,721	16,370	11,649	247%
Toll Trips	0	239,924	-	-
Toll Revenue	$0	$479,847	-	-
Per Mile Toll Rate	$0	$0.20	-	-

Table 12.10 Traffic Operations Changes: 30 Cents per Mile
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

	2015 Average Daily			
Measure	**No Build**	**Build**	**Change**	**Percent Change**
VMT				
I-84	2,783,938	2,115,517	-668,421	-24.0%
Alternate Route	447,294	1,015,452	568,158	127.0%
Total	3,231,232	3,130,969	-100,263	-3.1%
VHT				
I-84	46,379.7	32,546.4	-13,833	-29.8%
Alternate Route	13,951.3	96,265.1	82,314	590.0%
Total	60,331	128,812	68,480	113.5%
Average Speed				
I-84	60.0	65.0	5.0	8.3%
Alternate Route	32.1	10.5	-21.5	-67.1%
Overall	53.6	24.3	-29.3	-54.6%
Vehicle Hours of Delay				
I-84	3,550	0	-3,550	-100%
Alternate Route	1,171	67,252	66,081	5,641%
Total	4,721	67,252	62,531	1,324%
Toll Trips	0	211,552	-	-
Toll Revenue	$0	$634,655	-	-
Per Mile Toll Rate	$0	$0.30	-	-

As with I-95, the idea of tolling this Interstate is for funding the improvements that will be needed in the long term to accommodate traffic growth and reduce congestion. As the per-mile toll rate is increased, the reduction in I-84 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 a nearly 14 percent reduction in traffic on I-84 would essentially be correcting for approximately 15 years of growth. A low per-mile toll rate that can still generate enough revenue for the improvements, while minimizing and/or mitigating the potential diversion to the local roadway network would seem to be the ideal solution.

Transit Impacts

Contiguous transit services are limited throughout the I-84 corridor between Waterbury and the New York state line; therefore, any diversions to transit that are not within selected local communities with bus service would need to be accommodated by new express buses.

A strong network of local bus service does exist in Waterbury and in Danbury and surrounding communities such as Bethel, Brookfield, and New Milford, each of which supports local travel and the Danbury transit market. In between, local transit availability is limited or nonexistent in Newtown, Southbury, and Middlebury.

Local bus service in Danbury is operated by Housatonic Area Regional Transit (HART). Service in Waterbury is operated by North East Transportation Company (NET) for CTTransit. Both Danbury and Waterbury are served in the north-south direction (not along the I-84 corridor) by MNRR branch lines.

Therefore, short trips diverted from I-84 could be accommodated by transit in Danbury or Waterbury and their immediate environs, but longer, regional trips would be more difficult to accommodate. Peter Pan operates limited commuter bus service between Danbury and Waterbury and between the two cities and New York City. Some NET local bus service runs parallel to Route 8 in Waterbury and Naugatuck; however, this corridor also has limited transit resources.

The tolling of all lanes of I-84 would give drivers additional incentive to divert to transit trips where feasible since any trips in these corridors would become more expensive. Commuter services would be the most effective alternative as a daily commuting choice and typically represent moderate length trips. Again, additional investment would likely be required in the I-84 corridor to enhance existing services to provide suitable frequencies and park-and-ride facilities. Enhanced local shuttle services also would facilitate access to longer distance commuter transit.

Toll Revenue Estimates

Toll revenue estimates for the I-84 project are shown in Table 12.11. About $108 million per year could be expected from 10 cents per mile toll rate in 2015, increasing to almost $128 million by 2015. Higher revenue can be expected from the higher toll rates, but these higher rates would result in considerable impacts on alternative routes.

Table 12.11 Annual Toll Revenue: 2008 Dollars
Project F-2 –Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

Year	10 Cents per Mile	20 Cents per Mile	30 Cents per Mile
2015	$108,489,000	$197,913,000	$261,763,000
2030	$127,836,000	$233,207,000	$308,443,000

Implementation Requirements

Implementation requirements for this project are discussed under Project F-1.

Implementation Strategy

The tasks are identical to Project F-1, but there are approximately half as many tolling points for this project, so it is reasonable to expect the design and build durations to be reduced accordingly (although perhaps not by 50 percent – there are certain minimum times to run a design and build project regardless of size).

Implementation Schedule

Similar in nature in Project F-1, with the exceptions outlined above.

Costs

Physical Infrastructure Capital Costs

The capital costs to improve the physical infrastructure of I-84, widening it from four to six lanes, west of Waterbury to the New York state line was originally estimated at $282,568,000 (2001 dollars) in the ConnDOT I-84 West of Waterbury Needs and Deficiencies Study. By inflating the original cost estimate to 2008 dollars according to the U.S. Bureau of Labor Statistics' Consumer Price Index, the total capital cost for the physical infrastructure improvements is estimated to be $338.9 million.

Environmental

Alternative F-2 traverses central Connecticut, including two urban centers of Waterbury and Danbury. This segment of I-84 is the subject of a number of ongoing widening and improvement projects. It is assumed that any impacts to resources for this alternative also will be identified as part of the formal environmental documentation process for those improvement projects. As a part of the associated construction process, appropriate mitigation will be determined and implemented. Impacts associated solely with this tolling alternative will relate exclusively to the diversion of traffic onto local roads.

Consequently, Alternative F-2 is expected to have a minor adverse effect to all resources as follows and as highlighted in Table 12.12 and Figure 12.4:

- **Water Quality –** Approximately eight major water bodies could have increased exposure to degraded storm water runoff hazardous materials from additional traffic on alternate routes.

- **Air Quality –** Motorists divert from limited access highways to arterials to avoid paying tolls. Volatile organic compounds (VOC), a precursor to ozone, levels increase in this concept largely because the VOC emissions rate is higher for arterials than for freeways.

- **Community Disruption –** Added traffic congestion on local roads can result in barriers to ease of access to residences and/or businesses along those roads for residents, increased traffic noise, and conflicts with pedestrian-scale, aesthetic settings.

- **Bicycle and Pedestrian Travel –** Additional motor vehicles on the diversion routes may have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns for them.

- **Noise –** Additional traffic can elevate noise levels locally somewhat.

- **Energy Use and Conservation –** The average speed of travel decreases for vehicles traveling on local roads while increasing for vehicles on limited-access highways. However, if there are delays on local roads due to added congestion, fuel consumption may increase.

- **Environmental Justice Populations –** Tolls in the vicinity of disadvantaged populations may discourage highway use and make travel more expensive and/or more inconvenient. Added traffic congestion in a neighborhood with an environmental justice population has a potential to expose them to a higher burden of community impacts.

- **Cultural/Historic Resources –** Some of the alternate routes serve as the 'Main Street' through a number of village centers. Added traffic in these locations could have a minor adverse effect.

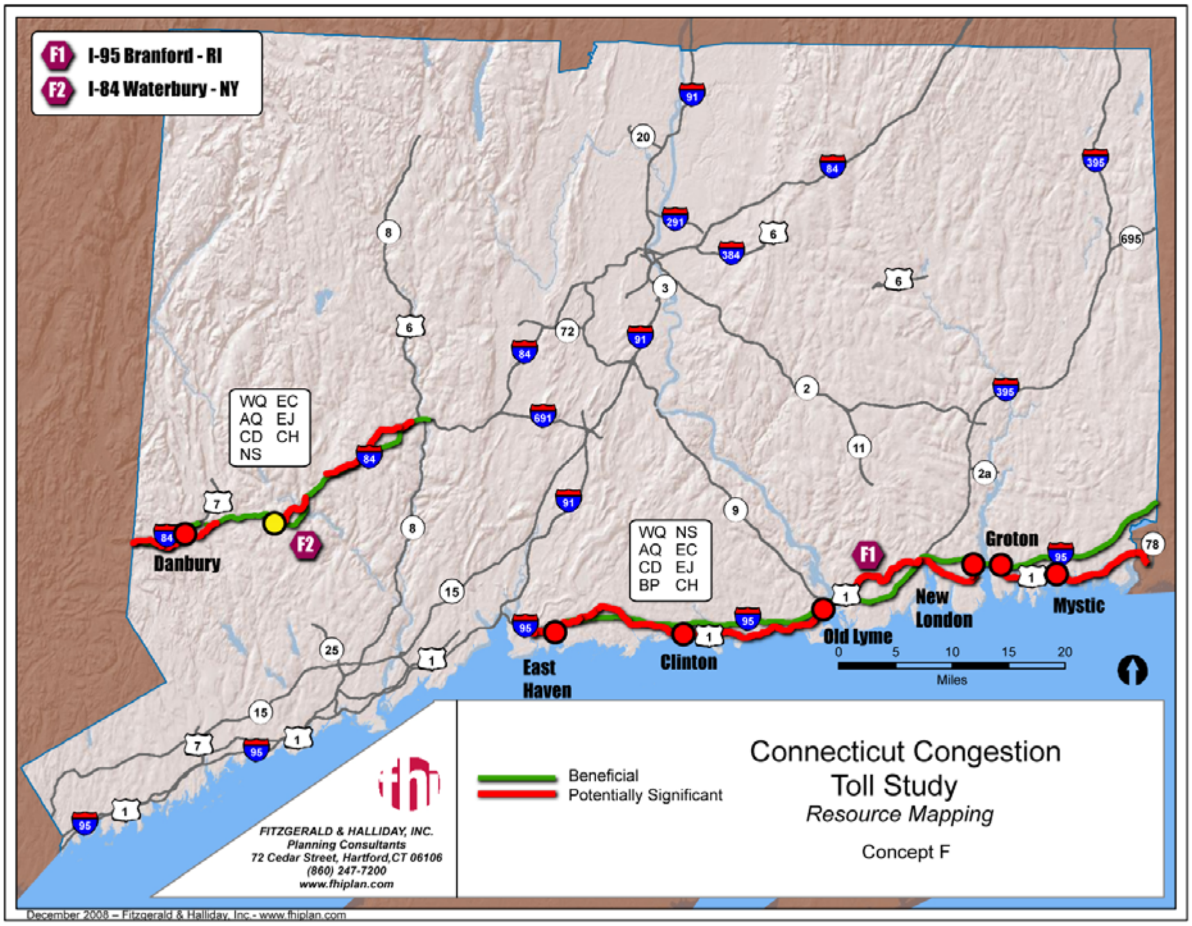
Table 12.12 Environmental Summary
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	2 = Approximately 8 major water bodies could have increased exposure to degraded stormwater runoff hazardous materials
Air Quality (AQ)	Yes	Minor Adverse	• Benefit to Limited Access Highways; • Minor Adverse Impact to all diversion routes

Table 12.12 Environmental Summary (continued)
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements

Resource	Potential Impact	Impact Description	
		Magnitude	**Location**
Social/Community			
Community Disruption (CD)	Yes	Minor Adverse	2 = diversions through 2 urban centers (Waterbury, Danbury) and 2 suburban towns (Newtown, Southbury)
Bicycle and Pedestrian (BP)	Yes	Minor Adverse	Motorist diversions onto local arterial roads used by bicyclists
Noise (NS)	Yes	Minor Adverse	2 = 8 sensitive noise receptors
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes
Environmental Justice (EJ)	Yes	Minor Adverse	2 = Danbury and Waterbury
Cultural/Historic (CH)	Yes	Minor Adverse	2 = diversions through historic village of Sandy Hook, historic center of Southbury

Figure 12.4 Environmental Impact Locations
Project F-2 – Toll All Lanes of I-84 – Waterbury to New York State Line to Fund Improvements



Economics

The main issues associated with the economic consequences of this project are similar to those discussed for F-1.

Equity

All drivers will be faced with the choice of paying new tolls (in return for improved travel conditions at times), diverting to other routes with degraded travel conditions, avoiding or changing trips, or mode shifting to transit. The increased costs to truckers could potentially be a horizontal equity issue due to the perception that it would increase shipping costs for businesses along the corridor. However, this would be offset by the planned increase in capacity and the likely modest level of tolls. The potential concentration of low-/moderate-income travelers would be a relatively limited issue for this concept, as the communities along this highway segment, with some notable exceptions, generally have higher than average income levels (especially close to the New York state border). Further, there is some meaningful transit service along much of this corridor (see transit discussion), and the corridor is such that a possible infusion of toll-related revenues to support transit could substantially increase transit's role in many of the travel markets (primarily work trips) that serve residential and industrial concentrations in the area.

Safety

The safety issues for F-2 are identical to those for F-1.

■ 12.7 Technical Analysis of Project F-3 – Projects F-1 and F-2 Combined

Project F-3 represents the combination of projects F-1 and F-2.

Transit Impacts

The transit impacts for F-3 are identical to those discussed under F-1 and F-2.

Toll Revenue Estimates

Annual revenue estimates for the I-95 and I-84 corridors were added together, reflecting the potential implementation of both projects (Table 12.13). At 10 cents per mile (in 2008 dollars) about $292 million could be collected in 2015 and $347 million could be realized in 2030.

Table 12.13 Forecast Annual Toll Revenue: 2008 Dollars
Project F3 – Projects F1 and F2 Combined

Year	10 Cents per Mile	20 Cents per Mile	30 Cents per Mile
2015	$291,589,000	$530,339,000	$700,691,000
2030	$346,812,000	$630,767,000	$833,372,000

Implementation Requirements

Implementation requirements are discussed under Project F-1.

Implementation Tasks and Durations

Similar in nature to Project F-1, except that implementing both projects in this concept concurrently may increase the duration of the further studies, and design and build times due to greater geographical coverage and the larger number of tolling sites required.

Implementation Schedule

Similar in nature to Project F-1, with the exceptions described above.

Physical Infrastructure Capital Costs

The combined total physical infrastructure cost is **nearly $1.6 billion**.

Environmental

Alternative F-3 is expected to have the combined effects of Alternatives F-1 and F-2. The cumulative effect of these two alternatives is expected to be adverse overall, with some potentially significant adverse effects along the diversion routes for I-95 and I-84.

Economics

The economic issues of F-3 are identical to those discussed in F-1 and F-2.

Equity

The equity issues of F-3 are identical to those discussed in F-1 and F-2.

Safety

The safety issues of F-3 are identical to those discussed in F-1 and F-2.

12.8 Financial Analysis of Concept F – Toll Individual Highways Needing New Capacity

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 (Table 12.14). On I-95, the $0.10 per mile auto toll rate (higher for trucks) would result in a surplus of over a billion dollars after accounting for the construction of the new lanes. This is significantly different from the finding for Concept A, which just involved tolling the new lanes. On I-84, the lowest toll rate would also yield a surplus of over one billion.

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 non-recourse 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.

As with other tolling concepts that involve tolls on existing Interstate highways, current Federal law prohibits the use of toll revenue beyond the highway on which it is collected.

Table 12.14 Financial Analysis of Concept F – Toll Individual Highways Needing New Capacity

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	2,939.7	6,162.4	8,490.7
Initial Capital Cost of Toll Collection System	381.1	357.8	330.3
Total Highway Construction Costs	1,468.5	1,468.5	1,468.5
Life-Cycle Surplus/(Shortfall)	**1,090.1**	**4,336.1**	**6,691.9**
Concept F-2: I-84			
Present Value of Net Toll Revenue	1,704.8	3,612.0	4,992.2
Initial Capital Cost of Toll Collection System	233.5	220.2	203.8
Total Highway Construction Costs	404.7	404.7	404.7
Life-Cycle Surplus/(Shortfall)	**1,066.5**	**2,987.1**	**4,383.7**

Table 12.15 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project F-1. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to

the toll collection system and highway construction. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept, no revenue shortfalls are projected throughout the 30-year analysis period for all toll levels. Significant toll collection capital costs are projected every eight years for Project F-1 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 12.15 Annual Toll Revenue and Expense Estimates Concept F-1 – I-95 Tolling All Lanes
(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.10/Mile in 2008 Dollars				Annual Costs			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.12	$1.39	$225.2	$11.3	84.9	7.5	121.6
2020	$0.14	$1.61	$277.1	$13.9	72.0	7.9	183.3
2025	$0.17	$1.87	$341.0	$17.0	71.2	8.0	244.6
2030	$0.19	$2.17	$419.6	$21.0	70.0	96.6	232.0
2035	$0.22	$2.51	$511.2	$25.6	84.4	2.4	398.8
2040	$0.26	$2.91	$622.9	$31.1	101.9	1.5	488.4
Toll Level 2 – $0.20/Mile in 2008 Dollars				**Annual Costs**			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.25	$2.78	$408.8	$20.4	83.7	6.8	297.9
2020	$0.29	$3.22	$503.1	$25.2	72.9	7.2	397.8
2025	$0.33	$3.74	$619.1	$31.0	73.2	7.3	507.6
2030	$0.38	$4.33	$761.8	$38.1	73.2	96.3	554.2
2035	$0.44	$5.02	$928.1	$46.4	88.3	2.2	791.2
2040	$0.52	$5.82	$1,130.9	$56.5	106.6	1.4	966.3

Table 12.15 Annual Toll Revenue and Expense Estimates Concept F-1 – I-95 Tolling All Lanes (continued)

(Millions of Year-of-Expenditure Dollars)

Toll Level 3 – $0.30/Mile in 2008 Dollars				Annual Costs			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.37	$4.17	$539.8	$27.0	79.9	6.0	426.9
2020	$0.43	$4.83	$664.3	$33.2	71.3	6.3	553.5
2025	$0.50	$5.60	$817.4	$40.9	72.3	6.4	697.8
2030	$0.57	$6.50	$1,005.8	$50.3	73.4	96.0	786.1
2035	$0.67	$7.53	$1,225.5	$61.3	88.6	2.0	1,073.7
2040	$0.77	$8.73	$1,493.2	$74.7	107.0	1.2	1,310.3

Table 12.16 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project F-2. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system and highway construction. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept, no revenue shortfalls are projected throughout the 30-year analysis period for all toll levels. Significant toll collection capital costs are projected every eight years for Project F-2 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 12.16 Annual Toll Revenue and Expense Estimates Concept F-2: – I-84 Tolling All Lanes
(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.10/Mile in 2008 Dollars				Annual Costs			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.12	$1.39	$133.4	$6.7	51.6	4.3	70.9
2020	$0.14	$1.61	$163.4	$8.2	44.0	4.5	106.7
2025	$0.17	$1.87	$200.0	$10.0	43.7	4.5	141.8
2030	$0.19	$2.17	$244.9	$12.2	43.1	53.2	136.4
2035	$0.22	$2.51	$298.4	$14.9	51.9	1.4	230.2
2040	$0.26	$2.91	$363.6	$18.2	62.5	0.9	282.1

Toll Level 2 – $0.20/Mile in 2008 Dollars				Annual Costs			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.25	$2.78	$243.4	$12.2	51.1	3.9	176.2
2020	$0.29	$3.22	$298.0	$14.9	44.7	4.1	234.3
2025	$0.33	$3.74	$364.9	$18.2	45.0	4.1	297.6
2030	$0.38	$4.33	$446.8	$22.3	45.1	53.0	326.4
2035	$0.44	$5.02	$544.4	$27.2	54.4	1.3	461.6
2040	$0.52	$5.82	$663.4	$33.2	65.5	0.8	563.9

Toll Level 3 – $0.30/Mile in 2008 Dollars				Annual Costs			
Year	Passenger Car Per-Mile Toll Rate	Average Toll	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.37	$4.17	$321.9	$16.1	49.0	3.4	253.5
2020	$0.43	$4.83	$394.2	$19.7	43.8	3.6	327.1
2025	$0.50	$5.60	$482.7	$24.1	44.6	3.6	410.3
2030	$0.57	$6.50	$591.0	$29.6	45.3	52.8	463.3
2035	$0.67	$7.53	$720.1	$36.0	54.6	1.1	628.3
2040	$0.77	$8.73	$877.4	$43.9	65.8	0.7	767.0

13.0 Concept G-1 –Toll All Limited Access Highways

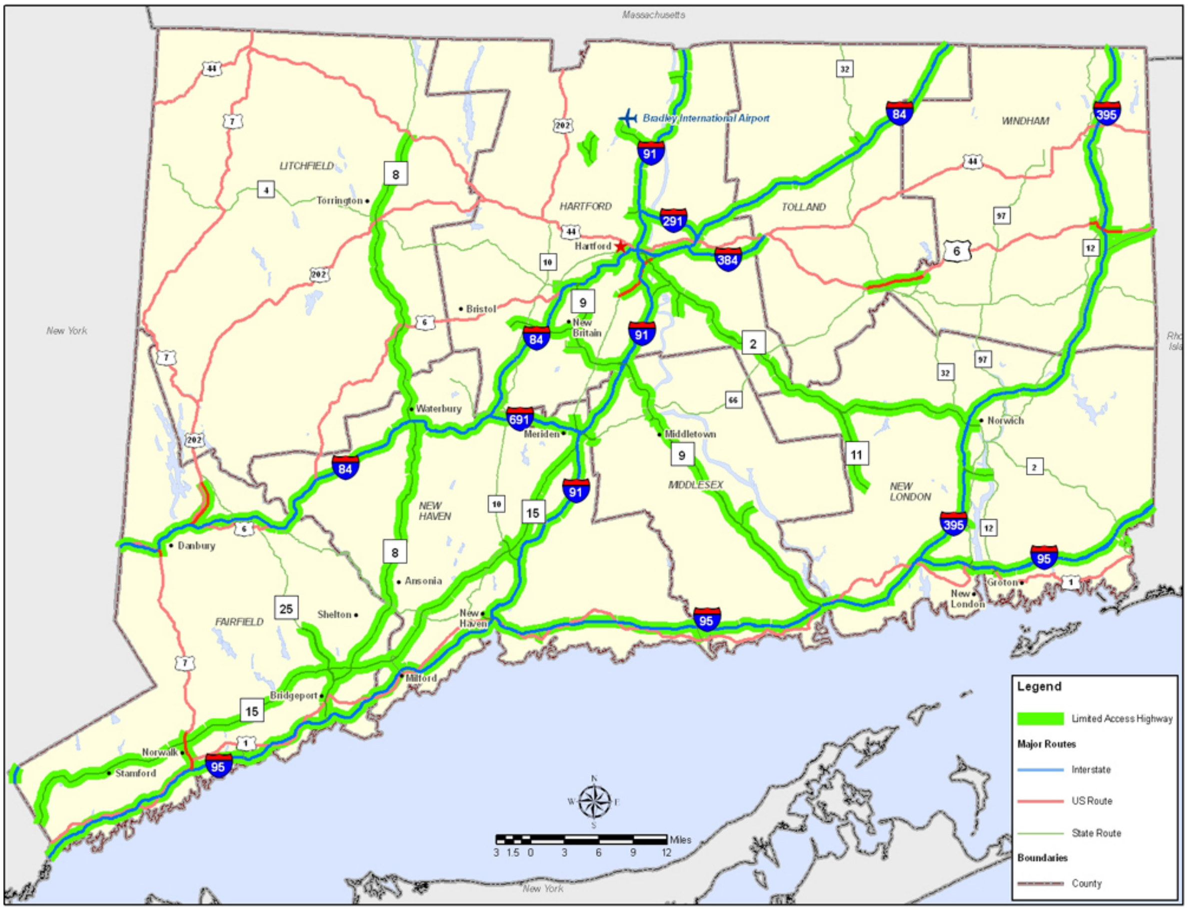
Project Description and Overview

This concept studies the implementation of mileage-based tolls for all vehicles on all limited access highways in the State of Connecticut. The study corridors, which are shown in Figure 13.1, include:

- Interstate 95 from New York state line to Rhode Island state line;
- Interstate 84 from New York state line to Massachusetts state line;
- Interstate 395 up to Massachusetts state line;
- Interstate 91 up to Massachusetts state line;
- Interstate 691;
- Interstate 291;
- Route 15 (limited access portions only);
- Route 2 (limited access portions only);
- Route 8 (limited access portions only); and
- Route 9 (limited access portions only).

The goal of this concept is to generate revenue for transportation improvements, including highway reconstruction, highway new capacity, and/or transit improvements. For the purpose of this study, we assumed that all highways would be tolled at the same levels throughout the day and that toll rates would vary by vehicle classification: cars, vans, single-unit trucks (SUT) and tractor trailers (TT).

Figure 13.1 Concept G-1 – Toll All Limited Access Highways



13.1 Institutional and Legal

A statewide program for tolling on all limited access facilities would need to be done under the Interstate System Reconstruction and Rehabilitation Toll Pilot Program for the Interstate highways. Tolling agreements would be needed for other reconstructed non-Interstate highways constructed with Federal funds. Tolling on highways not constructed with Federal funding would require approval of the state legislature (as would the Federally funded highways). As with Concept F, the portion of the system that was the former Connecticut Turnpike would be treated as any other Interstate highway, and would not require repayment of Federal funds if done under the toll pilot program.

The biggest obstacle to this concept under today's laws would be that the revenue could only be used for reconstruction and rehabilitation of the road being tolled. An extensive system of tolling such as Concept G would likely have revenues well in excess of that needed for current rehabilitation needs, so unless the rules were changed, it would be impossible to implement this scheme.

As discussed in Chapter Two in the section "Speculation on Tolling and Congestion Pricing under the Reauthorization of SAFETEA LU," the next transportation bill may allow for greater flexibility on tolling Federal highways, including full facility pricing.

■ 13.2 Technology and Deployment

This concept is similar to Concept F, except as described below.

Construction

No toll-related construction would be required to support this concept other than installation of toll gantries.

Toll Program Operation

A large back office and front office operation would be required to support statewide deployment, with a broad network of walk-in locations. Statewide partnerships for retails channels also should be considered.

■ 13.3 Potential PPP Approaches

Just as Germany implemented a national GPS truck tolling system through a PPP, Connecticut may be able to package and procure implementation of statewide highway tolling through a PPP proposal. Establishing a performance-based procurement would allow private firms to develop technological solutions for this admittedly complicated form of transportation financing, solutions that might be more effective than those that might be described in a typical, specifications-based public RFP.

Statewide tolling would be primarily a new form of transportation funding mechanism, and, therefore, a PPP project for implementation may be awarded based on the lowest cost of administration as a percentage of revenues collected.

Because this funding mechanism is so new and untested, the PPP procurement might be executed or solicited in phases, first for proof of concept, then for expanded testing, then for statewide implementation, with provisions for public performance monitoring before each step of project development. The early development may require some advance public funding, to be repaid from revenues from a new funding collection system. This may require the most radically different legal authority than the other alternative concepts.

PPP approaches that involve long-term concessions, though not technically out of the question, would likely face a difficult public relations debate surrounding private firms profiting from the privatization of public highways that had previously been toll free.

13.4 Privacy

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). Under this concept, it will be important to offer anonymous and one-off payment means to customers. Users that do choose to use the tolled lane are disclosing route journey information.

13.5 Technical Analysis of Project G-1 – Toll All Limited Access Highways

Transportation Impacts

The methodology for analyzing Concept G-1 is identical to that used for Concept C (truck tolling on all limited access highways); except that this concept assumes that all vehicles would be charged.

Existing Traffic Characteristics in Study Corridors

While the three major interstates – I-95, I-84, and I-91 – account for approximately 47 percent of the total limited access route mileage in the State, they account for almost 76 percent of the traffic on the State's highways. An overwhelming majority (91 percent) of the tractor trailers also are found on these three main roadways. Analysis of vehicle classification along the study corridors shows that cars account for approximately 79 percent of all the vehicles, while vans, SUTs, and TTs account for 10, 4, and 8 percent of the vehicles, respectively.

Toll Structure and Levels

Since this concept is predicated on revenue generation, we studied three different toll rates ranging from three to six cents per mile for passenger cars (in 2008 dollars) and higher levels for vans and trucks (Table 13.1). These rates are at the low end of rates typically charged on intercity toll roads. The rationale for the low rates is that the tolls are not needed for construction of a new highway, and that the low rates would tend to keep the diversion to non-tolled routes to a minimum.

Table 13.1 Per-Mile Tolls for Different Vehicle Classes
Concept G-1 –Toll All Limited Access Highways

	Cars	Vans	SUTs	TTs
Toll Level 1	$0.030	$0.060	$0.100	$0.200
Toll Level 2	$0.045	$0.090	$0.150	$0.300
Toll Level 3	$0.060	$0.120	$0.200	$0.400

Estimated Response to Tolls

The lack of good alternate routes to the study highways, especially for trucks, is projected to result in significantly slower speeds on diversion routes, which increases average travel time significantly even when the diversion routes are shorter than the direct highway routes. In comparison to the high cost of the alternative routing (in terms of travel time), the tolls for any trip in the study corridors are fairly modest, which results in a relatively low level of diversion from the tolled highways.

Even raising the tolls significantly over the Level 1 condition, the diversion rates remain low. The largest diversion in any corridor under the Level 1 toll scenario – 2,668 vehicles (on a 24-hour basis, in both directions, cars and trucks) in 2015 and 3,038 in 2030 – would occur on the I-91 corridor between New Haven and Hartford (Table 13.2). This translates to an approximate peak hourly diversion of roughly 260 to 280 vehicles in 2015, rising to 290 to 300 vehicles in 2030. Under the highest tolls (Level 3), these peak hour diversion figures would rise to only 370 to 380 and 430 to 440 vehicles in 2015 and 2030, respectively (never more than three percent in any corridor).

Table 13.2 Diversion to Non-Tolled Roads in 2015 and 2030 by Toll Levels

Concept G-1 –Toll All Limited Access Highways

	2015					
	Toll Level 1		Toll Level 2		Toll Level 3	
Study Corridors	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**
I-84 New York to Hartford	1,239	1.30%	2,130	2.23%	2,130	2.23%
I-84 Hartford to Massachusetts	804	1.06%	997	1.31%	1,018	1.34%
I-95 New York to New Haven	1,524	1.02%	1,650	1.11%	2,458	1.66%
I-95 New Haven to Rhode Island	893	1.28%	959	1.37%	1,087	1.56%
I-91 New Haven to Hartford	2,668	2.18%	2,668	2.18%	3,788	3.09%
I-91 Hartford to Massachusetts	1,509	1.29%	1,759	1.51%	2,629	2.25%
I-691 and I-291	621	1.04%	711	1.19%	735	1.23%
I-395	515	1.32%	883	2.26%	883	2.26%
Route 15	613	1.00%	613	1.00%	1,227	2.00%
Route 2, 8, 9	445	1.20%	461	1.24%	812	2.19%

	2030					
	Toll Level 1		Toll Level 2		Toll Level 3	
Study Corridors	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**	**Number of Vehicles**	**Percent of Total Vehicles**
I-84 New York to Hartford	1,411	1.30%	2,426	2.23%	2,426	2.23%
I-84 Hartford to Massachusetts	916	1.06%	1,136	1.31%	1,159	1.34%
I-95 New York to New Haven	1,736	1.02%	1,880	1.11%	2,799	1.66%
I-95 New Haven to Rhode Island	1,017	1.28%	1,092	1.37%	1,238	1.56%
I-91 New Haven to Hartford	3,038	2.18%	3,038	2.18%	4,314	3.09%
I-91 Hartford to Massachusetts	1,718	1.29%	2,003	1.51%	2,995	2.25%
I-691 and I-291	708	1.04%	810	1.19%	837	1.23%
I-395	586	1.32%	1,006	2.26%	1,006	2.26%
Route 15	699	1.00%	699	1.00%	1,397	2.00%
Route 2, 8, 9	507	1.20%	525	1.24%	925	2.19%

Impact on Highway and Local Roadway Traffic Operations

The projected change in traffic operations on the highways would be relatively minimal given the small change in traffic (generally 1.5 to 2.5 percent reduction). This concept will affect all users in all categories who use the limited access highway network.

Given the small number of vehicles diverted in these generally lengthy corridors, no discernable spot impacts would be expected along the diversion roadways or within local communities. For example, the section of I-95 from the New York border to New Haven is 46 miles long. With an expected diversion of 165 vehicles in the peak hour spread over that length, no single location will be impacted, although some volume could concentrate on links connecting these highways with major diversion routes.

Overall Impacts on VMT and VHT

In most instances, the total VMT would be expected to increase or decrease only marginally in response to the tolling, signifying that the diversion routes are of comparable length (Table 13.3). However, VHT would be expected to increase by a somewhat higher degree, reflecting the slow travel speeds for diverted vehicles on these alternate roadways. In 2015, the change in VMT is in the range of -0.39 percent to +0.65 percent whereas the VHT change is in the range of +2.28 percent to +3.38 percent. Such marginal increase in VHT signifies that very few vehicles are diverting to the non-tolled, slow-speed alternate routes.

Table 13.3 Corridor Traffic Operational Impacts at Toll Level 2
Concept G-1 –Toll All Limited Access Highways

I-84 New York State Line to Hartford

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	6,391,638	6,394,092	2,454	0.04%	7,279,365	7,282,034	2,668	0.04%
VHT	127,833	130,916	3,083	2.41%	161,764	166,405	4,641	2.87%
Avg Speed	50.00	48.84	-1.16	-2.32%	45.00	43.76	-1.24	-2.75%

I-84 Hartford to Massachusetts State Line

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	2,360,708	2,375,975	15,267	0.65%	2,688,584	2,705,624	17,040	0.63%
VHT	47,214	48,456	1,242	2.63%	59,746	61,577	1,830	3.06%
Avg Speed	50.00	49.03	-0.97	-1.93%	45.00	43.94	-1.06	-2.36%

I-95 New York State Line to New Haven

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	7,569,541	7,563,745	-5,796	-0.08%	8,620,866	8,616,820	-4,046	-0.05%
VHT	168,212	172,643	4,431	2.63%	215,522	220,196	4,674	2.17%
Avg Speed	45.00	43.81	-1.19	-2.64%	40.00	39.13	-0.87	-2.17%

I-95 New Haven to Rhode Island State Line

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	4,248,135	4,257,934	9,800	0.23%	4,838,153	4,844,882	6,729	0.14%
VHT	77,239	79,743	2,504	3.24%	96,763	99,739	2,976	3.08%
Avg Speed	55.00	53.40	-1.60	-2.92%	50.00	48.58	-1.42	-2.85%

I-395 to Massachusetts State Line

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	2,136,921	2,135,385	-1,536	0.07%	2,433,716	2,432,017	-1,699	-0.07%
VHT	38,853	39,876	1,023	2.63%	48,674	50,239	1,565	3.22%
Avg Speed	55.00	53.55	-1.45	-2.64%	50.00	48,341	-1.59	-3.18%

Table 13.3 Corridor Traffic Operational Impacts at Toll Level 2 (continued)

Concept G-1 –Toll All Limited Access Highways

I-91 New Haven to Hartford

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	5,016,037	4,996,601	-19,437	0.39%	5,712,709	5,697,578	-15,131	0.26%
VHT	100,321	102,742	2,421	2.41%	126,949	129,651	2,702	2.13%
Avg Speed	50.00	48.63	-1.37	-2.74%	45.00	43.95	-1.05	-2.34%

I-91 Hartford to Massachusetts State Line

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	1,985,519	1,992,039	6,521	0.33%	2,261,285	2,266,253	4,968	0.22%
VHT	39,710	40,866	1,156	2.91%	50,251	51,446	1,196	2.38%
Avg Speed	50.00	48.75	-1.25	-2.51%	45.00	44.05	-0.95	-2.11%

Route 15

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	4,102,970	4,106,785	3,815	0.09%	4,672,827	4,674,999	2,173	0.05%
VHT	91,177	93,257	2,080	2.28%	116,821	118,529	1,708	1.46%
Avg Speed	45.00	44.04	-0.96	-2.14%	40.00	39.44	-0.56	-1.40%

I-691 and I-291

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	915,122	917,921	2,800	0.31%	1,042,222	1,043,987	1,765	0.17%
VHT	20,336	21,023	687	3.38%	26,056	26,690	634	2.43%
Avg Speed	45.00	43.66	-1.34	-2.97%	40.00	39.12	-0.88	-2.21%

Routes 2, 8, and 9

	Toll Level 2, 2015				Toll Level 2, 2030			
Measure	**No Build**	**Build**	**Change**	**Percent Change**	**No Build**	**Build**	**Change**	**Percent Change**
VMT	6,174,361	6,183,880	9,519	0.15%	7,031,912	7,038,061	6,149	0.09%
VHT	137,208	140,778	3,570	2.60%	175,798	179,110	3,313	1.88%
Avg Speed	45.00	43.93	-1.07	-2.39%	40.00	39.29	-0.71	-1.76%

Transit Impacts

The tolling of all limited access facilities presents some of the same basic questions about transit availability and viability as Concept F – i.e., providing incentives to divert trips to transit since all highway drivers, a major portion of the daily travelers across the State, would face new tolling fees. Existing transit availability varies according to region and corridor, as summarized below.

Southwest

CTTransit's New Haven Division operates local and interregional fixed route service along the I-95 corridor. Two local routes provide service to the west of New Haven along U.S. Routes 1 and 34, and a variety of connecting bus services is available in the I-91/U.S. 5 corridor. Commuter rail service is operated by Metro-North Railroad from New Haven to New York City, with connections to: 1) Shoreline East for those who originate east of the tolling zone under this concept; or 2) the Waterbury Branch for those who feed into the corridor from Route 8. This type of service could potentially accommodate mid-length trips diverted from I-95 as a result of tolling.

The railroad would be able to absorb some trips on its trains – particularly between New Haven and Stamford. However, station area parking constraints exist at several rail stations along these lines. These constraints can be mitigated with increased funding for improved shuttle services to and from rail stations to facilitate access. Trips that would divert to the train would be moderate- to long-distance trips from I-95 and would be more effectively accommodated in locations where high-level connecting services are available to and from rail stations, such as in New Haven, Milford, Bridgeport, Westport, Norwalk, Stamford, and Greenwich.

In fact, the expected diversions are few; only 72 car trips (excluding trucks) between New Haven and New York are expected to divert from I-95 during the peak hour in both directions under toll level 2 in 2015. The transit share of these trips, even if 10 percent, is insignificant. The same applies to Route 15, with only 61 car trips diverted in both directions during the peak hours.

CTTransit's New Haven Division and Stamford Divisions, Norwalk Transit District (NTD), Greater Bridgeport Transit Authority (GBTA), and Milford Transit District (MTD) all operate local and interregional routes along the I-95 corridor west of New Haven, including rail-oriented services. The interregional Coastal Link route, which is jointly operated by NTD, GBTA, and MTD, runs immediately parallel to I-95 along U.S. 1 from Milford to Norwalk and has a very high frequency. The I-Bus Express, operated by CTTransit, is an interregional route that runs along the I-95 corridor from Stamford, Connecticut to Port Chester, New York, and then follows I-287 to White Plains, New York. These two bus services also are positioned to accommodate moderate distance trips diverted from I-95.

The Route 15 corridor, while running parallel to I-95 to the north, currently has no transit routes running along its corridor (buses are not allowed on the parkway). Nonetheless, with only 50 peak hour car trips in both directions expected to divert as a result of tolling on Route 15, there would be no notable transit impact.

Unlike new or converted HOV/HOT lanes, on-highway transit bus services would not explicitly benefit with no new capacity or express lanes, particularly since the number of anticipated car diversions is very low. Nonetheless, additional revenue from new tolling concepts would support transit initiatives, including greater frequency of service, new connections to major origins/destinations, filling gaps in the local and express networks, and supporting shuttle/feeder services to express buses and rail.

North/Central (Hartford Area)

CTTransit and several private bus carriers offer numerous express bus routes on the I-84 and I-91 corridors serving downtown Hartford. This express network (and related park-and-ride facilities), combined with local transit options in the Hartford region, provide a variety of alternatives should drivers divert from the limited access highways as a result of tolling initiatives. Express services reach as far as communities such as Winchester, Torrington, Enfield, Windham, Colchester (on Route 2), and Cromwell, often connecting to local bus systems in these areas which may be considered outside of the Hartford metropolitan area.

Car trip diversions are not expected to represent any significant volume. On I-84 from Hartford to Massachusetts, only 60 cars would divert from the highway in both directions during the morning or evening peak hour. On I-291 and I-691 combined the anticipated diversions total only 50 cars. On I-91 from Hartford to Massachusetts the numbers are similar (87 cars in both directions) and still insignificant from a transit mode share perspective. Only from Hartford south to New Haven on I-91 do the total car trip diversions exceed 200, yet this still does not result in any significant transit trip impact.

West

The I-84 corridor, which currently hosts limited express bus service between Danbury and Waterbury/Hartford, could benefit from increased toll-supported funding to enhance the local and regional transit network. Local bus networks currently exist in Danbury and Waterbury, and to a lesser extent in neighboring towns such as Brookfield, New Milford, Watertown, Middlebury, and Naugatuck, but the transit connections between these communities in the I-84 corridor are limited. These improvements would likely attract many more transit riders than would be generated by the travelers diverted by this tolling scheme.

The Route 8 corridor does not feature any significant transit services at present.

Diversions resulting from tolling are not expected to exceed 147 peak hour car trips on I-84 between Hartford and the New York state line, resulting in a similarly low transit mode share.

Southeast

Congestion is generally not as acute in the southeastern region of the State as it is in the southwest or Hartford area, thus tolling initiatives that focus on adding capacity through shoulder lanes and charging drives only for this added capacity is unlikely to provoke a substantial number of trip diversions to transit.

Transit capacity does exist and can accommodate diverted trips in certain segments of the I-95 and I-395 corridors. Nonetheless, as most of this service is local bus transit, trip lengths would be short or moderate distance, within or between municipalities such as New Haven/Branford and Old Saybrook (Estuary Transit District local bus, Shore Line East rail), New London and Norwich (local bus), and New London and Croton or Stonington. Service in this area is provided by the Southeast Area Transit Authority (SEAT). Longer distance trips, particularly east to Rhode Island, are provided by Amtrak.

Transit options are limited or nonexistent in the Routes 2 and 11 corridors with the exception of express bus service to/from Colchester to Hartford. Only 50 peak hour car trips are expected to be diverted from I-95 as a result of tolling. This two-way figure results in an even lower number in each direction and an insignificant impact on transit. Routes 8, 9, and 2 across the State total only 30 diverted trips combined.

Northeast

Transit availability is generally limited in northeastern Connecticut. Local bus services are available in Putnam, Killingly, and Brooklyn, operated by the Northeastern Connecticut Transit District (NCTD), including flexible route services in the I-395 corridor.

The limited section of Route 6 that is a limited access facility currently does feature express bus service to Hartford and local services in Windham and Mansfield. Otherwise, connections to the east currently are not available with existing transit services. Additional funding generated through tolling concepts could be used to increase transit availability, yet the overall level of ridership seen in this area is unlikely to support service frequent enough to induce diversions from highway commuting. This is particularly true if the tolling mechanism adds capacity to the highways via shoulder lanes as opposed to tolling all existing capacity (and thus prompting trip diversions). As with the other highway segments, the car trip diversions on I-395 are minimal. Only 58 peak hour cars would be diverted in both directions, representing a potential transit share of fewer than 10 person trips in each direction.

Toll Revenue Estimates

Annual 2015 toll revenue at Toll Level 1, 2, and 3 in 2015 would be approximately $0.70 billion, $1.04 billion and $1.40 billion, respectively. By 2030, the equivalent revenues would increase to $0.80 billion, $1.19 billion, and $1.59 billion dollars, respectively (see Table 13.4).

Table 13.4 Toll Trips and Revenue Forecasts (in 2008 Dollars) for 2015 and 2030 by Study Corridors

Concept G-1 –Toll All Limited Access Highways

Toll Trips and Revenue Projections for Toll Level 1

Study Corridors	Toll Trips 2015	Revenue 2015	Toll Trips 2030	Revenue 2030
I-84 New York to Hartford	34,423,150	$121,192,045	39200635	$138,024,385
I-84 Hartford to Massachusetts	27,502,020	$43,267,830	31321745	$49,277,190
I-95 New York to New Haven	53,759,025	$140,458,935	61225465	$159,967,090
I-95 New Haven to Rhode Island	25,160,180	$80,880,350	28654690	$92,113,955
I-91 New Haven to Hartford	43,702,910	$90,599,205	49772860	$103,182,215
I-91 Hartford to Massachusetts	42,029,385	$38,582,325	47866830	$43,941,255
I-691 and I-291	21,576,245	$13,769,260	24572895	$15,681,495
I-395	14,074,035	$37,473,820	16028610	$42,678,355
Route 15	22,164,990	$44,478,170	25243400	$50,655,795
Route 2, 8, 9	13,390,755	$88,633,315	15250795	$100,943,670
Total	**297,782,695**	**$699,335,255**	**339137925**	**$796,465,405**

Toll Trips and Revenue Projections for Toll Level 2

Study Corridors	Toll Trips 2015	Revenue 2015	Toll Trips 2030	Revenue 2030
I-84 New York to Hartford	34,094,650	$180,355,625	38,830,160	$205,405,210
I-84 Hartford to Massachusetts	27,431,210	$64,433,085	31,241,080	$73,382,155
I-95 New York to New Haven	53,713,035	$210,150,575	61,172,905	$239,338,165
I-95 New Haven to Rhode Island	25,136,090	$120,877,780	28,626,950	$137,666,320
I-91 New Haven to Hartford	43,702,910	$135,898,625	49,772,860	$154,773,505
I-91 Hartford to Massachusetts	41,938,135	$53,510,095	47,762,805	$60,941,860
I-691 and I-291	21,543,395	$20,562,640	24,535,665	$23,418,400
I-395	13,939,350	$55,746,450	15,875,675	$63,488,830
Route 15	22,164,990	$66,717,255	25,243,400	$75,983,510
Route 2, 8, 9	13,385,280	$132,776,415	15,244,225	$151,217,675
Total	**297,049,045**	**$1,041,028,545**	**338,305,725**	**$1,185,615,630**

Toll Trips and Revenue Projections for Toll Level 3

Study Corridors	Toll Trips 2015	Revenue 2015	Toll Trips 2030	Revenue 2030
I-84 New York to Hartford	34,094,650	$240,474,410	38,830,160	$273,873,370
I-84 Hartford to Massachusetts	27,423,910	$101,762,000	31,232,685	$115,895,530
I-95 New York to New Haven	53,239,630	$278,570,190	60,634,165	$317,260,555
I-95 New Haven to Rhode Island	25,089,370	$160,788,340	28,574,025	$183,120,135
I-91 New Haven to Hartford	43,294,475	$179,606,280	49,307,485	$204,551,475
I-91 Hartford to Massachusetts	41,620,585	$71,022,430	47,401,090	$80,886,555
I-691 and I-291	21,534,635	$27,389,965	24,525,445	$31,194,360
I-395	13,939,350	$74,328,600	15,875,675	$84,651,895
Route 15	21,940,880	$88,058,075	24,988,265	$100,288,130
Route 2, 8, 9	13,256,800	$175,574,490	15,098,225	$199,959,775
Total	**295,434,285**	**$1,397,574,780**	**336,467,220**	**$1,591,681,780**

Implementation Requirements

This concept requires instrumenting a large number of roadways in excess of 585 miles. Using the assumption that all vehicles will pay a toll for using these highways regardless of distance traveled results in the need to deploy 710 tolling points to cover all segments of the highway in both directions. Furthermore, each tolling point would need to cover all lanes of traffic. Since the tolling is likely to be based on the vehicle type, effective classification equipment would need to be installed at each location. This concept would likely not use dynamic pricing so that traffic monitoring equipment and dynamic message signs for toll rates are not required as part of this concept, although it is likely that some dynamic messaging signs would be installed to convey other information to drivers. CCTV cameras would not be required for traffic monitoring but would be used to monitor tolling equipment. Since the project is not associated with the requirement to improve traffic flow, no additional roadway assistance facilities would be required. Significant allowance has been made for additional enforcement staff to provide toll evasion deterrent along the extended length of these facilities. Since equipment will be distributed along the length of the roadways, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The back office for this concept will be a major operation in order to support nearly all drivers in the State and a large volume of out-of-state customers. Given that tolling will be widespread, we anticipate that there would be a fairly high level of account participation, including leveraging current E-ZPass tag holders from other states. However, the large number of out-of-state users may indicate a reasonable percentage of video-based transactions. Since travelers will have little alternative to paying tolls, a very comprehensive customer service operation has been estimated involving six regional walk-in centers and several partnerships with grocery store type chains to provide payment locations.

Toll Collection Costs

The capital cost for this project is driven by the large number of tolling points that need to be installed to toll every segment of the limited access highways, with 86 percent of the capital investment being required to deploy the tolling points. However, a large investment also is required to purchase the large number of tags associated with the anticipated accounts (it is estimate that virtually every vehicle in Connecticut would eventually be equipped.)

O&M costs are driven by the large back office account management and video processing costs (37 percent) and the cost to maintain the extensive network of toll equipment (32 percent.) Since the revenue from this project also will be significant, the financial processing costs also are large at 15 percent of the O&M cost. These financial processing costs also account for the majority of the difference in costs between the different toll rate scenarios.

The total toll collection cost over the construction period plus 30 years of operation is estimated to be between $6.6 billion and $7.1 billion (Table 13.5)

Table 13.5 Life-Cycle Technology Costs
Concept G-1 – Toll All Limited Access Highways

Scenario	Total Capital Cost	Total O&M Cost	Total
Toll Rate 1	$3,186,026,262	$3,375,784,084	**$6,561,810,346**
Toll Rate 2	$3,185,226,144	$3,648,631,400	**$6,833,857,544**
Toll Rate 3	$3,183,252,048	$3,929,479,773	**$7,112,731,821**

Implementation Strategy

This concept will toll existing capacity (although it will fund additional capacity downstream), and users of those roads would not be able to avoid paying the toll, so the ability to build consensus with stakeholders, public and elected officials will require considerable time. For Federally maintained roads, Federal approval would be required which may increase the duration of any legislative and funding tasks. Due to the wide-scale geographical coverage of this concept, with tolls being applicable to all vehicles, and no equivalent non-tolled alternative routes, there is a higher degree of risk of delays to the consensus building activities; similarly the further studies would require extensive work (due to the amount of road network to study) and hence their durations would expand.

This concept applies to all limited access highways and, because of the large geographical coverage, deployment risk could be reduced by rolling out section by section rather than adopting a ‘big-bang’ delivery. The number of phases, and the time between them to learn from the previous phase, will vary according to the amount of delivery risk the agency is prepared to accept. Even though the delivery is phased, it is likely a single procurement will be conducted for all phases to allow for the continuity between phases and to promote the ability to apply lessons learned. Design efforts in the first phase should be used to set the standards to be applied in later phases.

This project requires the construction of over 700 tolling points. As with Concept C, appropriate time savings might be gained through creation of a new business for the sole purpose of constructing these tolling points. Nevertheless, it is unlikely that 700 tolling points could be erected in fewer than five years. It is likely a small amount of roadway construction will be required along the tolled roads, such as enforcement pull-offs and drainage.

Accordingly, the tasks to implement this concept, and their likely durations, are noted below in Table 13.6:

Table 13.6 Illustrative Implementation Durations
Concept G-1 – Toll All Limited Access Highways

Task	Duration
Further Studies and Consensus Building	48 months
Studies Sufficient for Funding	18 months
Legislation and Funding	36 months
Assemble Program Staff	9 months
Procurement	24 months
Design	42 months over 3 phases
Build – Highway	36 months over 3 phases
Build – Roadside Equipment	60 months over 3 phases
Build – Back-Office	12 months
Test	18 months over 3 phases
Distribute Tags	6 months
Go-Live	3 milestones

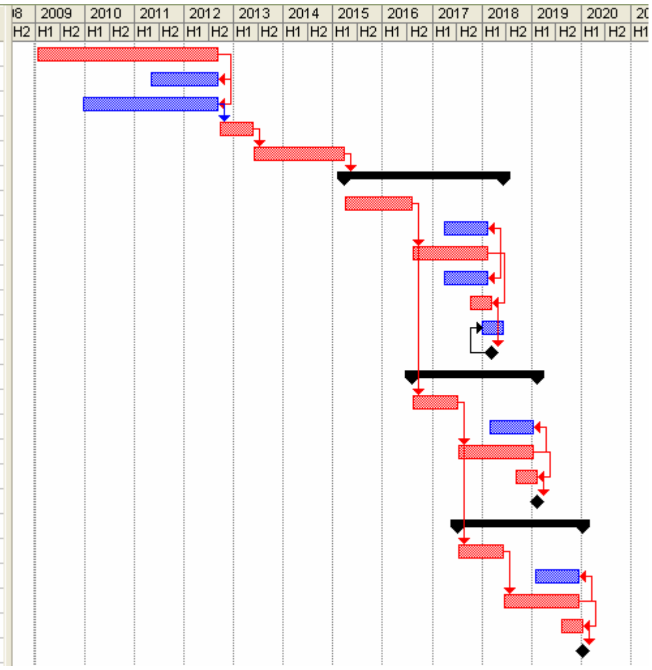
Implementation Schedule

There are many ways in which the above tasks could be scheduled, with the actual approach being influenced by desired delivery dates, political considerations, financing constraints and resource availability. One such arrangement is detailed in the Gantt chart in Figure 13.2 below; this format allows key dependencies to be highlighted and the critical path[56] to be identified (in red). This schedule anticipates completion by 2020.

[56] The Critical Path is the set of activities that must be completed on time for the project completion date to be met. Activities on the critical path have no slack time and delays to these tasks will delay the entire project.

Figure 13.2 Illustrative Implementation Schedule
Concept G-1 – Toll All Limited Access Highways

	Task Name	Duration	Predecessors
1	Further studies and consensus building	48 mons	
2	Studies sufficient for funding	18 mons	1FF
3	Legislation and funding	36 mons	1FF
4	Assemble program staff	9 mons	3
5	Procurement	24 mons	4
6	**Phase 1**	**42 mons**	**5**
7	Design	18 mons	
8	Build - highway	12 mons	9FF
9	Build - roadside equipment	20 mons	7
10	Build - back office	12 mons	9FF
11	Test	6 mons	9FF+1 mon
12	Distribute tags	6 mons	13SS-3 mons
13	Go-live 1	0 mons	11
14	**Phase 2**	**33 mons**	
15	Design	12 mons	7
16	Build - highway	12 mons	17FF
17	Build - roadside equipment	20 mons	15
18	Test	6 mons	17FF+1 mon
19	Go-live 2	0 mons	18
20	**Phase 3**	**33 mons**	
21	Design	12 mons	15
22	Build - highway	12 mons	23FF
23	Build - roadside equipment	20 mons	21
24	Test	6 mons	23FF+1 mon
25	Go-live 3	0 mons	24



Under a phased approach, there are in fact critical paths for each delivery phase go-live milestone, with the overall critical path length determined by the total duration of its constituent paths.

Environmental

Alternative G-1 would impact all of the limited access highways in Connecticut. A number of diversion routes are expected to be used by all classes of vehicles with tolling of those highways. Consequently, the impacts of this alternative can be considered to be statewide but vary somewhat by highway. The map for this concept labels 1 through 7 referring to the Interstates, 8 through 11 referring to the Connecticut state routes, and 12 referring to the Merritt Parkway. The impacts are summarized by magnitude as follows and as shown in Table 13.7 and Figure 13.3.

Alternative G-1 would only have beneficial impacts in terms of air quality along the limited access highways. We anticipate that traffic movement will be somewhat more free-flowing with Alternative G-1. Consequently, vehicle hours of travel and vehicle hours of delay will both decrease. In addition, average travel speeds are expected to increase. These factors would have the effect of reducing emissions along the limited access highway.

Concept G-1 is expected to have a minor adverse impact to the following factors due to diversion to alternative routes:

- **Water Quality –** Approximately 97 major water bodies would have increased exposure to hazardous materials and degraded stormwater runoff. Less traveled local roads are often not as well maintained as the interstates and state routes and due to their age, do not have contemporary stormwater treatment facilities along their length. As those roads receive more traffic, there is greater potential for hazardous waste spills and stormwater runoff contaminated with petroleum products to impact unprotected streams, rivers, and wetlands, or groundwater.

- **Energy Use/Conservation –** The average speed of travel decreases for vehicles traveling on local roads as opposed to on a limited-access highway. However, as they travel longer distances, they will have more vehicle miles of travel and slight increases in energy use. If there are delays on local roads due to added congestion, causing cars and trucks to idle in place, fuel consumption also may increase.

- **Environmental Justice –** Tolls in the vicinity of disadvantaged populations may discourage highway use and make travel more expensive and/or more inconvenient. Added traffic congestion in a neighborhood with an environmental justice population has a potential to expose them to a higher burden of community impacts.

Concept G-1 is expected to have potentially significant impacts to:

- **Air Quality –** Volatile organic compounds (VOC), a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. In addition, if there are delays along the diversion routes in part due to added traffic, this could increase overall vehicle emissions somewhat.

- **Community Disruption –** Several of the diversion routes also are the ‘Main Street’ for communities through which they travel. The addition of traffic through these community centers will adversely affect quality of life by inhibiting pedestrian access, reducing pedestrian safety, and altering sense of place. This is particularly true for the smaller towns and villages where the ‘Main Street’ serves as the central gathering place for the community. In particular, diversions from I-95 in southwestern Connecticut would occur in what is often referred to as the ‘Gold Coast’ due to its relative wealth. It is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. Additional traffic through these centers such as Greenwich, Fairfield, Darien, New Canaan, and Westport would conflict with the pedestrian-scale character of these communities’ residents’ experience of quality of life.

- **Bicycles and Pedestrian Travel –** Portions of the diversion routes serve as designated cross-state bicycle routes. Traffic diverted to those routes reduces safety and can hinder travel for bicyclists. Where trucks are diverted to routes that serve as a ‘Main Street’ within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel.

- **Noise –** As vehicles are added to local roads, noise levels can be expected to increase. There are a significant number of noise sensitive receptors along the anticipated diversion routes. In particular, several of the diversion routes pass through residential enclaves in southwestern Connecticut, north and west of Hartford, and in the suburban rings around Norwich, New London, and Windham.
- **Cultural/Historic –** The Merritt Parkway is listed on the National Register of Historic Places, in large part due to its unique overpass bridges. The location of tolling facilities along this parkway would conflict with the historic setting and could impact historic structures that characterize the roadway.

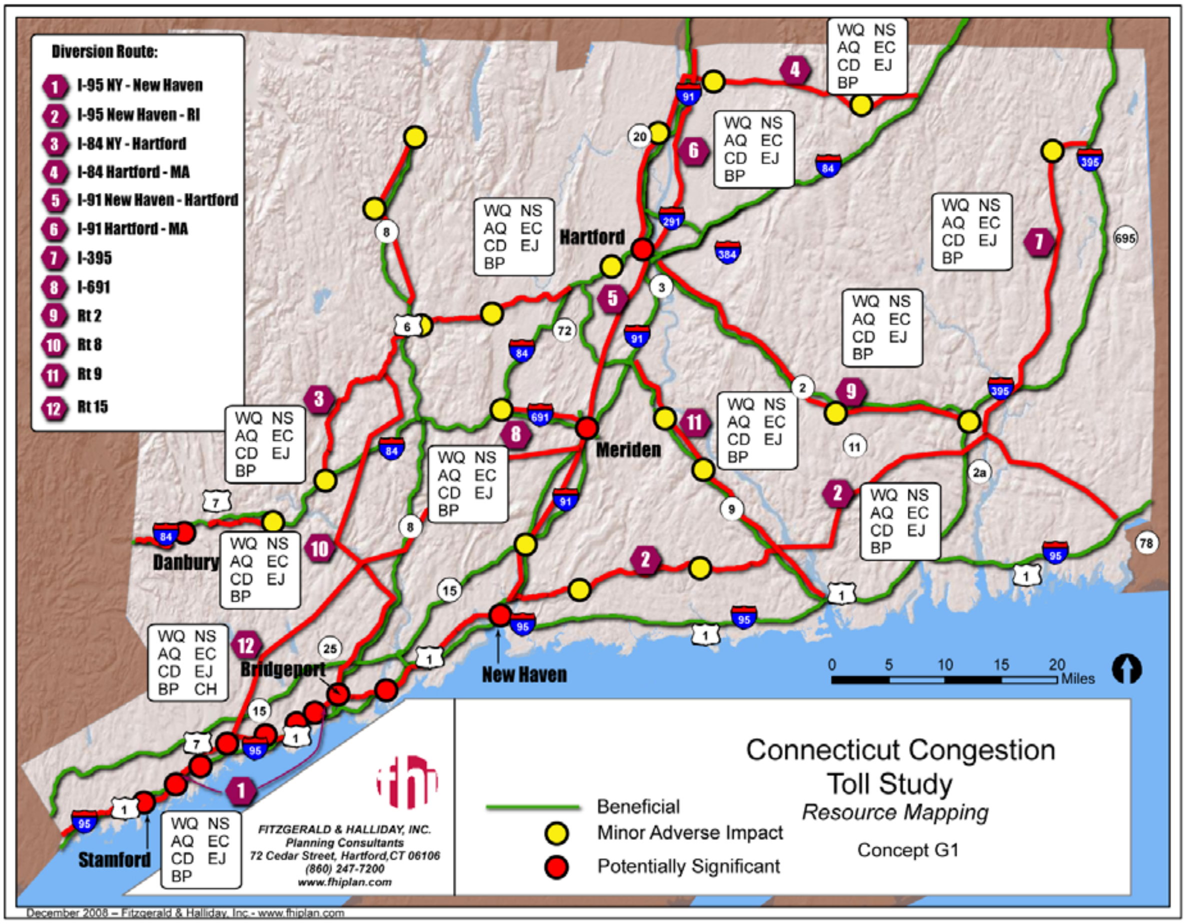
Table 13.7 Environmental Impact Summary
Concept G-1 – Toll All Limited Access Highways

Resource	Potential Impact	Impact Description	
		Magnitude	Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	Approximately 97 major water bodies would have increased exposure to hazardous materials and degraded stormwater runoff due to trucks diverting to local arterials
Air Quality (AQ)	Yes	Potentially Significant	Benefit to Limited Access Highways Potentially Significant Impact to all diversion routes
Social/Community			
Community Disruption (CD) – includes quality of life deterioration, economic development impacts, and community character impacts	Yes	Potentially Significant	Gold Coast Town Centers 1) – heavily developed/commercial Urban Centers (1, 2, 3, 5) – higher density, increased conflicts Numerous suburban and rural community centers (all routes) where diversion route is the 'Main Street'
Bicycle and Pedestrian (BP)	Yes	Potentially Significant	Motorist diversions onto arterials, portions of which are cross-state bicycle routes, including: Route 1 (Stamford, Darien, Stratford, and Milford), Route 148 (Chester), Route 6 (Woodbury, Southbury), Route 190 (Stafford Springs, Union), Route 169 (Canterbury, Brooklyn), CT 136 (Darien, Norwalk, and Westport), Route 57 (Weston), Route 6 (Thomaston), CT 154 (Chester), and CT 3 (Middletown, Cromwell).

Table 13.7 Environmental Impact Summary (continued)
Concept G-1 – Toll All Limited Access Highways

Resource	Potential Impact	Impact Description: Magnitude	Impact Description: Location
Social/Community (continued)			
Noise (NS)		Potentially Significant	Over all diversion routes there is increased vehicular noise exposure to 532 sensitive land uses. Locations with heavy receptor concentrations are located in segments (1 – SW CT, 6 – Hartford north, and 2, 9, 7 – in Norwich)
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes have the potential for increased fuel consumption due to longer trips
Environmental Justice (EJ)	Yes	Minor Adverse	Numerous EJ populations along diversion segment (1), including Stamford, Norwalk, Bridgeport and New Haven Segments (3, 5, 9) include EJ population in Greater Hartford area Segment 3) has EJ issues in Danbury area
Cultural/Historic (CH)	Yes	Potentially Significant	Placement of overhead structures on the Merritt Parkway may impact the historic character of the facility

Figure 13.3 Environmental Impact Locations
Concept G-1 – Toll All Limited Access Highways



Economics

As with the truck-only tolls under Concept C, the main issues associated with the economic consequences of these concepts are the level of tolls, the level of existing congestion, and whether the types of tolls involved under this concept would provide some offsetting congestion relief. Any effort through higher 24-hour flat tolls to bring about a major shift in traffic (especially higher tolls on TTs and other large trucks), would likely raise substantial economic concerns. If a certain segment (e.g., I-95 between the New York border and Bridgeport) has significant congestion and high truck volumes, but the flat-toll approach does not substantially address the congestion issue, the offsetting benefits for local residents, commuters and corridor businesses, shippers and trucking interests would be hard for the public to see. The western portions of both I-95 and I-84 also fall into this category.

Extensive use of the highway for local and subregional trips – a typical pattern in highway segments in more urbanized areas – combined with a lack of suitable alternative routes also can pose a perceived economic problem for local residents (especially those often going on and off the highway for relatively short intraregional trips), local market businesses, and for communities along the likely alternative routes that would absorb the modest but still noticeable diverted traffic. Of course, the interstate highways were not constructed with these trips in mind, and the highways would work better without them, but there has to be viable alternative routes or modes available, which is not always the case in these examples.

The potential for significant impacts on interstate freight operations due to these tolls, with limited offsetting travel speed benefits, would pose an economic issue along those segments that carry the bulk of these shipments. A key to the overall economic benefit of the tolling concept – for local residents, for corridor employers and major shippers and for commuters – is once again not the collection of the toll itself but what the State does with those revenues to improve transportation (or other) conditions in the corridor – including the potential to improve the highways themselves, the alternative local routes, and related transit services.

Equity

Equity issues with respect to this concept depend on the level of tolling involved. The tolls reviewed under this concept are similar to those on highways in other states (e.g., NYS Thruway, Mass Pike). Some of the equity considerations include:

- **Geographic Distribution of Travelers –** Due to the comprehensive nature of this concept, traffic in virtually all areas of the State would be affected by this tolling plan.

- **Distribution of Auto Travel Markets –** Due to the 24-hour, bidirectional, and statewide nature of this concept, virtually all auto travel markets, from commuter peak daily work trips to midday or early evening personal business trips, would be impacted. As with most flat tolling schemes, it would affect work trips the most due to the frequency of their trips and the limited route options relative to other types of trips.

- **Likely Truck Markets Involved –** As with the truck-only highway toll, virtually all truck markets, from local van-based delivery and service operations to long-haul interstate freight movements, would face these proposed charges. The major interstate truck routes – I-91, I-84, and especially I-95 – have a larger share of the longer-haul truck market, while secondary highways (e.g., CT Route 8) would carry more regional and local trips. At the same time, highways like I-95 and I-84 (especially in their western portions) carry a substantial amount of local truck traffic as well. The eventual level and mix of tolls would reflect the State's policy on which vehicles should be using the highway and which should use the local and arterial network, with relevant consequences to both networks. The relative level of truck versus car tolls is critical to this issue. Also, the possibility that certain tolls for certain vehicle groups might be lowered or eliminated at various time of the day to direct traffic to or from various highways would impact the effects on certain truck markets.

- **Time Savings –** The goal of this approach is not to substantially reduce congestion but primarily to raise revenue. All lanes on each highway in both directions would be tolled. The primary time versus toll issue in this instance would be the additional travel distance and associated lower speeds on alternate routes. Unlike a HOT express lane, where one pays more but gets a clear time savings compared to general traffic lanes, drivers in this instance could either pay a highway toll but with limited offsetting congestion relief (except at relatively high toll levels) or avoid the toll by taking a longer, possibly less reliable route – i.e., a potential "lose-lose" situation depending on the quality of the alternative routes. Over time, though, if the State invests the new revenue in improved transportation systems then the equation will change.

- **Potential Low-/Moderate-Income Concentration –** This would most likely not be a major issue under this concept in terms of falling disproportionately on lower-income areas, due to its broad statewide coverage. An important issue for lower-income groups, however, would be whether other forms of taxation or user changes (fuel tax, sales tax, etc.) would be reduced because of these new tolls, and whether a portion of these funds will be used to expand and subsidize public transit options in the tolled corridors.

- **Available Alternative Routes –** In most instances, there is some form of alternate route, although clearly more options are available for cars than for trucks. As with the other statewide concept (truck-only tolls), the time penalty on alternate routes relative to the highway and the ability of those routes to absorb more traffic (especially truck traffic) from capacity, safety and environmental perspectives are the critical issues. These issues are particularly important for longer-haul; larger single-unit and tractor trailer trucks, which by design are intended to be on the highways which are better designed to handle them.

- **Available and Potential New/Expanded Transit Service –** The equity impacts of this concept could be mitigated over time by reinvesting the new revenue in improved transit services.

Safety

The concept of tolling all limited access highways in the State on a mileage-based toll rate would raise the same safety and operational issues as the truck-only tolling plan (Concept C). Unlike congestion-based tolling (see Concept H), where tolls (and diversions) are focused around peak travel periods, 24-hour flat tolls create diversions throughout an extended period rather than just in the congested periods. Further, it would generate diversions from all of the State's limited access facilities, not only those that experience congestion.

13.6 Financial Analysis of Concept G-1 – Toll All Limited Access Highways

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. At an auto toll rate of $0.03 per mile, life cycle revenues after the cost of collection would be almost $10 billion; at $0.06 per mile, they would be almost $24 billion (Table 13.8).

Table 13.8 Financial Analysis of Concept G-1 – Toll All Limited Access Highways

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	11,273.8	18,255.9	25,544.4
Initial Capital Cost of Toll Collection System	1,644.4	1,643.7	1,642.03
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**9,629.4**	**16,612.3**	**23,902.4**

Table 13.9 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project G-1. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept, no revenue shortfalls are projected throughout the 30-year analysis period for all toll levels. Significant toll collection capital costs are projected every eight years for Project G-1 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 13.9 Annual Toll Revenue and Expense Estimates Concept G-1 – Tolling on Limited Access Highways

(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.03/Mile in 2008 Dollars				**Annual Costs**			
Year	**Per-Mile Passenger Car Toll Rate**	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue (Millions, YOE)**
2015	$0.04	$2.89	$860.1	$43.0	194.5	8.1	614.6
2020	$0.04	$3.35	$1,041.3	$52.1	179.3	8.4	801.6
2025	$0.05	$3.88	$1,260.6	$63.0	183.2	8.3	1,006.0
2030	$0.06	$4.50	$1,526.1	$76.3	188.4	1,073.2	188.2
2035	$0.07	$5.22	$1,859.4	$93.0	223.9	2.9	1,539.7
2040	$0.08	$6.05	$2,265.5	$113.3	266.1	1.7	1,884.4
Toll Level 2 – $0.045/Mile in 2008 Dollars				**Annual Costs**			
Year	**Per-Mile Passenger Car Toll Rate**	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue (Millions, YOE)**
2015	$0.06	$4.31	$1,280.3	$64.0	206.3	8.0	1,002.0
2020	$0.06	$5.23	$1,550.0	$77.5	192.5	8.3	1,271.7
2025	$0.07	$6.34	$1,876.5	$93.8	197.8	8.3	1,576.6
2030	$0.09	$7.69	$2,271.8	$113.6	204.7	1,073.2	880.3
2035	$0.10	$8.91	$2,767.9	$138.4	243.7	2.8	2,383.0
2040	$0.12	$10.33	$3,372.5	$168.6	290.3	1.7	2,911.8
Toll Level 3 – $0.06/Mile in 2008 Dollars				**Annual Costs**			
Year	**Per-Mile Passenger Car Toll Rate**	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue (Millions, YOE)**
2015	$0.07	$5.82	$1,718.8	$85.9	218.3	8.0	1,406.6
2020	$0.09	$6.74	$2,080.9	$104.0	206.1	8.3	1,762.5
2025	$0.10	$7.82	$2,519.2	$126.0	212.8	8.3	2,172.2
2030	$0.11	$9.06	$3,049.8	$152.5	221.5	1,073.2	1,602.7
2035	$0.13	$10.51	$3,715.9	$185.8	264.2	2.8	3,263.1
2040	$0.15	$12.18	$4,527.5	$226.4	315.2	1.7	3,984.2

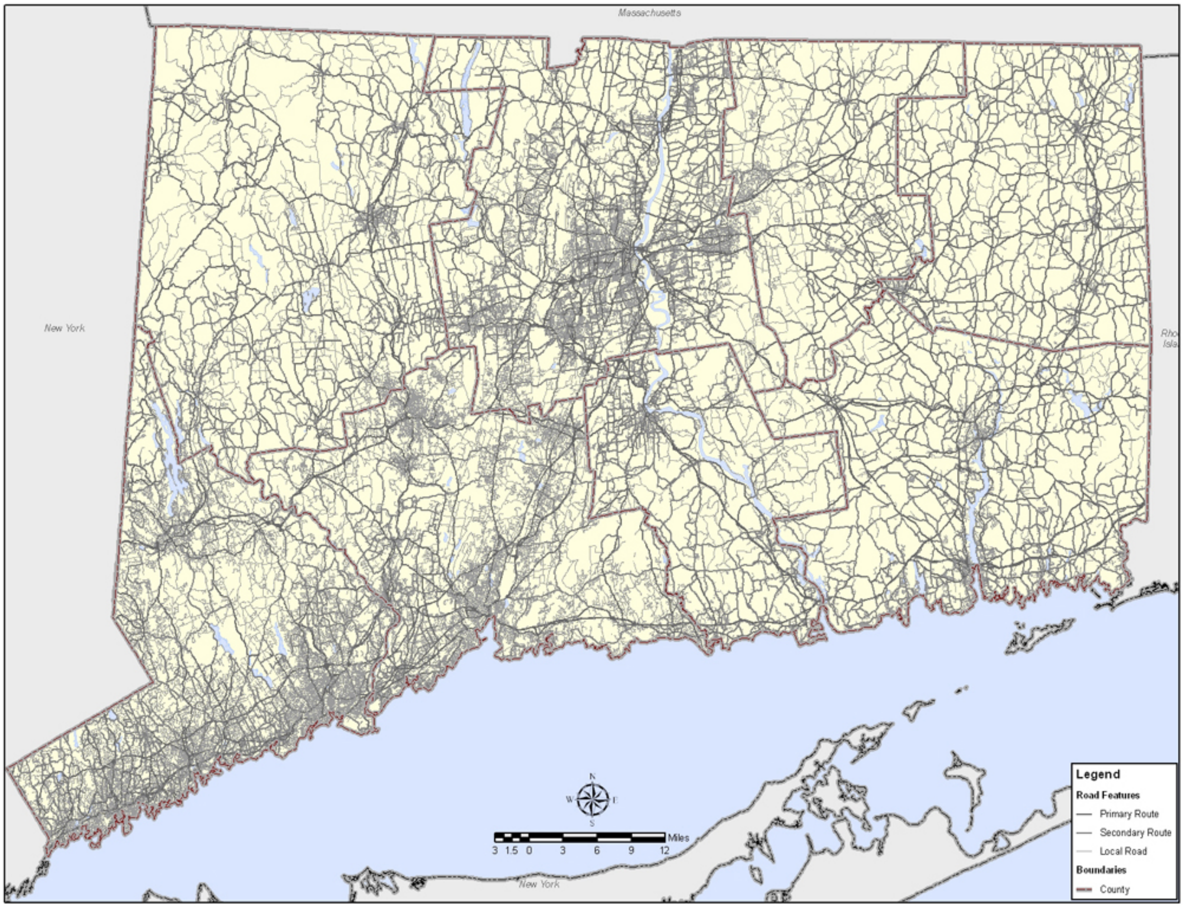
14.0 Concept G-2 – Statewide Tax on All Vehicle Miles Traveled

Project Description and Overview

As the motor fuel tax loses productivity over time due to increasing fuel economy, tolling all travel in the State has the potential to replace or augment 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. VMT tolling would resolve some of the troublesome issues with congestion pricing that only toll certain facilities – that of diversion from the tolled facility to the non-tolled facility. If all facilities were tolled, with toll set by time of day, it would be possible to achieve the type of congestion pricing envisioned by economists when they think about optimizing the transportation system through pricing. To really use congestion pricing at this scale to create uncongested roadways, however, would require extensive investigation into price setting and driver responses to those prices when all options are priced. We could anticipate significant changes in travel patterns, including business location decisions and decisions about where people live and work. There would be pressure for additional investment in transit services to pick up the slack from drivers that are priced-off of the system due to the tolls.

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 – revenue generation and system efficiency. This has never been attempted but Oregon has implemented a pilot project to test this concept. The concept is shown at a generic level in Figure 14.1.

Figure 14.1 Concept G-2 – Statewide Tax on All Vehicle Miles Traveled



■ 14.1 Institutional and Legal

Tolling all existing Federally funded highway capacity would be illegal unless that revenue was dedicated to the reconstruction and rehabilitation of the highways being tolled. However, tolling all other mileage in the State would not require any additional Federal permission, but would require Connecticut legislation. This concept could only be advanced if current laws were changed, and extensive involvement of Federal, state, regional, and local agencies and stakeholders would be needed. It is difficult to foresee how this concept could be implemented in the short term, but there is considerable research underway exploring this option due to concerns about the future revenue productivity of the motor fuel tax.

14.2 Technology and Deployment

Toll Collection Concept

This toll program tolls by vehicle miles traveled on all roads. This would be a system significantly above and beyond anything ever tried before, and would require an extensive infrastructure to carry out. None of the typical toll facility systems are really appropriate for this – something entirely different is needed.

Technology and Roadside Components

Use of transponders or video would require an extensive network of tag readers and image capture across the entire state, on every road, which even then would not truly reflect mileage-based payment.

GPS OBUs would allow tolls to be based on not only the distance traveled, but also on which specific roadways were driven and time of day. This approach also does not require roadside equipment to determine the toll as this is calculated directly using the OBU. However, a large network of video cameras would be required for compliance and for video billing of non-equipped vehicles, the coverage of which is dependent upon the tolerated leakage levels.

Roadside equipment needs to be deployed for verifying correct operation of in-vehicle units, however a large number of enforcement sites need to be deployed across the State to ensure compliance. Mobile enforcement devices also would be required to allow law enforcement officials to validate correct equipment operation and that appropriate one-off payments had been made by non-equipped vehicles. If this concept were to be rolled out nationally, the issue of on-off vehicles would not be as significant an issue.

Payment Types

Comprehensive VMT tolling would be unlike any other toll system ever implemented, and new payment mechanisms would likely be invented to make it work.

Toll Policy

The technology required for this concept supports flexible rate setting based on current conditions, time, day, vehicle type, and location. The most effective implementation of congestion pricing can be accomplished with such a system, however, effectively determining toll rates over such a large network and communicating changing information to the road user to enable appropriate travel choice would be a major challenge.

A simplified static time-of-day location-based mileage charge might be more appropriate for this concept. The location variation could be achieved by allocating toll rates to specific roads, road segments, or zones. Developing such a program would be a significant undertaking.

One possible mechanism for communicating changing tolls is via the GPS OBU itself (similar to existing in-vehicle GPS navigation devices), which also could assist the user in determining the tolls themselves.

Toll Program Operation

There is significant effort to distribute, install, and maintain the OBUs, and a high level of customer service required to support customer issues. If payments were accepted from non-equipped vehicles, the back office system and network of customer kiosks and retail channels to support this is significant.

Interoperable Programs

There currently are no other comparable GPS toll programs with which to interoperate.

14.3 Potential PPP Approaches

The PPP approaches for this concept are identical to those discussed for Concept G-1.

14.4 Privacy

The option of tolling all mileage driven in Connecticut would involve tracking of trips undertaken by vehicles. This system would be the most intrusive of all concepts in terms of privacy concerns regarding roadway usage, because no alternatives (e.g., non-tolled routes) exist. The large network of enforcement cameras also will add to the privacy issues.

GPS OBUs give rise to the biggest privacy concerns because they monitor exact position over time journey information. However, the system can be designed such that this detailed information may not be required to be uploaded or managed in a central database. By calculating the toll due in the OBU and reporting general mileage traveled then it should be possible to never upload travel data except where discrepancies with the enforcement system are detected. The program could offer alternatives such as anonymous accounts to users. One-off payments are not suitable because of the complexity of the charging rules.

14.5 Financial Analysis of Concept G-2 – Statewide Tolling on All Vehicle Miles

It was not possible to estimate precisely 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 and diversion estimates for both the scenarios of replacing the motor fuel tax and leaving it in place.

Toll revenue could range from almost $16 billion at two cents per mile (for autos) to $45 billion at 6 cents per mile (Table 14.1)

Table 14.1 Financial Analysis of Concept G-2 – Statewide Tolling on All Vehicle Miles

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

Tables 14.2 and 14.3 show the gross annual revenues and expenditures for selected years (every five years) over the analysis period for all toll levels for Project G-2. Capital and operating costs for implementation of a VMT-based system are unknown, and thus not included in the financial analysis. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion) only.

Table 14.2 Annual Toll Revenue and Expense Estimates Concept G-2 – VMT Tolling with Gas Tax
(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.02/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.03	$949.6	$47.5	$0.0	$0.0	$902.1
2020	$0.03	$1,144.4	$57.2	$0.0	$0.0	$1,087.1
2025	$0.04	$1,379.1	$69.0	$0.0	$0.0	$1,310.1
2030	$0.04	$1,661.9	$83.1	$0.0	$0.0	$1,578.8
2035	$0.05	$1,975.2	$98.8	$0.0	$0.0	$1,876.5
2040	$0.06	$2,347.6	$117.4	$0.0	$0.0	$2,230.3

Toll Level 2 – $0.04/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.06	$1,858.5	$92.9	$0.0	$0.0	$1,765.6
2020	$0.06	$2,239.7	$112.0	$0.0	$0.0	$2,127.7
2025	$0.08	$2,699.0	$134.9	$0.0	$0.0	$2,564.0
2030	$0.09	$3,252.5	$162.6	$0.0	$0.0	$3,089.9
2035	$0.10	$3,865.8	$193.3	$0.0	$0.0	$3,672.5
2040	$0.11	$4,594.7	$229.7	$0.0	$0.0	$4,364.9

Toll Level 3 – $0.06/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.08	$2,726.7	$136.3	$0.0	$0.0	$2,590.4
2020	$0.10	$3,285.9	$164.3	$0.0	$0.0	$3,121.6
2025	$0.11	$3,959.8	$198.0	$0.0	$0.0	$3,761.8
2030	$0.13	$4,771.9	$238.6	$0.0	$0.0	$4,533.3
2035	$0.15	$5,671.7	$283.6	$0.0	$0.0	$5,388.1
2040	$0.17	$6,741.1	$337.1	$0.0	$0.0	$6,404.0

Table 14.3 Annual Toll Revenue and Expense Estimates Concept G-2 – VMT Tolling without Gas Tax
(Millions of Year-of-Expenditure Dollars)

Toll Level 1 – $0.02/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.03	$970.0	$48.5	$0.0	$0.0	$921.5
2020	$0.03	$1,168.9	$58.4	$0.0	$0.0	$1,110.4
2025	$0.04	$1,408.6	$70.4	$0.0	$0.0	$1,338.2
2030	$0.04	$1,697.5	$84.9	$0.0	$0.0	$1,612.6
2035	$0.05	$2,017.6	$100.9	$0.0	$0.0	$1,916.7
2040	$0.06	$2,398.0	$119.9	$0.0	$0.0	$2,278.1

Toll Level 2 – $0.04/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.06	$1,899.2	$95.0	$0.0	$0.0	$1,804.3
2020	$0.06	$2,288.7	$114.4	$0.0	$0.0	$2,174.3
2025	$0.08	$2,758.1	$137.9	$0.0	$0.0	$2,620.2
2030	$0.09	$3,323.8	$166.2	$0.0	$0.0	$3,157.6
2035	$0.10	$3,950.4	$197.5	$0.0	$0.0	$3,752.9
2040	$0.11	$4,695.3	$234.8	$0.0	$0.0	$4,460.5

Toll Level 3 – $0.06/Mile in 2008 Dollars				Annual Costs		
Year	Per-Mile Toll Rate	Gross Revenue (Millions, YOE)	Non-Collection (Millions, YOE)	Operating Expenses (Millions, YOE)	Recurring Toll Collection Capital Cost (Millions, YOE)	Net Revenue (Millions, YOE)
2015	$0.08	$2,787.8	$139.4	$0.0	$0.0	$2,648.4
2020	$0.10	$3,359.5	$168.0	$0.0	$0.0	$3,191.5
2025	$0.11	$4,048.5	$202.4	$0.0	$0.0	$3,846.1
2030	$0.13	$4,878.8	$243.9	$0.0	$0.0	$4,634.8
2035	$0.15	$5,798.7	$289.9	$0.0	$0.0	$5,508.7
2040	$0.17	$6,892.0	$344.6	$0.0	$0.0	$6,547.4

15.0 Concept H – Congested Corridor Tolling

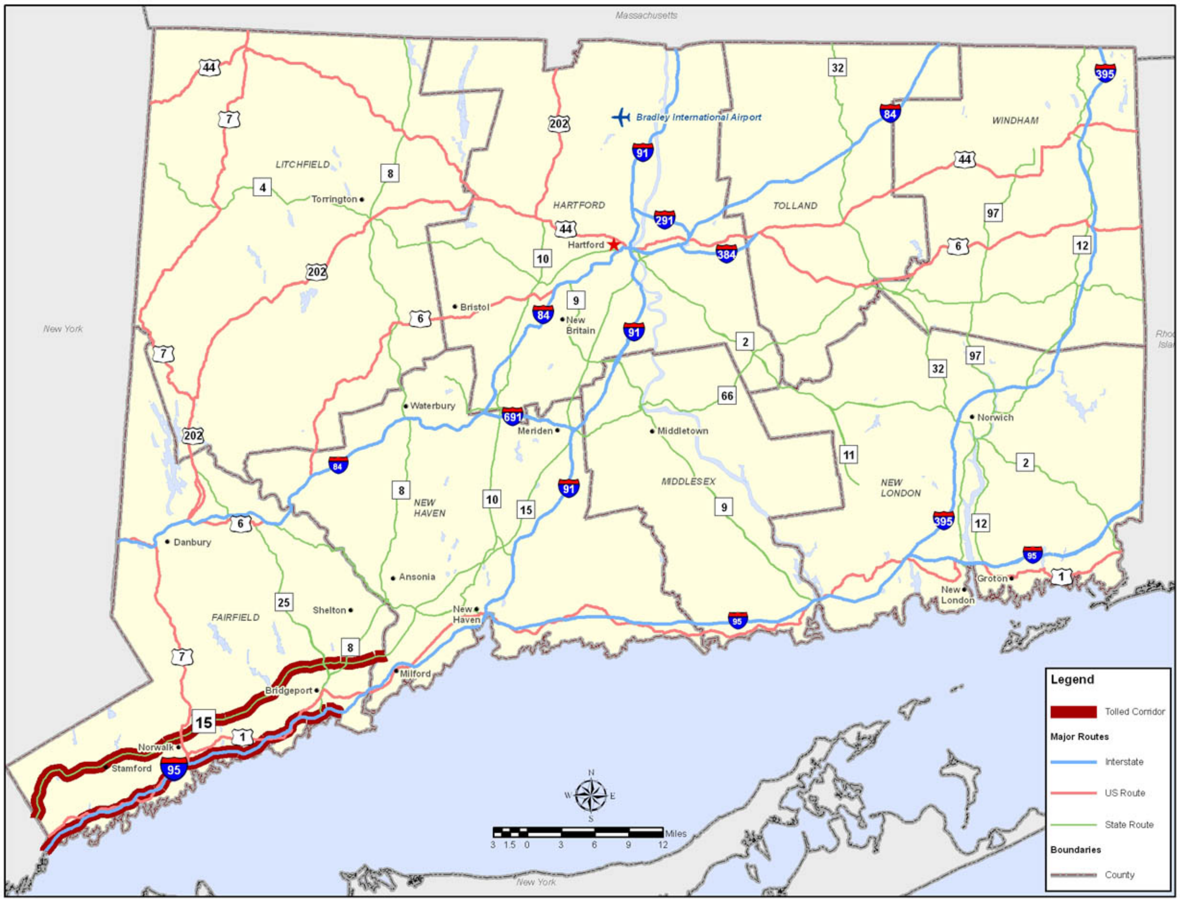
Project Description and Overview

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 the congestion pricing plan could fund improvements to the tolled highway, alternate routes, or transit services.

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 (see Figure 15.1):

- 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.

Figure 15.1 Congested Corridor Tolling
Illustrative Location in Southwest Connecticut



■ 15.1 Institutional and Legal

Tolling of congested corridors in the State, including, but not limited to highways, would not differ much programmatically from Concept G-1, tolling all limited access facilities in the State.

■ 15.2 Technology and Deployment

This concept has very similar considerations to Concept F – Toll Individual Highways Needing New Capacity with the exception of toll policy.

Toll Policy

With no practical real-time decision points for motorists, this concept is suited to static pricing, with an emphasis on time-of-day variations. In order for the program to provide ongoing congestion management, time-of-day toll rates should be varied on a periodic basis (such as monthly) depending on achieved traffic conditions.

15.3 Potential PPP Approaches

Tolling only congested corridors in the State varies in scale and complexity with regard to Concept G-1 – however, the PPP mechanisms and issues are similar. It is recommended that the previously suggested phasing of procurement occur by corridor. The State could begin with less complex corridors and apply those lessons learned to later projects of increasing significance and complexity.

15.4 Privacy

Depending on the extent of corridors that would be tolled, privacy concerns would vary in severity. If only a few corridors were identified, then privacy issues would mirror that of Concept F. The more corridors that would be included, the more privacy concerns will resemble that of a more comprehensive tolling concept such as G-1. Users that do choose to use the tolled lane are disclosing route journey information.

15.5 Technical Analysis of Concept H – Congested Corridor Tolling

Transportation Impacts

These corridors have been studied by others, including a recent analysis for ConnDOT by the University of Connecticut.[57] That study came to a similar selection of these two highway corridors as likely candidates for this type of tolling strategy. This and other studies provided some background information and a useful check on this study's findings.

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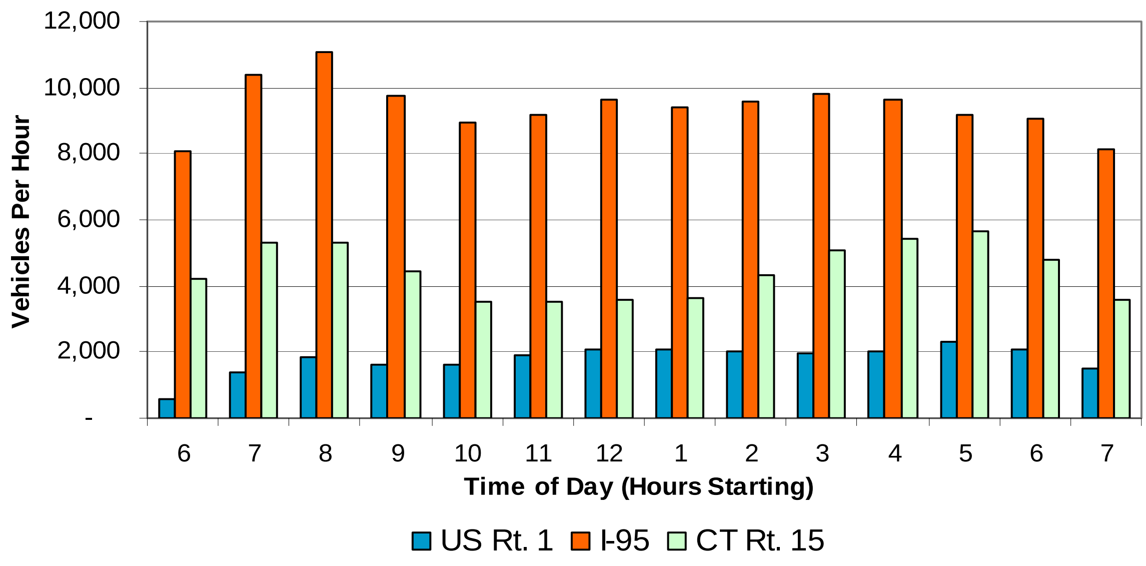
[57] Joint Highway Research Council of University of Connecticut and ConnDOT, *Value Pricing in Connecticut*, September 2008.

In developing this concept, we initially considered also tolling U.S. 1 in the same corridor, because Route 1 would be the primary diversion route for people not wanting to pay a toll on Route 15 and I-95. Figure 15.2 below shows the relative volumes carried by these three roads throughout a typical weekday (6:00 a.m. to 8:00 p.m.).

Of the roughly 13,000 to 17,000 vehicles per hour (vph) handled collectively on these three highways in the 6:00 a.m. to 8:00 p.m. period on weekdays, approximately 11 percent (1,400 to 2,300 vph) travels on U.S. 1. While both this roadway and Route 15 have two lanes in each direction for most of their length, Route 1 is both an arterial and a local distributor road, functioning as a "Main Street" for numerous communities. It has many signalized intersections, active curb cuts (often for busy retail centers), areas of curbside parking and other factors that substantially limit its effective capacity. Based on these factors and a close familiarity with the roadway and its typical operations, the study team realized that it would be very difficult to implement this type of congestion tolling system on U.S. 1, even though it would likely be the major diversion route for travelers from I-95 and CT Route 15. The analysis, therefore, assume that no tolls would be levied on this road as part of this tolling concept.

Figure 15.2 Traffic Volumes: 6:00 a.m. to 8:00 p.m.
I-95, CT Route 15, and U.S. Route 1 in SW Corridor
Concept H – Congested Corridor Tolling



Source: ConnDOT (2007 Data).

Analysis Methodology

We developed a spreadsheet analysis technique based on FHWA's TRUCE model, which attempts to identify the number of vehicles that would need to be removed from a given highway for it to operate at or close to "free-flow" speeds, and the toll rates that would result. Highway ADT and VMT along the two highway corridors were obtained from ConnDOT, and approximate capacities were established (by direction and time period) using the eight-hour peak V/C ratios, and information from the State's Congestion Management System (CMS) database. V/C ratios were then calculated from these ADT volume and capacities derived from the highway's design in these areas and the maximum throughput achieved under congested conditions.

We first established if a toll was required on either highway in either direction in the four analysis time periods, based on the existing (and projected future) V/C levels. Consideration of pricing began when V/C ratios were in excess of Level of Service (LOS) D/E at a V/C ratio of 0.85. This represents the point at which more significant congestion problems typically occur. The rules used for setting a target improvement in the V/C ratio (i.e., in the congestion level) are shown in Table 15.1, with the aim at moving from the baseline V/C ratio to the desired V/C ratio.

Table 15.1 Target V/C Ratios for Congestion Pricing in I-95/ Route 15 Corridor
Concept H – Congested Corridor Tolling

Existing/Future V/C Ratio Range		Desired V/C Ratio
From	**To**	
.850	.950	.85
.950	1.05	.95
1.05	1.15	1.05
> 1.15		1.1

These "rules" reflect the reality of this corridor: it would be very difficult to achieve anything close to free flow speeds during peak periods, as the requisite tolls would be onerously high and the level of diversion would be impossible for other routes or transit services in the corridor to handle.

For purposes of this evaluation, we assumed that there would be four levels of toll rates on weekdays:

- A.M. Peak Period (6:00 a.m. to 10:00 a.m.);
- Midday (10:00 a.m. to 3:00 p.m.);
- P.M. Peak Period (3:00 p.m. to 7:00 p.m.); and
- Nighttime (7:00 p.m. to 6:00 a.m.).

This is a sketch-planning technique that looks at tolls within four- to five-hour periods throughout the day. If this concept was implemented it is likely that smaller time periods would be used to slowly ramp up and ramp down the toll rates to avoid incentives for people to wait a few minutes (or hurry up) until the toll rate changed dramatically.

We assumed that tolls for vans would be 1.25 times the car rate, and single-unit truck and tractor-trailer tolls would be 1.5 and 2.0 times the car rate, respectively.

Overall Impacts of Congestion Tolling

Table 15.2 shows the number of vehicles by classification that would be tolled and diverted from the highway during each of the four travel-time periods in 2015 on I-95. Virtually all of the major diversion from I-95 would occur during the AM peak period (approximately 3,000 southbound vehicles in the four-hour peak). Roughly 750 and 1,200 vehicles would be diverted from the northbound and southbound directions, respectively, during the five-hour midday peak. Diversions in the four-hour PM peak would be approximately 1,050 vehicles in the northbound direction and 825 in the southbound direction. Congestion tolls would be the highest in the AM Peak period, while the Midday and PM peak period tolls would be 50 percent and 25 percent of those levels.

Diversion from Route 15 (Table 15.3) would be approximately 1,000 vehicles (southbound only) in the four-hour AM peak period, and approximately 1,100 and 400 in the northbound and southbound directions respectively in the four-hour PM peak period. Tolls would be highest in the AM peak period. On neither highway would there be any congestion charges during the nighttime hours, while no tolls would be charged during the midday on Route 15.

Table 15.2 Tolled and Diverted Traffic on I-95
Concept H – Congested Corridor Tolling

2015 **Corridor Distance: 31.11 Miles**

I-95: Diverted Vehicles, Transactions, and Toll Revenues: 6:00 a.m. to 10:00 a.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	-	1,877				NB Tolls	SB Tolls
Vans	-	703				(Per Mile)	
SUT	-	317				$0.00	$1.50
TT	-	55				$0.00	$1.88
Total	-	2,953				$0.00	$2.25
Tolled Vehicles				Revenues		$0.00	$3.00
Cars	10,963	13,766	-	$642,377	$642,377		
Vans	1,971	2,335	-	$136,200	$136,200		
SUT	811	711	-	$49,782	$49,782		
TT	1,241	1,085	-	$101,236	$101,236		
	14,987	17,897	-	$929,596	$929,596		

2015 **Corridor Distance: 31.11 Miles**

I-95: Diverted Vehicles, Transactions, and Toll Revenues: 10:00 a.m. to 3:00 p.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	499	756				NB Tolls	SB Tolls
Vans	154	264				(Per Mile)	
SUT	47	64				$0.60	$0.90
TT	58	99				$0.75	$1.13
Total	759	1,183				$0.90	$1.35
Tolled Vehicles				Revenues		$1.20	$1.80
Cars	16,150	14,363	$301,455	$402,146	$703,601		
Vans	2,925	2,376	$68,251	$83,172	$151,422		
SUT	1,125	1,006	$31,502	$42,240	$73,742		
TT	1,399	1,555	$52,215	$87,092	$139,307		
	21,599	19,300	$453,422	$614,649	$1,068,072		

Table 15.2 Tolled and Diverted Traffic on I-95 (continued)
Concept H – Congested Corridor Tolling

I-95: Diverted Vehicles, Transactions, and Toll Revenues: 3:00 p.m. to 7:00 p.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	741	655				NB Tolls	SB Tolls
Vans	227	103				(Per Mile)	
SUT	39	26				$0.90	$0.80
TT	36	45				$1.13	$1.00
Total	1,043	829				$1.35	$1.20
Tolled Vehicles				Revenues		$1.80	$1.60
Cars	14,082	12,454	$394,278	$309,952	$704,230		
Vans	2045	1,608	$71,567	$50,019	$121,586		
SUT	605	491	$25,398	$18,330	$43,727		
TT	571	851	$31,968	$42,365	$74,333		
	17,302	15,404	$523,211	$420,666	$943,877		

I-95: Diverted Vehicles, Transactions, and Toll Revenues: 7:00 p.m. to 6:00 a.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	0	0				NB Tolls	SB Tolls
Vans	0	0				(Per Mile)	
SUT	0	0				$0.00	$0.00
TT	0	0				$0.00	$0.00
Total	-	-				$0.00	$0.00
Tolled Vehicles				Revenues		$0.00	$0.00
Cars	11,800	10,723	-	-	-		
Vans	1,321	1,471	-	-	-		
SUT	429	527	-	-	-		
TT	2,253	2,246	-	-	-		
	15,804	14,967	-	-	-		

Table 15.3 Tolled and Diverted Traffic on Route 15
Concept H – Congested Corridor Tolling

2015 **Corridor Distance: 37.08 Miles**

Route 15: Diverted Vehicles, Transactions, and Toll Revenues: 6:00 a.m. to 10:00 a.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	-	1,005				NB Tolls	SB Tolls
Vans	-	-				(Per Mile)	
SUT	-	-				$0.00	$1.20
TT	-	-				$0.00	$0.00
Total	-	1,005				$0.00	$0.00
Tolled Vehicles				Revenues		$0.00	$0.00
Cars	6,520	9,045	-	$201,242	$201,242		
Vans	-	-	-	-	-		
SUT	-	-	-	-	-		
TT	-	-	-	-	-		
	6,520	9,045	-	$201,242	$201,242		

Route 15: Diverted Vehicles, Transactions, and Toll Revenues: 10:00 a.m. to 3:00 p.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	-	-				NB Tolls	SB Tolls
Vans	-	-				(Per Mile)	
SUT	-	-				$0.00	$0.00
TT	-	-				$0.00	$0.00
Total	-	-				$0.00	$0.00
Tolled Vehicles				Revenues		$0.00	$0.00
Cars	8,188	8,862	-	-	-		
Vans	-	-	-	-	-		
SUT	-	-	-	-	-		
TT	-	-	-	-	-		
	8,188	8,862	-	-	-		

Table 15.3 Tolled and Diverted Traffic on Route 15 (continued)
Concept H – Congested Corridor Tolling

2015 **Corridor Distance: 37.08 Miles**

Route 15: Diverted Vehicles, Transactions, and Toll Revenues: 3:00 p.m. to 7:00 p.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	1,150	429				NB Tolls	SB Tolls
Vans	-	-				(Per Mile)	
SUT	-	-				$0.60	$0.00
TT	-	-				$0.00	$0.00
Total	1,150	429				$0.00	$0.00
Tolled Vehicles				Revenues		$0.40	$0.00
Cars	10,347	8,153	$230,205	$105,809	$336,014		
Vans	-	-	-	-	-		
SUT	-	-	-	-	-		
TT	-	-	-	-	-		
	1,0347	8,153	$230,205	$105,809	$336,014		

Route 15: Diverted Vehicles, Transactions, and Toll Revenues: 7:00 p.m. to 6:00 a.m.

Diverted Vehicles	NB	SB	NB	SN	Total	AM Peak	
Cars	0	0				NB Tolls	SB Tolls
Vans	0	0				(Per Mile)	
SUT	0	0				$0.00	$0.00
TT	0	0				$0.00	$0.00
Total	-	-				$0.00	$0.00
Tolled Vehicles				Revenues		$0.00	$0.00
Cars	7,580	5,999	-	-	-		
Vans	-	-	-	-	-		
SUT	-	-	-	-	-		
TT	-	-	-	-	-		
	7,580	5,999	-	-	-		

Impact on Highway and Local Roadway Traffic Operations

Table 15.4 shows the projected change in V/C levels on the two targeted highways in the three main travel periods in 2015 and 2030. These figures show the effects of the considerable growth in corridor traffic by 2030, with the limited ability of congestion tolls to substantially improve these conditions. In the Build (i.e., with tolls) condition, virtually all V/C ratios on I-95 are still above 1.0 and often 1.10 – but considerably better than the 1.30+ V/C ratios without corrective tolling. In some instances, auto travelers could switch between the two highways when congestion in one or both directions was lower (e.g., northbound in the Midday, shifting from I-95 to Route 15).

However, much of the diversion would involve trucks, including approximately 250 to 500 tractor-trailers diverting from I-95 in the AM and PM peak periods respectively in

2030. These diversions are in both directions, and would occur over the more than 30-mile distance of the highway segment being tolled, but in any single hour would be no more than 75 to 110 trucks in both directions. However, given the size of these trucks and the limitations of the local roadways to handle them (especially where Route 1 and other roadways pass through communities), this becomes a significant issue.

Table 15.4 Impact of Congestion Tolls on V/C Ratios: 2015 and 2030
Concept H – Congested Corridor Tolling

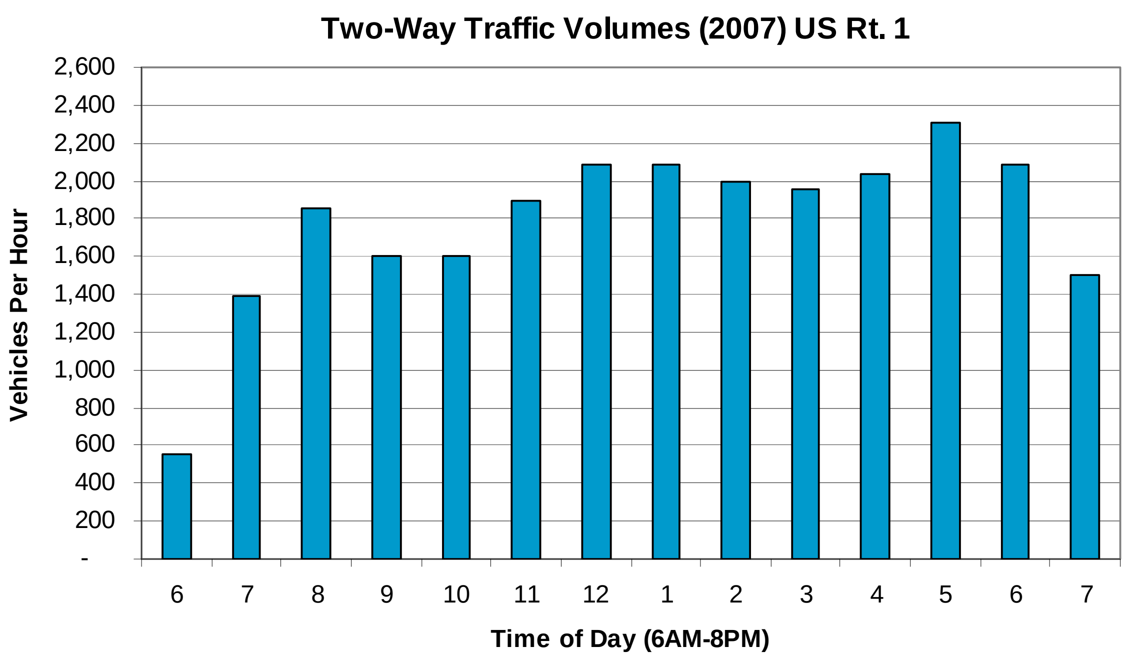
	Route 15		I-95	
2015	**No Build**	**Build**	**No Build**	**Build**
AM				
Northbound	0.67	0.67	0.83	0.83
Southbound	1.04	0.95	1.15	1.00
Midday				
Northbound	0.68	0.73	0.99	0.95
Southbound	0.83	0.83	0.90	0.85
PM				
Northbound	1.19	1.1	1.01	0.95
Southbound	0.89	0.85	0.89	0.85
	Route 15		**I-95**	
2030	**No Build**	**Build**	**No Build**	**Build**
AM				
Northbound	0.77	0.77	0.94	0.85
Southbound	1.18	1.10	1.31	1.10
Midday				
Northbound	0.77	0.77	1.12	1.05
Southbound	0.83	0.83	1.03	0.95
PM				
Northbound	1.35	1.1	1.15	1.05
Southbound	1.01	0.85	1.02	0.95

Figure 15.3 shows the approximate hourly two-way traffic volumes on U.S. 1, averaged over several locations within the tolled corridor. While these volumes are well below the levels on the two highways (especially I-95), these numbers show two things:

1. The volumes are substantial for a bidirectional, typically two-lane (each direction) roadway with frequent intersections, considerable truck volumes and extensive traffic "friction" activities – driveways, parked cars and other activities that reduce effective capacity.

2. The volumes grow throughout the day, reflecting the extensive amount of active commercial activity as the roadway passes through various communities – volumes in the midday are higher than in the AM peak, which is a common occurrence on roads that handle both through traffic and local collector-distributor volume, and traffic headed to and from commercial and other uses located along the road.

Figure 15.3 Two-Way Traffic Volumes (2007): U.S. Route 1



Overall, from a traffic perspective, the data on the highways themselves show that V/Cs would continue to worsen, with this type of tolling program able to somewhat control the effects of continued traffic growth. However, given the extensive use of I-95 for local trips, the limitation of the local roadway network to handle substantial diverted traffic, and the cars-only status of Route 15, a "no place to go" condition is created. More finely tuned toll rates than the rough planning system used in this analysis could make the overall corridor work better, but would not eliminate the issues of people having limited options.

Transit Impacts

Congestion tolling on I-95 in southwestern Connecticut would lead to varying number of auto diversions throughout the day. The highest number of autos diverted from I-95 would actually occur during the four-hour AM peak period (6:00 a.m. to 10:00 a.m.) with 1,877 cars diverted in the southbound direction. This is followed by the PM four-hour period (3:00 p.m. to 7:00 p.m.), when 1,396 cars are forecast to divert from I-95 (741 are expected to divert northbound and 655 southbound).

The I-95 corridor parallels the Metro-North Railroad New Haven Line, which presents the most viable alternative to automobile trips, particularly during the peak commuting periods. Substantial service is provided from Connecticut to New York City and reverse commute service is extensive as well. While it could be argued that most drivers who would consider taking transit to commute into the New York City area already are doing so, a number of auto diversions may still move to that mode in response to congestion tolling. As noted for the Concept G-1 (tolling all highways), train capacity could likely accommodate these trips but parking capacity at rail stations represents a limiting factor.

The drivers most likely to switch to transit as a response to tolling would be those for whom station parking is available or commuter connection shuttle bus services are within easy reach. The greatest number of diverted cars (1,877) would represent approximately 2,252 person trips assuming a 1.2 person per car occupancy rate. Of these 2,252 diverted trips, a 10 percent transit mode share would lead to only 225 trips during the four-hour morning peak period. This range of travelers could be absorbed by any of the corridor's transit operations.

On Route 15, the highest diversion rate anticipated comes during the evening peak period (3:00 p.m. to 7:00 p.m.), when 1,150 cars are expected to divert from the highway. This is roughly a mirror image of the 1,005 cars expected to divert in the southbound direction during the morning peak period. While Route 15 does not feature any significant transit service at present (no buses operate on the parkway itself), some of these trips may be accommodated by transit in the I-95 corridor, including Metro-North Railroad and limited local bus services. As with I-95, the total number of trips that might divert from cars to transit would not exceed 150 in the peak four-hour periods. This number could be accommodated by existing transit services to the extent to which they are viable alternatives for drivers on Route 15. No meaningful car diversions from congestion tolling are anticipated on Route 15 during the midday period.

Potential Complementary Improvements to Enhance System Performance

In evaluating the potential for congestion pricing in the southwest Connecticut corridor, we found that pricing on its own could alleviate (but not necessarily eliminate) congestion on those routes. We also identified concern about the impact of diverted traffic onto the non-priced Route 1, and indicated that Route 1 would not be able to efficiently handle these diversion rates.

However, as will be seen in the subsection below, this concept will also generate considerable revenue – over $38 billion over 30 years. This revenue could be used to support highway improvements, transit services, or other socially beneficial projects that would enhance the value of pricing on its own, and/or mitigate undesirable impacts. Some potential uses of revenue include:

- More commuter rail parking;
- More express bus and BRT networks supported by park-and-ride facilities and local feeder services;
- Continuous and earmarked funding for transit operations to maintain service levels and limit fare increases;
- Expanded travel demand management efforts, organized ridesharing efforts, etc. ;
- More incentives for development in urbanized portions of the corridor that are or could be well served by transit;
- Expanded support for alternative freight modes, both rail and waterborne;
- Capacity, operational, or safety improvements to Route 1 or other impacted roadways; and
- Grants to municipalities that might be impacted by the congestion pricing concept.

Toll Revenue Estimates

Congested corridor tolling is expected to generate about $1.3 billion in toll revenue in 2015 (in 2008 dollars), about 85 percent of which would come from I-95 (Table 15.5). Toll revenue would be expected to rise to $2.8 billion in 2030.

Table 15.5 Annual Toll Revenue: 2015 and 2030
Concept H – Congested Corridor Tolling

	Annual Toll Revenues (Millions $2008)						Combined Totals
	I-95			Route 15			
	NB	SB	Total	NB	SB	Total	
2015							
Cars	$253.9	$494.4	$748.3	$84.0	$112.1	$196.1	$944.40
Vans	$51.0	$98.3	$149.3	-	-	-	$149.30
SUT	$20.8	$40.3	$61.1	-	-	-	$61.10
TT	$30.7	$84.2	$114.9	-	-	-	$114.90
Total	**$356.4**	**$717.2**	**$1,073.6**	**$84.0**	**$112.1**	**$196.1**	**$1,269.70**
2030							
Cars	$752.4	$860.0	$1,612.4	$159.8	$280.9	$440.7	$2,053.10
Vans	$154.8	$171.0	$325.9	-	-	-	$325.90
SUT	$67.9	$70.8	$138.7	-	-	-	$138.70
TT	$117.3	$146.2	$263.5	-	-	-	$263.50
Total	**$1,092.4**	**$1,248.0**	**$2,340.4**	**$159.8**	**$280.9**	**$440.7**	**$2,781.20**

Implementation Requirements

This concept requires tolling nearly 91 miles of roadway and will require collection across all lanes of the highways. For this level of analysis, it has been assumed that entrance and exit points will correspond to the existing freeway entrance and exits and that all travelers using the facilities will be charged regardless of the length of their trip. This will require about 122 tolling points to cover both directions of traffic. In practice, some short on- and off-trips might not be tolled to reduce costs, but this would raise equity concerns and be counter to the congestion pricing goals of the concept.

Since the tolling is likely to be based on the vehicle type, effective classification equipment would need to be installed at each location. This concept would likely not use dynamic pricing so that traffic monitoring equipment is not required. CCTV cameras would not be required for traffic monitoring but would be used to monitor tolling equipment. However, given that toll rates may be adjusted on a periodic basis to respond to historic traffic pattern changes, dynamic message signs may be useful and have been assumed to be deployed to allow communication of the changes to rate structures. Since the project is not associated with the requirement to provide improved trip reliability, no additional roadway assistance facilities would be required. Allowance has been made for additional enforcement staff to provide toll evasion deterrent along the extended length of these facilities. Since equipment will be distributed along the length of the roadways, it has been assumed that fiber optic cables will be laid to support communication with the field equipment.

The back office for this concept is equivalent to an existing small to medium size E-ZPass operation. The connection with adjacent state borders will likely leverage some of the existing E-ZPass account holders from other states. Given that all traffic will be tolled and that long distance trips may be taken by a high number of users that do not make frequent trips, a fairly high-level of video transaction processing has also been estimated. Since travelers needing to use these facilities will not have much alternative other than to pay the toll, a fairly comprehensive customer service operation has been estimated involving a regional walk-in center for each facility and partnership with a grocery store type chain to provide payment locations.

Toll Collection Costs

The capital cost for this project is driven by the large number of tolling points that need to be installed to toll every segment of the selected highways; contributing 75 percent of the capital costs (Table 15.6). About 23 percent of the capital is to cover tag purchases for the number of ETC accounts anticipated over the 30 years.

Table 15.6 Life-Cycle Toll Collection Costs (Millions)
Concept H – Congested Corridor Tolling

Scenario	Total Capital Cost	Total O&M Cost	Total
Project H: I-95 and Route 15 – New York to New Haven	$586.8	$2,303.3	**$2,890.2**

The ongoing operations costs are dominated by the cost of financial transaction processing or credit card fees due to the high value of the revenue being processed through the back office. These fees account for 62 percent of the O&M costs. The back-office operation is commensurate with a medium size operation at about 19 percent of O&M costs. Toll equipment maintenance costs only make up 8 percent of the ongoing costs due to the comparative size of the back office operation and amount of revenue being processed.

Environmental

The area between Bridgeport and the New York border in Connecticut along Interstate 95 and Route 15 (the Merritt Parkway) is in a portion of coastal Connecticut often referred to as the 'Gold Coast' due to its relative wealth. It is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. Alternative H is expected to include several diversion routes through this area.

Alternative H is expected to have no beneficial impacts to environmental resources. It is expected to have minor adverse impacts to the following as highlighted in Table 15.7 and Figure 15.4:

- **Water Quality –** Approximately 10 major water bodies would have increased exposure to hazardous materials and degraded stormwater runoff. Less traveled local roads are often not as heavily maintained as the interstates and state routes and due to their age, do not have contemporary stormwater treatment facilities along their length. As those roads receive more traffic, there is greater potential for hazardous waste spills and stormwater runoff contaminated with petroleum products to impact unprotected streams, rivers, wetlands, or groundwater.

- **Air Quality –** Some increase in congestion on local roads; large numbers of motorists may travel fairly short distances on local roads to avoid paying tolls.

- **Noise –** Additional traffic can elevate noise levels locally somewhat.

- **Energy Use/Conservation –** The average speed of travel decreases for vehicles traveling on local roads while increasing for vehicles on a limited-access highway. However, if there are delays on local roads due to added congestion, causing cars and trucks to idle in place, fuel consumption may also increase.

- **Environmental Justice –** Tolls in the vicinity of disadvantaged populations may discourage highway use and make travel more expensive and/or more inconvenient. Added traffic congestion in a neighborhood with an environmental justice population has a potential to expose them to a higher burden of community impacts.

Alternative H is expected to have potentially significant impacts to:

- **Community Disruption –** Several of the diversion routes are also the 'Main Street' for communities through which they travel. The addition of traffic through these community centers will adversely affect quality of life by inhibiting pedestrian access, reducing pedestrian safety, and altering sense of place. This is particularly true for the smaller towns and villages where the 'Main Street' serves as the central gathering place for the community. In particular, additional traffic through communities such as Greenwich, Fairfield, Darien, New Canaan, Southport, and Westport would conflict with their pedestrian-scale character and residents' experience of quality of life.

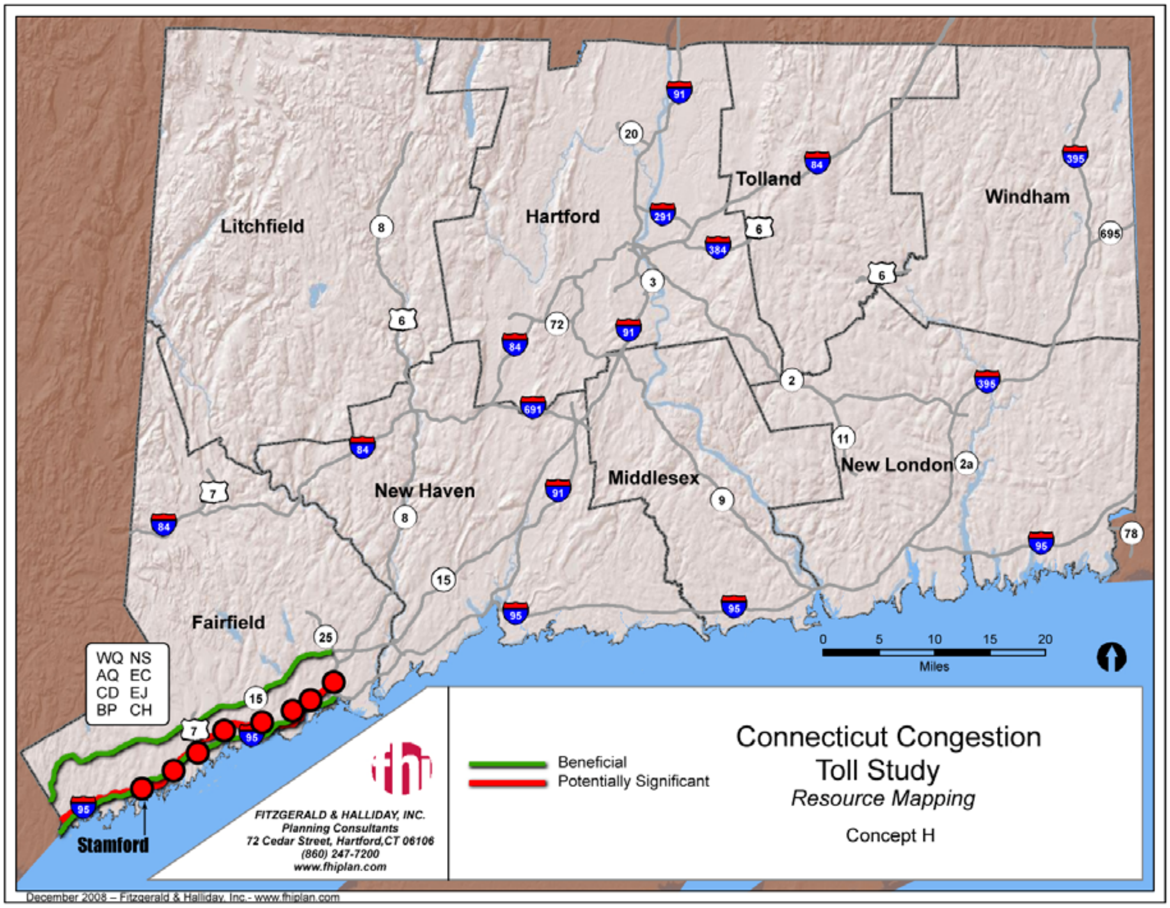
- **Bicycles and Pedestrian Travel –** Portions of the diversion routes serve as designated cross-state bicycle routes. Traffic diverted to those routes reduces safety and can hinder travel for bicyclists. Where traffic is diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel.

- **Cultural/Historic –** The Merritt Parkway is listed on the National Register of Historic Places, in large part due to its collection of unique overpass bridges. The location of tolling facilities along this parkway would conflict with the historic setting and could impact historic structures that characterize the roadway.

Table 15.7 Environmental Impact Summary
Concept H – Congested Corridor Tolling

Resource	Potential Impact	Impact Description – Magnitude	Impact Description – Location
Natural			
Water Quality (WQ)	Yes	Minor Adverse	Approximately 10 major water bodies would have increased exposure to hazardous materials and degraded stormwater runoff
Air Quality (AQ)	Yes	Minor Adverse	• Benefit to Limited Access Highways • Minor Adverse Impact to all diversion routes
Social/Community			
Community Disruption (CD)	Yes	Potentially Significant	Gold Coast Town Centers including Greenwich, Darien, New Canaan, Westport, Southport, Fairfield – heavily developed/commercial
Bicycle and Pedestrian (BP)	Yes	Potentially Significant	Motorist diversions onto arterials, portions of which are cross state bike routes, including Route 1 (Stamford, Darien)
Noise (NS)	Yes	Minor Adverse	Over all diversion routes there is increased vehicular noise exposure to 22 sensitive land uses
Energy Use/Conservation (EC)	Yes	Minor Adverse	All diversion routes
Environmental Justice (EJ)	Yes	Minor Adverse	EJ populations along diversion segment in Stamford, Norwalk, and Bridgeport
Cultural/Historic (CH)	Yes	Potentially Significant	Placement of overhead structures on the Merritt Parkway may impact the historic character of the facility

Figure 15.4 Environmental Impact Locations
Concept H – Congested Corridor Tolling



Economics

The economic impacts of this concept hinges on the tradeoffs between the benefits received by travelers who continue to travel in peak hours on the roads of their choice and those who choose their second-best choice because of the toll. Those who choose to pay the toll will, by definition, find that option more economically advantageous than not paying the toll, but they may be worse off than they were before the tolling concept was implemented. Those who are "priced off" the highway, either onto a parallel route, transit, or not making a trip at all, will definitely be worse off than they were before. A key to the overall economic benefit of the tolling concept – for local residents, corridor employers, major shippers and commuters – is what the State does with those revenues to improve transportation (or other) conditions in the corridor. If those revenues are used effectively, there can be an overall economic benefit. If they are not, then the economic consequences might be worse.

Equity

The range of tolls would have to be quite high to achieve any meaningful reduction in congestion on these roadways, although not out of line with congestion-based tolls on HOT lanes in operation elsewhere in the United States. Some of the equity considerations include:

- **Geographic Distribution of Travelers –** By definition, this tolling plan focuses on the southwestern corner of the State, and given the extensive use of these highways (especially I-95) by corridor residents and businesses and the likely perception of the program's travel-time benefits relative to its toll costs to local and subregional travelers, this will raise significant equity issues.

- **Distribution of Auto Travel Markets –** The commuter peak daily work trip travelers and (on I-95) the midday personal and work-related business trip travelers would be the most impacted.

- **Likely Truck Markets Involved –** Given the critical role of I-95 as an inter- and intrastate truck route, including its extensive use by corridor businesses for local delivery and service trips, virtually all truck markets, from local van-based delivery and service operations to long-haul interstate freight movements, would face these proposed tolls. The fact that CT Route 15 is cars only, and U.S. 1 has very limited capacity and problems handling large trucks, truckers looking to avoid the tolls may feel they have few viable alternative routes.

- **Time Savings –** The goal of this approach is to improve operations in all lanes by having vehicles shift to other time periods, routes, or modes. The primary time versus toll issues in this instance would be: 1) the time benefit from somewhat improved highway operations by staying on the highway and paying the toll; and 2) the implied cost of the additional travel distance and associated lower speeds on alternate routes compared with avoiding that toll. Unfortunately, under very congested conditions, the speed change and associated time savings for the average highway trip are not that great when the tolling scheme can only moderate congestion levels (e.g., lower the V/C ratio from 1.2 to 1.05).

- **Potential Low-/Moderate-Income Concentration –** Although much of the corridor is within the "Gold Coast" with some of the highest household income levels in the county, there also are lower-income areas (especially within and near Bridgeport). The bigger income issue would be the high tolls during commute periods and the burden that would place on this group of travelers in a corridor with few viable alternate routes and reasonable but still limited transit options for most work trips. Once again, an important issue would be whether other forms of taxation or user changes (fuel tax, sales tax, etc.) would be reduced because of these new charges, and whether a portion of these funds are used to expand and subsidize public transit options in the tolled corridors.

- **Available Alternative Routes –** As the transportation analyses demonstrated, the available alternate routes are relatively limited, especially for heavy trucks and longer-haul larger single-unit and tractor trailer trucks, which by design are intended to be on highways. The options for cars are somewhat greater, as they can choose to switch between I-95 and CT Route 15 where differing congestion levels and tolls make that a viable option, as well as using U.S. 1 within the limits of that roadway's capacity.

- **Available and Potential New/Expanded Transit Service –** The density of population and employment centers along the corridor and the relatively extensive existing transit systems make this a very relevant issue for this concept. It also is likely that expanded or newly developed transit services supported by toll revenues could create a more effective travel option for a larger share of the corridor's trips (especially work trips).

Safety

Tolling congested sections of highways in the State can be expected to increase speeds on the tolled facilities with some diversions to alternate routes, the magnitude of which will depend on the time of day, traffic conditions along the diversion routes and the level of tolls imposed.

On the highways being tolled, reduction in volumes due to tolling may result in a reduction in certain types of crashes typically associated with stop-and-go traffic conditions. Since an open-road tolling system architecture will be in place, there will be little or no additional physical roadside features that would increase the propensity for crashes (such as overhead gantries, for example).

Approaching the tolled sections, and as traffic begins to divert off the highway, exit ramps and intersections located within proximity of the ramp junctions would be expected to experience heavier traffic volumes. These locations also may experience a disproportionate amount of turning vehicles (including trucks), thereby increasing vehicular-vehicular and vehicular-pedestrian conflicts and the propensity for certain types of crashes to occur.

Traffic conditions along the alternate routes (such as along Route 1 in southwest Connecticut) also may deteriorate due to heavier volumes, including trucks. Emergency vehicle access and response times also could be adversely affected due to increased congestion.

Signage (preferably dynamic, variable message signing) and other ITS strategies may be deployed to help to reduce the safety and operational impacts of diverted traffic on alternate routes, particularly on those routes that may not have been designed to accommodate large volumes of through traffic.

15.6 Financial Analysis of Concept H – Congested Corridor Tolling

Since congested corridor tolling would have toll rates designed to reduce traffic in a very congested corridor, the toll rates, and revenues, would be quite high, and the net revenues, even after collection costs and the initial infrastructure investment of collection, would also be quite high – almost $40 billion (Table 15.8).

Despite these significant revenues, the state would be limited from spending the component collected on I-95 on anything other than that highway – at least according to current rules.

Table 15.8 Financial Analysis of Concept H – Congested Corridor Tolling

Financial Summary (Millions of 2008 Dollars) Concept H: Toll Congested Highways	
Present Value of Net Toll Revenue	40,056.8
Initial Capital Cost of Toll Collection System	355.0
Total Highway Construction Costs	0
Life-Cycle Surplus/(Shortfall)	**39,741.8**

Table 15.9 shows the gross annual revenues and expenditures for selected years (every five years) over the analysis period for Project H1. Note that the financial analysis presented here excludes the financial impact of the initial capital costs related to the toll collection system. To get from gross revenue to net revenue, subtract non-collection of tolls (evasion), operating costs, and recurring reinvestment in the system. Under this concept, no revenue shortfalls are projected throughout the 30-year analysis period for all toll levels. Significant toll collection capital costs are projected every eight years for Project H-1 for major toll collection infrastructure replacement. One such replacement cycles fall in 2030 and it is reflected in the recurring capital costs for that year.

Table 15.9 Annual Toll Revenue and Expense Estimates Concept H – Congested Pricing Only

(Millions of Year-of-Expenditure Dollars)

			Annual Costs			
Year	**Average Toll**	**Gross Revenue (Millions, YOE)**	**Non-Collection (Millions, YOE)**	**Operating Expenses (Millions, YOE)**	**Recurring Toll Collection Capital Cost (Millions, YOE)**	**Net Revenue (Millions, YOE)**
2015	$22.98	1,506.0	75.3	84.6	2.6	1,343.6
2020	$29.45	2,262.1	113.1	95.5	2.8	2,050.6
2025	$38.50	3,405.5	170.3	117.1	2.9	3,115.2
2030	$51.69	5,139.2	257.0	150.4	185.0	4,546.9
2035	$59.92	6,261.7	313.1	181.9	0.9	5,765.9
2040	$69.46	7,629.3	381.5	220.1	0.5	7,027.2

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Connecticut Electronic Tolls and Congestion Pricing Study

Volume 3 – Technical Appendices

April 20, 2009

Appendix A

Toll Revenues, Traffic Diversion, and Changes in Transportation System Performance

Toll Revenues, Traffic Diversion, and Changes in Transportation System Performance

1.0 Overview

1.1 Analysis Requirements

For the remaining concepts, the intent of this aspect of these planning-level studies was to determine the approximate reaction of travelers to the tolls being considered, including the number of travelers that would be tolled and the number that would divert to other roadways, modes or (where applicable) time periods. These data, along with the projected toll levels, could then be used to estimate daily and annual toll revenues. With those values, the approximate change in traffic conditions along the tolled roadway segments and on alternate "diversion" roadways could be estimated depending on the level of available data for the roadways in question.

1.2 Analysis Metrics and Data Requirements

Several basic measures of travel volume and operating conditions were established for the affected travel corridors – the vehicle miles of travel (VMT), the vehicle hours of travel (VHT) and average speed (VMT/VHT). The selected analysis models or procedures required information on the volume and mix of traffic (autos, buses, various truck categories) on the roadways in question and a measure of operating conditions – volume/capacity (V/C) ratios, average speeds, etc. Data broken out by time of day and day of week was also helpful and in some instances essential (i.e., congestion pricing). The availability of data and the type of data needed often differed considerably among the various concepts. Concept G1, for example, with a flat mileage-based toll charged throughout the day, for example, requires considerably different data than Concept H, which would have tolls varying by time of day or even direction of travel.

1.3 Models Considered

Given the broad range of concepts to be considered and the limitations of available regional and statewide travel demand models, the team determined that more spreadsheet-based models would be developed or applied to assess travelers' reactions to the range of tolling concepts under consideration. One candidate model developed by FHWA for use in similar broad reviews of tolling concepts – the Tool for Rush Hour User Charge Evaluation (TRUCE) model – was initially considered for application across all concepts. The model was intended to quantify the impacts of congestion pricing on limited-access highways, focusing on weekday A.M. and P.M. peak periods. The TRUCE model uses existing congestion levels and volumes on the highways in question to estimate the volume shifts needed to achieve "free flow" or "moderate" travel conditions, assesses the impacts of these shifts on alternate travel routes, and then uses the value of travel time (VOT) for highway travelers to calculate the level of toll needed to achieve the defined level of diversion from the highway.

Because of the nature of the tolling concepts being considered – from tolling all travel on all roadways throughout the states to border tolls at major highways and tolling trucks – the TRUCE model was not appropriate for most of these applications. The Study Team took two steps:

1. The initial set of interlocking spreadsheets that comprise the TRUCE 3.0 model were revised and simplified to create an analysis tool that better fit the required assessment of the eight tolling concepts subjected to quantitative analysis; and

2. Because of the inability of the TRUCE model to address the range of concepts under consideration, the Study Team developed several spreadsheet models that used many of the same underlying assumptions as the TRUCE model but included analysis methods to address the specifics of each tolling concept.

1.4 Analysis Methods for Tolling Concepts

The following sections summarize the methods used to assess each of the eight tolling concepts analyzed, including the specific analysis model – the revised TRUCE model or a separate spreadsheet model – applied to each concept.

1.5 Transit Impacts

To assess the impacts on (and potential benefits to) public transportation under these tolling alternatives, the travel corridors under each concept were reviewed within the context of existing transit services and service types (local bus, regional bus, express bus). The Study Team established the relevant local, express, and intercity bus operations as well as relevant intercity and commuter rail services. Figures 1 through 5 show the approximate location of these services statewide and in the northwestern, northeastern, southeastern, and southwestern quadrants of the State, respectively. Information on these operations (routes, types of service, schedules, fares, ridership [where available], etc.) were obtain from CTTransit, MTA Metro-North Railroad and other operators as needed to support these analyses.

Figure 1. Existing Statewide Transit Resources

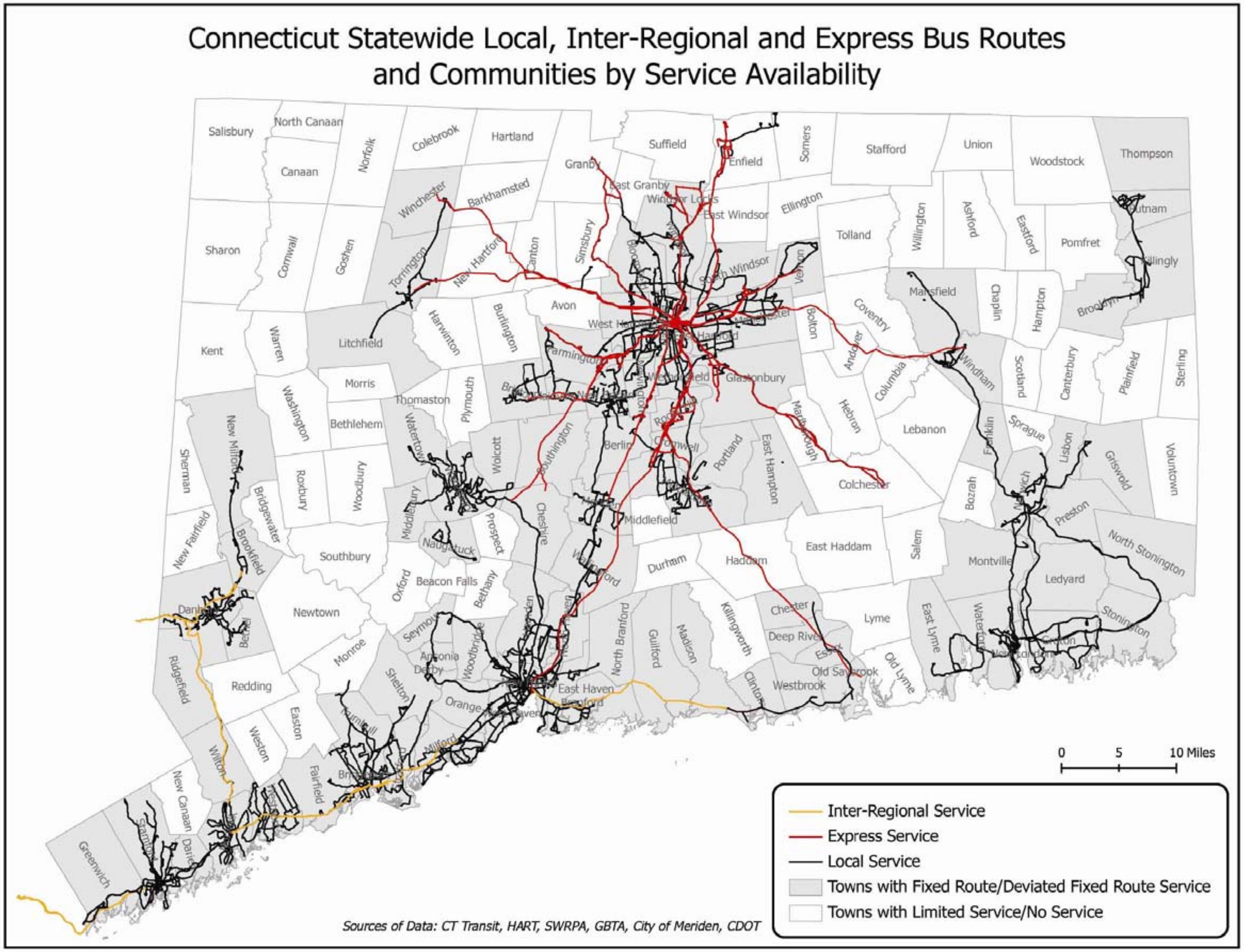


Figure 2. Existing Statewide Transit Resources – Northwest Detail

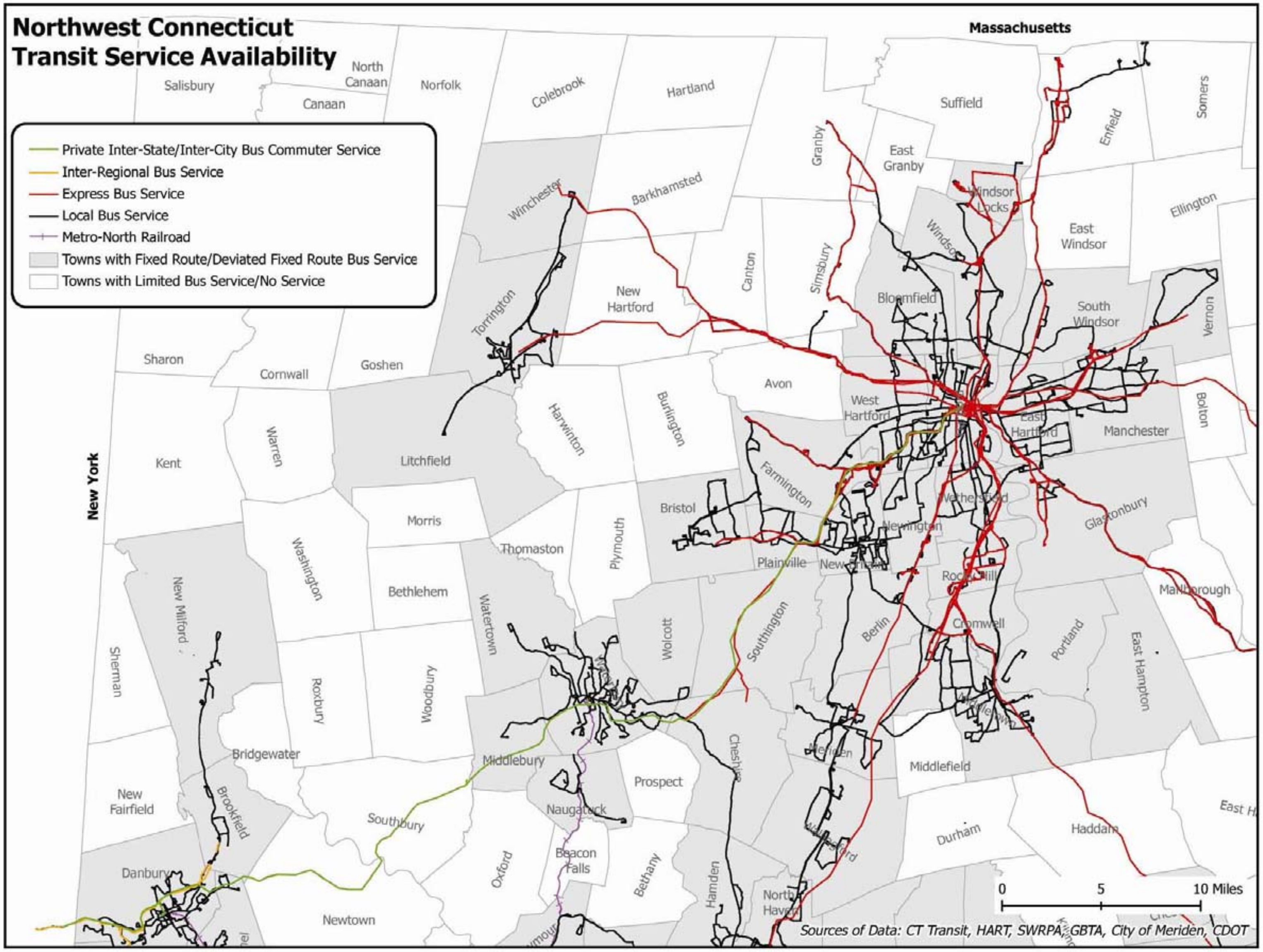


Figure 3. Existing Statewide Transit Resources – Northeast Detail

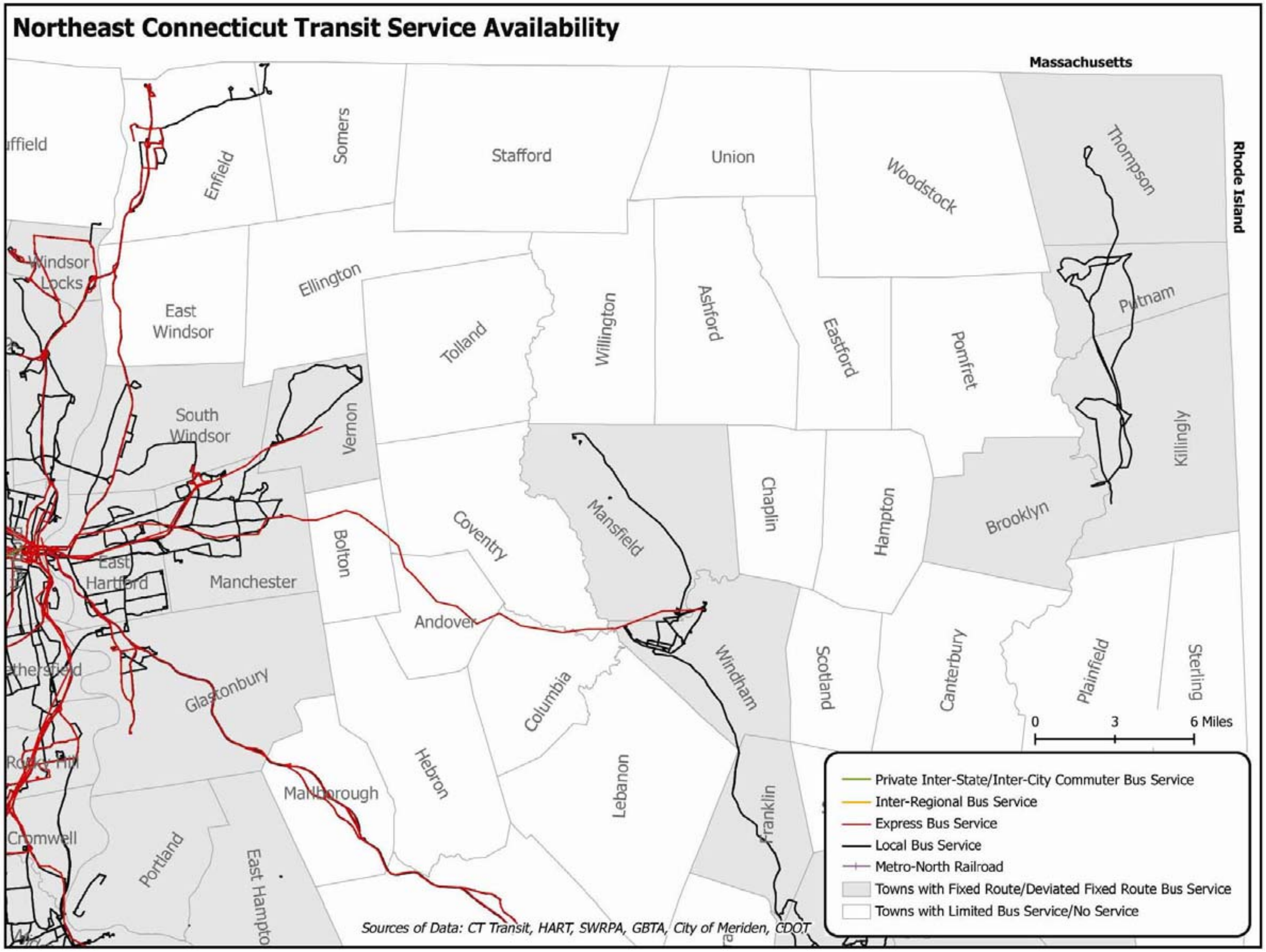


Figure 4. Existing Statewide Transit Resources – Southeast Detail

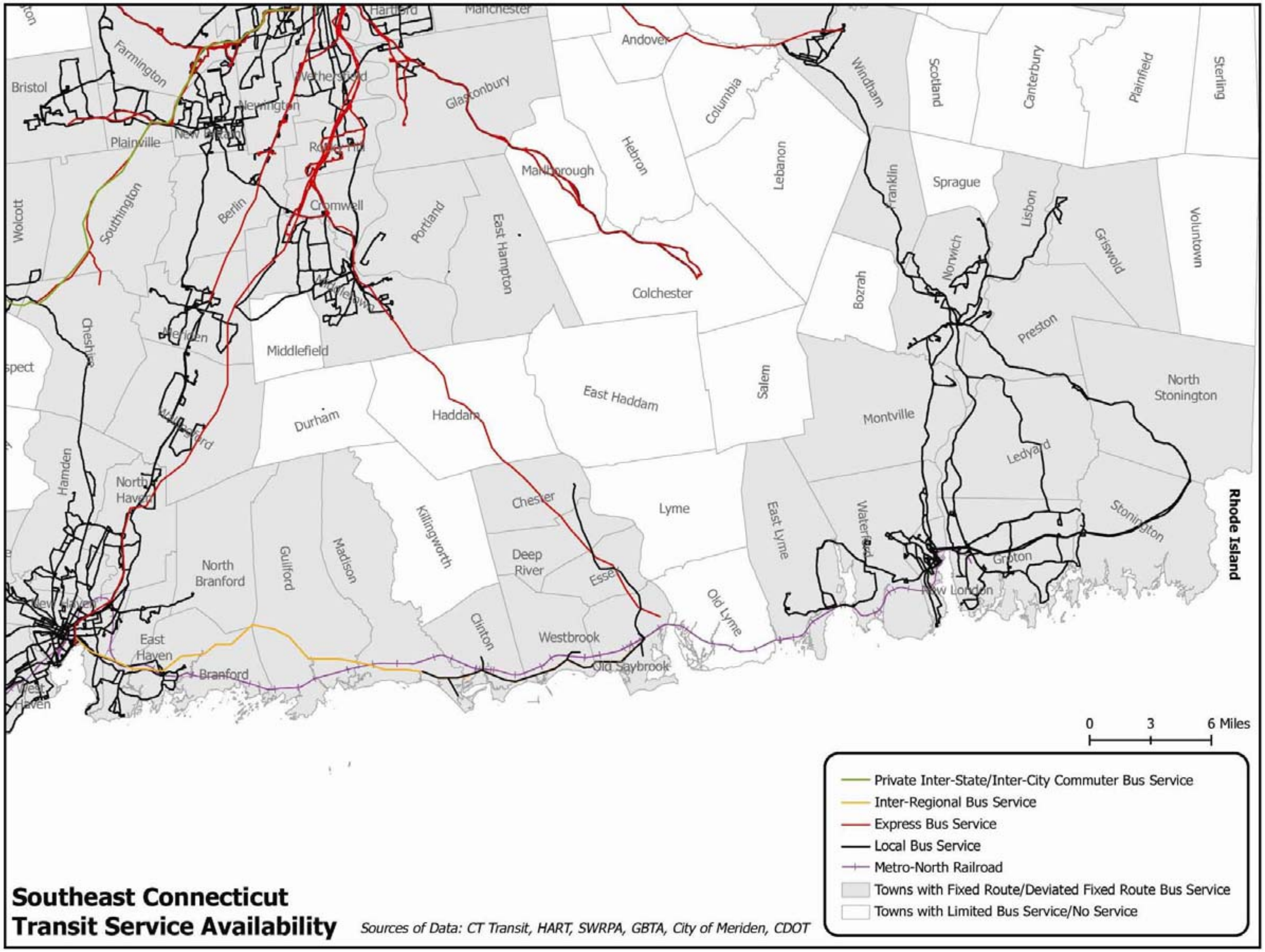
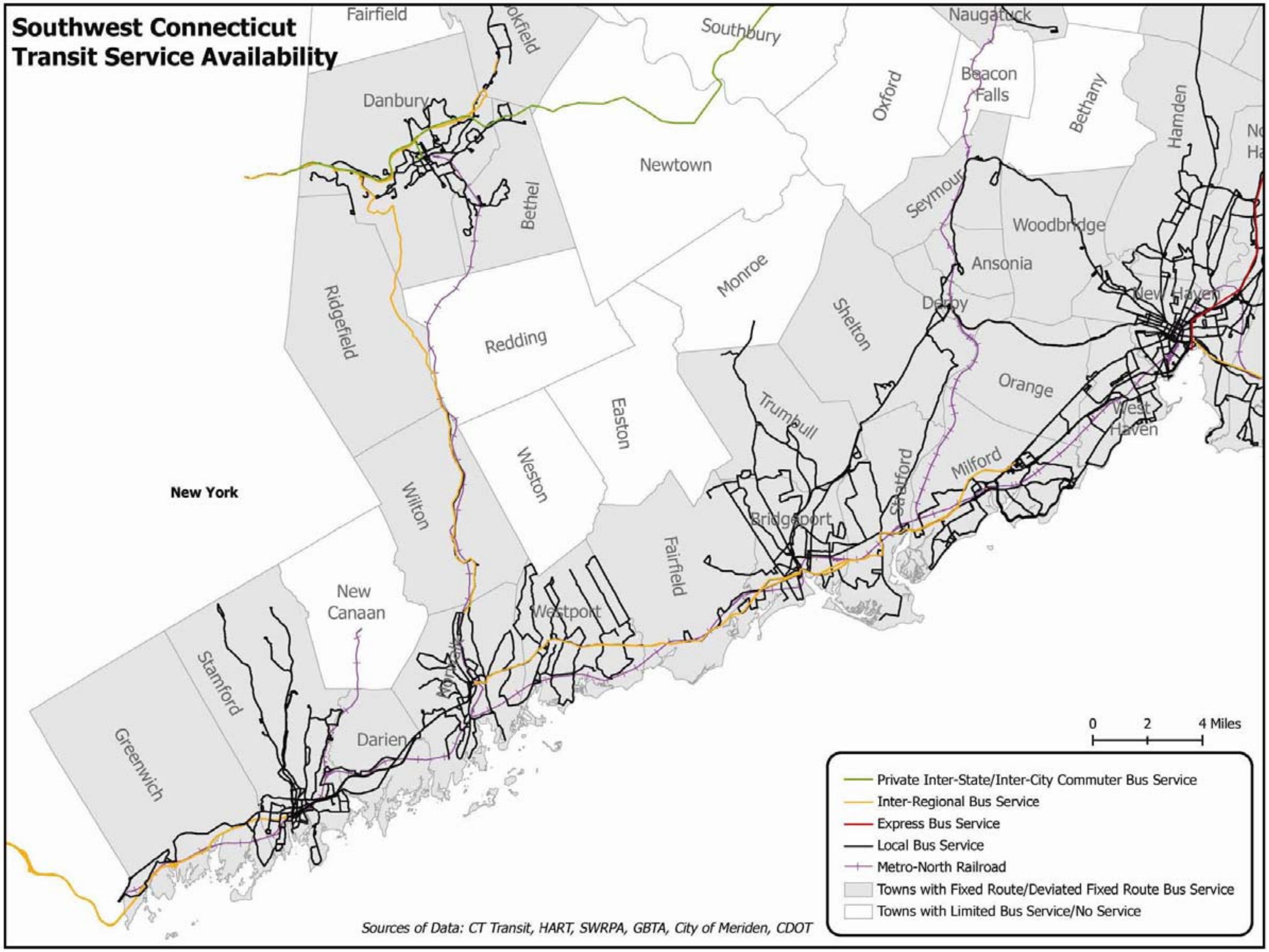


Figure 5. Existing Statewide Transit Resources – Southwest Detail



The key elements of these assessments were:

1. The potential for each concept to enhance the role of transit in these corridors (e.g., by increasing the cost of competing modes, providing a time advantage for transit on the tolled highways, etc.); and

2. Whether existing or potential new or expanded transit services could effectively attract these riders.

Key Questions

For corridors in which transit services exist at present, several basic questions were considered in assessing the impacts of tolling and the anticipated number of trips diverted from highway to transit as a result; i.e.,:

1. Can the diverted trips be accommodated by transit as it exists now?

2. Is the total number of diverted trips sufficiently large during the peak periods to support new or expanded transit services?

3. Are there any known capacity constraints in the transit network that would require additional investment (greater trip frequency, new services, etc.)?

4. How can revenues generated through tolling initiatives support the enhancement of existing transit or support new transit services?

General Analysis Assumptions

The following approach was taken in the team's assessment of these transit-related issues:

1. If no transit services exist at present, it was assumed that this would remain the case in the foreseeable future.

2. Where limited transit services exist and where diversion numbers tended to be fairly low as well (generally found to be the case for these concepts), it was assumed that: 1) the current services would have the capacity needed to accommodated diverted trips; or 2) relatively little investment would be required to increase trip frequencies and services to meet demand.

3. Transit services most likely to accommodate trip diversions on highway corridors would be those conducive to mid-length or lengthy work commute trips. Short trips (e.g., <5 miles) are unlikely to prompt a diversion from automobile to transit.

4. The primary capacity constraint recognized throughout the various Connecticut transit systems was rail station parking capacity at Metro-North Railroad commuter stations. Parking constraints are more significant than actual train capacity constraints, and directly impact potential new riders diverting from automobile to transit.

5. For trip diversions to transit, only automobile trips were considered. Using the projected diversion figures generated in these analyses, the following assumptions were made:

   – Where only 24-hour diversions were estimated, it was assumed that approximately 10 percent of those would occur in one or both of the traditional peak (commuter) travel period (analyses were done for typical weekdays);

   – Where four-hour a.m. and p.m. peak-period diversions were estimated, approximately 30 percent of that four-hour total was assumed to occur in the peak one-hour period;

   – For each car diverted, an occupancy of 1.2 persons was assumed, translating into 1.2 transit trips; and

   – An initial (and conservatively high) estimate of potential transit mode share – i.e., the percent of the diverted travelers that would potentially shift to transit modes – was used in the analyses.

The results of these assessments are included in the detailed reviews of each concept.

■ 2.0 Concept A – New Toll Express Lanes

2.1 Concept Overview and Rationale for Selection of Highway Segments

This concept analyzes the addition of new tolled express lanes to existing interstate highways. There are two corridors in Connecticut where additional lane capacity is being considered – I-95 between Branford and the Rhode Island state line, and I-84 between Waterbury and the New York state line. The rationale behind adding new tolled capacity to existing highways is to raise revenue to pay for the new lanes – revenue that might not otherwise be available. As the corridor becomes more congested, an express toll lane also provides a congestion-free alternative for those who find the need for a quicker or more reliable trip. Unlike HOT lanes, where high-occupancy vehicles are free or discounted, with express toll lanes, all vehicles would pay a toll.

Building a new toll lane is similar to building a new toll road in that drivers can continue to use the existing free capacity or chose to pay for the new capacity. However, there must be enough congestion in the nontolled general-purpose lanes or there is no incentive for drivers to pay for what they can otherwise experience at no toll cost.

Therefore, in order to make the most use of the tolled lane, as well as to generate the most revenue, the toll should vary based on congestion levels. This could be accomplished either through a published toll schedule based on historical patterns or dynamically, based on actual traffic levels on the highway.

2.2 Analysis Methodology and Rationale for Selection

The attractiveness of a tolled express lane is dependent upon there being congestion in the nontolled parallel general purpose lanes. Congestion in the general purpose lanes is a result of too much demand relative to capacity, and/or operational deficiencies such as bottlenecks and access/egress friction at interchanges. Since congestion can vary significantly throughout the day and in these cases by season of the year, we estimated a 24-hour distribution of demand in each direction along the I-95 corridor.

Hourly distribution data was summarized from hourly count data collected along I-95 through Connecticut's traffic management center and from available hourly counts in ConnDOT's traffic count locator program for both corridors. Hourly demand profiles were estimated for an average weekday, an average Friday, a summer Friday (for I-95), and an average weekend day. For I-95, year 2015 traffic volume was estimated through interpolation between year 2000 and 2025, while year 2030 traffic was developed by extrapolating from year 2025 traffic.

Future travel demand exceeding the available capacity of the two free lanes was assumed to be captured by the express toll lane. The toll rate assumed to be in place for the express lanes was determined by calculating the time-savings benefit of the express lane compared to the general purpose lanes and multiplying by the average value of time. VMT, VHT, average speed, toll transactions, and toll revenue were estimated for 2015 and 2030. These measures were compared against the No-Build condition to demonstrate the effectiveness of this tolled express lane scenario.

Operational impacts and annual revenue were estimated for years 2015 and 2030. A 30-year revenue stream was prepared by interpolating between the 2015 and 2030 forecasts and by applying a nominal growth factor through 2044. This revenue stream was then used in the financial analysis.

In our analysis of this concept, we developed estimates of operating conditions in the general purpose lanes and the express lane for No-Build (two general purpose lanes in each direction) and Build conditions (two general purpose lanes and one express toll lane in each direction). We would expect the highest usage of the express lane in their early years of operation to occur on Fridays during the summer season followed by Fridays in general. Because of lack of congestion, we would not expect many people to choose to pay a toll in the express lanes on other weekdays and weekend days during the early years of operation.

2.3 Basic Structure of Calculation Model

We developed a spreadsheet model that considered traffic levels and the resultant speeds on the general purpose lanes and the express lanes to carry out the methodology described above. We compared the traffic levels and speeds between each opportunity for entrance and exit to the highway.

2.4 Key Model Assumptions

The primary assumptions involved the relationship of traffic levels to speed, using standard industry speed-flow curves contained in the TRUCE model. We also considered average values of time for passenger cars in the study area. We assumed that the toll rate would be based on the value of time saved over the general-purpose lanes.

2.5 Selection of Diversion Routes

Since these projects would represent an increase in capacity on the highway itself, the best alternative route is always the main lanes of the highway.

2.6 Source and Application of Traffic Data

For the I-95 project, average daily traffic (ADT) estimates for years 2000 and 2025 between each interchange from Branford to the Rhode Island border were taken from the 2004 study report. P.M. peak-hour traffic for 2002 and 2025 representing summer Friday travel also were provided within the 2004 study report. The 2004 report based the assessment of I-95 on peak summer Friday traffic conditions and travel times.

For the I-84 project, we obtained data from a 2001 study of I-84 by ConnDOT and the Council of Governments of Central Naugatuck Valley that identified peak-hour traffic congestion and safety deficiencies as the major issues along I-84 between the Housatonic River in Southbury and Interchange 23 in Waterbury. ADT estimates for year 2015 between each interchange from Waterbury to the New York state line were estimated by utilizing ConnDOT's 2007 traffic log report and interpolating between the 2006 and forecast 2030 traffic estimates provided in that report.

■ 3.0 Concept B – Border Tolling At Major Highways

3.1 Concept Overview and Rationale for Selection of Highway Segments

The tolling strategy for the border tolling concept was a flat toll charged in both directions at the point where specific limited access highways crossed into and out of Connecticut. For this concept, the locations where border tolls would be applied included:

- I-95 at New York state border;
- I-95 at Rhode Island state border;
- I-84 at New York state border;

- I-84 at Massachusetts state border;
- I-91 at Massachusetts state border;
- I-395 at Massachusetts state border;
- Route 15 at New York state border; and
- Route 6 at Rhode Island state border.

3.2 Analysis Methodology and Rationale for Selection

Refer to Section 7.2 of this appendix.

3.3 Basic Structure of Calculation Model

Refer to Section 7.3 of this appendix.

3.4 Key Model Assumptions

Refer to Section 7.4 of this appendix.

3.5 Selection of Diversion Routes

The analysis looks at "direct" and "diversion" routes. The direct routes are the highways themselves, and the diversion routes are the likely alternate nonhighway routes which were established to reflect possible diversion patterns at each of the toll locations. Since the tolling location for this concept is a discrete location, the diversion routes selected are nontolled roads connecting the last exit before the tolls to the first entry point back onto the highway beyond the toll location. Regular trip mapping programs (MapQuest, GoogleMap, etc.) as well as knowledge of the local roadway systems at each location were used to establish likely routes that diverted travelers might take, and the approximately travel time on those routes.

3.6 Source and Application of Traffic Data

Refer to Section 7.6 of this appendix.

4.0 Concept C – Toll Trucks on Limited Access Highways

4.1 Concept Overview and Rationale for Selection of Highway Segments

The basic tolling strategy under this concept was a flat per-mile toll in both directions along the entire length of the chosen study corridors (highways). For this concept, all the major limited access highways in the State were studied. The routes chosen include:

- I-95 between New York state line and the Rhode Island state line, divided for analysis purposes into two segments (New York to New Haven and New Haven to Rhode Island);
- I-84 between New York state line and Massachusetts state line (divided into two analysis segments at Hartford);
- I-91 between New Haven and the Massachusetts state line (divided into two analysis segments at Hartford); and
- I-395 up to Massachusetts state line.

As with Concept G1, two short intrastate segments – I-691 and I-291 – and the secondary highway corridors – Routes 2, 8, and 9 – were grouped together and analyzed as two additional highway segments.

The above routes combine for almost all of the limited access highways in the State of Connecticut and also carry a majority of the truck traffic in the State. Connecticut Route 15, which was included under Concept G1 (Toll All Limited Access Highways), was excluded from this concept due to the cars-only operation of Route 15.

4.2 Analysis Methodology and Rationale for Selection

For this type of generally modest-toll concept, the goal of the analysis methodology was to calculate the likelihood that trucks would divert from the highway route to a nontolled route or time period to avoid the tolls. The likelihood of diversion was established by: 1) calculating the value of the extra time incurred in traversing the slower and typically longer alternate route; and 2) comparing that against the various tolls that would be charged for those vehicles choosing to remain on the highway, with different tolls for different types of trucks – vans, single unit trucks (SUT) and tractor trailers (TT). The concept looked at different overall levels of tolls and calculated the likely diversion for each type of truck at each toll level. Per-mile tolls were highest for TTs followed by SUTs and vans. This spreadsheet-based method allowed for a relatively robust but flexible assessment of a wide range on highway segments, from high-volume segments passing primarily through urbanized areas to lower-volume highways almost entirely within rural areas.

4.3 Basic Structure of Calculation Model

Refer to Section 7.3 of this appendix.

4.4 Key Model Assumptions

Refer to Section 7.4 of this appendix.

4.5 Selection of Diversion Routes

Refer to Section 7.5 of this appendix.

4.6 Source and Application of Traffic Data

Refer to Section 7.6 of this appendix.

5.0 Concept D – HOV to HOT Lane Conversion

5.1 Concept Overview and Rationale for Selection of Highway Segments

Concept D involves conversion of existing HOV to HOT lanes on I-84 and I-91 in the Hartford area. The concepts are completely described in Volume 2 – Background Report.

5.2 Analysis Methodology and Rationale for Selection

The attractiveness of an HOV lane comes from the travel-time advantage that it can provide over the general-purpose lanes during congested periods. Since the time-saving advantage of the HOT lane is typically only significant during several hours of the day, we analyzed traffic flows for the following time periods, based on traffic count data provided by ConnDOT:

- AM1: 6:00 a.m. to 7:00 a.m.;
- AM2: 7:00 a.m. to 9:00 a.m.;
- MD: 9:00 a.m. to 3:00 p.m.;
- PM1: 3:00 p.m. to 4:00 p.m.;

- PM2: 4:00 p.m. to 6:00 p.m.;
- PM3: 6:00 p.m. to 7:00 p.m.; and
- NT: 7:00 p.m. to 6:00 a.m.

We obtained the travel demand model used by the Capitol Region Council of Governments (CRCOG) to estimate growth in future corridor demand. This growth in demand was applied to the 2007 time period levels of demand to create baseline traffic demand levels for 2015 and 2030.

Using this information, we developed a spreadsheet market share model to estimate the amount of SOV traffic by time period and by direction that would use the HOT lane at various toll rates. HOV traffic is assumed to continue to use the HOT lane toll free. Toll rates for SOV traffic were chosen at levels that aimed to maximize revenue wherever possible, but also limiting usage of the HOT lane to 1,650 vehicles per hour so as to maintain free flow conditions for HOV and transit. Another policy option could be to maximize usage of the facility, bounded by a minimum toll and limiting usage to 1,650 vehicles per hour per lane in the HOT lane. In some instances, maximizing usage also will maximize revenue, but not in all cases.

5.3 Basic Structure of Calculation Model

Discussed in Section 5.2, above.

5.4 Key Model Assumptions

The primary assumptions involved the relationship of traffic levels to speed, using standard industry speed-flow curves contained in the TRUCE model. We also considered average values of time for passenger cars in the study area. We assumed that the toll rate would be based on the value of time saved over the general-purpose lanes.

5.5 Selection of Diversion Routes

Since these projects would represent an increase in capacity on the highway itself, the best alternative route is always the main lanes of the highway.

5.6 Source and Application of Traffic Data

Discussed in Section 5.2, above.

6.0 Concept F – Tolling for Highways Needing New Capacity

6.1 Concept Overview and Rationale for Selection of Highway Segments

This concept examines the same two highway corridors analyzed in Concept A for new tolled express lanes – I-95 between Branford and the Rhode Island state line and I-84 between Waterbury and the New York state line. However, in this concept, instead of adding a tolled express lane, the two corridors would be reconstructed with an additional general purpose lane in each direction, and the entire corridor would be tolled.

Three sections of I-95 were analyzed independently:

1. Branford to the Connecticut River;
2. Connecticut River to the Thames River; and
3. Thames River to the Rhode Island state line.

We analyzed U.S. 1 as the best alternative route along the entire length. We developed estimates of VMT, VHT, average speed, and hours of delay for No-Build and Build conditions. No-Build conditions assume the current configuration of I-95 would remain – two lanes in each direction. The Build condition assumed widening to three lanes in each direction and tolls would be charged for all trips.[1]

Three sections of I-84 were analyzed independently. These sections and their corresponding alternate routings are described below:

- I-84 New York to Newtown:
  - Alternate Route: U.S. 6 (from New York state line to U.S. 7 in Danbury), Lake Avenue, West Street, Liberty Street, Patriot Drive, White Street, Newtown Road, U.S. 6 (from Exit 8 on I-84 to Exit 10 on I-84);
- I-84 Newtown to Southbury:
  - Alternate Route: Church Hill Road (at I-84 Exit 10), Glen Road, River Road, Fish Hook Road, Main Street (Junction of U.S. 6/I-84 Exit 15);

[1] Although our analysis assumed that all trips would be tolled, there may be a good reason for two exceptions – the crossings of the Connecticut and Thames rivers. In both cases, U.S. 1 uses the I-95 bridge, which would mean that there would be no toll-free alternative for the river crossing. If the state believed it were important to maintain a toll-free alternative, then these segments of highway might be left toll free.

- I-84 Southbury to Waterbury:
  - Alternate Route: Old Waterbury Road, SR 188 (Southford Road), SR 64 (Middlebury Road), Chase Parkway (in Waterbury), and Highland Avenue (I-84 Exit 18).

6.2 Analysis Methodology and Rationale for Selection

For I-95, average daily traffic (ADT) estimates for years 2000 and 2025 between each interchange from Branford to the Rhode Island border were taken from the 2004 study report. Year 2015 traffic was developed through interpolation between 2000 and 2025. Year 2015 was chosen for an opening year analysis. ADT along U.S. 1 (which generally parallels I-95) also was summarized from ConnDOT's 2006 traffic volume log report[2] to establish the baseline of VMT and VHT estimates along U.S. 1 before applying diversion impacts from tolling I-95. We estimated VMT on U.S. 1 for 2015 by using I-95 forecast growth rates.

For I-84, ADT estimates for years 2015 between each interchange from Waterbury to the New York state line were forecasted by starting with ConnDOT's 2007 traffic log report[3] and factoring to 2015 levels by using ConnDOT's 2007 Congestion Screening and Monitoring Report which provides a growth forecast for I-84. ADT along assumed alternate routes also was summarized from ConnDOT's 2007 traffic log report to establish the baseline of VMT and VHT estimates along these roadways before applying diversion impacts from tolling I-95. Baseline alternate route traffic for year 2015 was estimated by using I-84 forecast growth rates applied to 2007 volumes.

We developed a spreadsheet analysis tool based on the TRUCE model developed by the Federal Highway Administration[4] to estimate the amount of diversion from the tolled highway to alternative routes. We assumed that 85 percent of the diverted traffic would choose to use the nearest arterial alternative, with the remaining 15 percent using more minor routes, forming carpools, reducing trips, and shifting to transit. We compared the time savings benefit of staying on the highway compared to using the best alternative for an average 10-mile trip.

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[2] State of Connecticut Department of Transportation. 2006 Traffic Volumes State-Maintained Highway Network (Traffic Log). Prepared by Division of Systems Information, Bureau of Policy and Planning, in cooperation with U.S. Department of Transportation – Federal Highway Administration.

[3] State of Connecticut Department of Transportation. 2007 Traffic Volumes State-Maintained Highway Network (Traffic Log). Prepared by Division of Systems Information, Bureau of Policy and Planning, in cooperation with U.S. Department of Transportation – Federal Highway Administration.

[4] Federal Highway Administration, TRUCE 3.0, available at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/tools/truce_model_guide.htm.

We tested three per-mile toll rates: 10, 20, 30 cents. The lower end of that scale is in the general range of the older intercity turnpikes in the northeast. The midrange is at the level of urban toll expressways built within the last 20 years, and the higher end is a level in use on a few highways that use congestion pricing in urban areas or congested corridors. Average daily revenue was calculated by multiplying the remaining tolled VMT by the corresponding per-mile toll rate. Daily estimates of revenue were then annualized.

6.3 Basic Structure of Calculation Model

The percentage of vehicles that would be diverted due to a particular toll rate is determined based on standard industry diversion curves that are linked to the time savings estimated for the toll facility and the associated value of time.

Time savings is determined based on a comparison of travel times between the tolled facility and the parallel arterial for 10-mile trips. It is assumed that the toll facility would operate at ideal free-flow speed conditions, while the parallel facility would have an operating speed based on volume and capacity.

Time savings is monetized by using a value of time as described in the section below.

The resultant number of vehicles using the toll facility is used to determine revenue forecasts.

6.4 Key Model Assumptions

The value of time is determined based on a calculation structure used in the TRUCE model. In the TRUCE model, the value of time is calculated for autos and trucks separately.

For autos, two trip purposes, business and personal, are used to determine a value of time. A split of 85 percent personal/15 percent business trips was used.

- For personal auto trips, a value of time is determined by taking the median household income for the region being evaluated and dividing it by 2,000 hours and also dividing that result by two to represent one adult. For example, a $60,000 household income is divided by 2,000 annual work hours and then divided by two to represent one adult.

- For business auto trips, the mean hourly wage for all industry sectors, as provided by the Bureau of Labor Statistics (BLS), was multiplied by a compensation to wage ratio. This ratio is determined by dividing the mean hourly compensation by the mean civilian hourly wage and salary.

- Based on the aforementioned 85/15 percent personal-business trip purpose split, a weighted average auto value of time is determined.

- For trucks, the value of time is based on combining the value of time for the driver with the value of time for the contents and fuel being carried.

- The value of time for a truck driver is a weighted average of the mean hourly wage paid to heavy truck drivers and the mean hourly wage paid to light truck drivers. They are weighted based on the number of heavy truck and light truck drivers in the region as determined by the BLS. The wages are also listed in the BLS for Connecticut. The weighted average wage is then multiplied by the compensation to wage ratio as described above for autos.

- The value of time for the contents and fuel was assumed to be $41 as provided in the TRUCE model.

A value of time for all vehicles combined is determined by a weighted based on the VMT split between autos and trucks.

6.5 Selection of Diversion Routes

See Section 6.1, above.

6.6 Source and Application of Traffic Data

See Section 6.2, above.

7.0 Concept G1 – Toll All Limited Access Facilities

7.1 Concept Overview and Rationale for Selection of Highway Segments

The basic tolling strategy under this concept was a flat per-mile toll in both directions along the entire length of the chosen study corridors (highways). For this concept, all the major limited access highways in the State were studied. The routes chosen include:

- I-95 between New York state line and the Rhode Island state line, divided for analysis purposes into two segments (New York to New Haven and New Haven to Rhode Island);

- I-84 between New York state line and Massachusetts state line (divided into two analysis segments at Hartford);

- I-91 between New Haven and the Massachusetts state line (divided into two analysis segments at Hartford);
- I-395 up to Massachusetts state line; and
- The limited access potion of Route 15.

Two short intrastate segments – I-691 and I-291 – and the secondary highway corridors – Routes 2, 8, and 9 – were grouped together and analyzed as two additional highway segments.

The above routes combine for almost all of the limited access highways in the State of Connecticut and also carry a majority of the truck traffic and a high percentage of car traffic.

7.2 Analysis Methodology and Rationale for Selection

For this type of generally modest-toll concept, the goal of the analysis methodology was to calculate the likelihood that vehicles would divert from the highway route to a nontolled route or time period to avoid the tolls. The likelihood of diversion was established by: 1) calculating the value of the extra time incurred in traversing the slower and typically longer alternate route; and 2) comparing that against the various tolls that would be charged for those vehicles choosing to remain on the highway, with different tolls for different vehicle classes – cars, vans, single unit trucks (SUT) and tractor trailers (TT). The concept looked at different overall levels of tolls and calculated the likely diversion for each vehicle class at each toll level. Per-mile tolls were generally higher for vans and trucks than for cars. This spreadsheet-based method allowed for a relatively robust but flexible assessment of a wide range on highway segments, from high-volume segments passing primarily through urbanized areas to lower-volume highways almost entirely within rural areas.

7.3 Basic Structure of Calculation Model

The calculation model developed for this application is primarily driven by the average speed and volume of traffic on the tolled highway, and associated speed and length of the likely alternate routes to arrive at the same destinations. Using estimates for the monetized value of time perceived by the drivers of the different vehicle class and the various tolls levels, the model calculates the ratio (R1) between the value of the extra time required to reach the same destination using a nontolled alternate route and the toll to remain on the highway. A "response curve" was established that relates different values of this ratio to percent diversion levels from the highway. The diversion percentage increases with the value of R1 although at different rates depending on the level of tolls. This curve was based on available information on toll elasticity estimates from studies around the county. Calculation of the diverted traffic and the tolled traffic forms the basis of calculations of tolled and diverted vehicles, vehicle miles traveled and vehicle hours traveled.

7.4 Key Model Assumptions

The factors that effectively drove the results of this diversion model were:

- Segment length and travel time (speed) on the highway and on alternate routes;
- Value of Travel time (VOT) for the tolled travelers on these highways; and
- Response by drivers to the difference between the perceived costs of the highway route with the toll versus the nontolled alternate route.

Segment length for each highway segment was taken from mileage-volume data tables provided by ConnDOT, while distances on diversion routes were taken from estimates generated from MapQuest and GoogleMaps, matching the same origin-destination points but using the "no highway" alternative. Generally the distances were relatively close, with the alternate routes sometimes shorter than the highway option. (See discussion below about average trip length used in diversion analyses.)

The main factor in these alternate route analyses was less the length of these segments and more the assumed average speed and travel time for the same trip under the highway and alternate route options. Speeds were based on: 1) any available information on congestion conditions (average speed, V/C ratios); 2) approximate V/C and associated speed estimates based on volume data; and 3) the Study Team's knowledge of the corridors in question and their conditions throughout the day. In future analysis years, average speeds were lowered somewhat for both highway and alternate routes to account for the increase in traffic with no assumed increase in roadway capacity.

The diversion model separately assessed each of the vehicle classes to define the likely reaction to the tolling by each vehicle group – i.e., the approximate numbers that would remain on the highway and divert to nontolled alternate routes. The monetized value of the additional travel time on alternate routes reflected the VOT for the drivers of the diverted vehicles. For cars VOT was established using the TRUCE model methodology, which applied various socioeconomic data from the BLS and the U.S. Census for communities along each corridor. While the resultant VOT estimates were somewhat regionally specific, the range of car VOTs was relatively constant across the various highway corridors. For trucks, separate values of times were defined for vans, SUTs, and TTs and used for all study corridors. These values were based on a study recently conducted by Cambridge Systematics, Inc. in Vancouver, British Columbia.

7.5 Selection of Diversion Routes

The analysis looks at "direct" and "diversion" routes. The direct routes are the highways themselves, and the diversion routes are the likely alternate nonhighway routes which were established to reflect possible diversion patterns for each of the corridors. The diversion routes established are the shortest travel distance between the end points of the study corridor along routes within reasonable proximity to the respective corridors, providing a potentially viable option for diverted traffic. The diversion routes assumed for each corridor were provided in the analysis section of this report.

It was understood that only a minority of travelers would be traveling the entire length of each of these corridors, and that other roadways (especially local streets) would likely be used by potentially diverted travelers. Estimated average trip lengths were, therefore, established for cars, vans, SUTs, and TTs, based on a TRUCE model estimate for average auto trip lengths and estimate of average truck trips from a Caltrans study for the greater Los Angeles, California area. These average trip lengths were used to assess the likely diversion patterns, with the full corridor lengths used to establish overall VMT, VHT, and toll transaction and revenue estimates.

7.6 Source and Application of Traffic Data

Current speeds and distances for the study corridor and the diversion routes were obtained by averaging values obtained from multiple directional and interactive mapping websites, and on data on hourly and daily traffic levels, V/C ratios and other data (where available) for these corridors. All traffic data inclusive of ADT for various locations along the highways in question, and vehicle classification were obtained from ConnDOT. In some instances (especially for highways in southwestern Connecticut), hourly data in both directions were available, from which operating conditions could be estimated, while for many other locations only ADT-level data were available.

■ 8.0 Concept G2 – Tax on All Vehicle Miles of Travel

8.1 Concept Overview and Rationale for Selection of Highway Segments

For purposes of this report, we have assumed that VMT fees would be collected from all vehicle movement in the State, whether Connecticut-registered or not, and that GPS technology would be used to collect the data. For consistency of comparison with other concepts, we have assumed implementation starting in 2015, although this timeline is unlikely given the technical and policy issues that would be involved.

Note that it would be possible to implement a simpler method of VMT charging by recording odometer readings of vehicles at the time of safety inspections. The problems with this concept include addressing vehicle miles traveled by Connecticut registered vehicles while out of state, and travel by non-Connecticut residents while in Connecticut.

For purposes of this report, two types of scenarios were analyzed: 1) the VMT fee is over and above the existing motor fuel tax; and 2) the VMT fee replaces the motor fuel tax. The two scenarios differ in what is assumed about how drivers would respond to the VMT fee price. In the scenario where the motor fuel tax is assumed to be eliminated, a VMT fee of $0.02 per mile (about the average cost of the existing state motor fuel tax) was assumed to have no travel-reduction impacts – because the average cost to drivers would be the same as they pay now.

Higher rates were analyzed based on the difference between today's fees and the total future fees under the new concept. We tested rates ranging from $0.02 cents per mile for passenger cars to three times that amount, both with and without removing the existing motor fuel tax. Trucks were assumed to pay $0.067 per mile, consistent with their state motor fuel tax contribution on a per-mile basis when looking at a one-for-one replacement of the motor fuel tax.

We kept the analysis simple and assumed that the same VMT fee would be charged at all times on all roads. If GPS technology is used, it would be possible to charge different prices to optimize system performance by varying the rate based on many factors, including time of day, congestion, roadway type, vehicle type, etc. We did not analyze the many potential approaches that would be possible with a VMT fee.

8.2 Analysis Methodology and Rationale for Selection

We estimated the transportation impacts of this concept assuming price elasticity to travel of -0.20, which is based on recent research that focused on traveler behavior as motor fuel prices increased. The elasticity for trucks was assumed to be less, since truck drivers and companies have fewer options to change mode or to change travel behavior. In a one-for-one replacement of the motor fuel tax (two cents per mile), we would not expect to see any change in travel.

8.3 Basic Structure of Calculation Model

The calculation model was a relatively simple spreadsheet that calculated reductions in highway travel in the State for each functional classification.

8.4 Key Model Assumptions

See Section 8.2, above.

8.5 Selection of Diversion Routes

Not applicable to this concept, since all routes would be tolled.

8.6 Source and Application of Traffic Data

VMT data came from highway statistics.

9.0 Concept H – Congested Corridor Tolling

9.1 Concept Overview and Rationale for Selection of Highway Segments

The basic tolling strategy in this concept was to apply variable per-mile tolls within congested highway segments, with toll levels based on the congestion levels at different times of the day. The goal of these actions would be to reduce congestion in those sections and time periods, with portions of the toll revenues used to provide for a regionwide congestion reduction program and to support transit modes.

The tolls are based on: 1) the current levels of congestion; and 2) the level of improvement in congestion that the concept seeks to achieve by removal of vehicles from these congested corridors. Higher levels of congestion need greater reduction in vehicle volumes to achieve acceptable levels of traffic flow and, therefore, higher levels of tolling.

The corridors selected for this study includes:

- I-95 between New York state border and the Bridgeport-Stratford town line in Connecticut; and
- Route 15 between New York state border and the Milford-Stratford town line.

The option of tolling Route 1 in this travel corridor was also studied, but was eventually abandoned due to the physical limitations of the roadway which did not lend itself to effective tolling, without incurring exorbitant infrastructure costs.

9.2 Analysis Methodology and Rationale for Selection

For this type of tolling, the day was divided into four different time periods:

- 6:00 a.m. to 10:00 a.m.;
- 10:00 a.m. to 4:00 p.m.;
- 4:00 p.m. to 8:00 p.m.; and
- 8:00 p.m. to 6:00 a.m.

Existing traffic conditions in each period were analyzed to ascertain: 1) the level of congestion; and 2) the necessary reduction in the number of vehicles to achieve better traffic flow conditions. Congestion was expressed as a function of V/C ratios. A V/C ratio of 0.85 was initially the target goal, in instances with often much higher V/C ratios, a more realistic target V/C level was established to minimize the amount of traffic that would have to be diverted off of the highways during congested time periods; i.e.:

Target V/C Ratios for Congestion Pricing in I-95/Route 15 Corridor

Existing/ Future V/C Ratio Range		**Desired V/C Ratio**
From	To	
.850	.950	.85
.950	1.05	.95
1.05	1.15	1.05
> 1.15		**1.10**

Depending on the volume reduction needed in a given corridor to achieve the target V/C level, iterative calculations were made to adjust the toll levels sufficiently to achieve that reduction. In each scenario, tolls for vans, SUTs, and TTs were set at 1.25 times, 1.5 times, and 2.0 times the level of the car toll, respectively. The calculations used the calculation model from Concept G1 to establish the tolls necessary to achieve improved traffic flow on these two corridors.

The two corridors chosen for this study are the two most congested corridors in Connecticut and have high levels of congestion through extended hours of the day and all studies have pointed towards the problems of extreme congestions in this section of southwest Connecticut.

9.3 Basic Structure of Calculation Model

The calculation model for this concept is primarily based on the existing levels of congestion (which were obtained from the State's Congestion Management System) and expressed in terms of V/ C ratios. The calculation also assumes acceptable levels of V/C ratio which would not need further reduction in vehicle volumes and also establishes reduced V/C ratios which would need to be achieved during congested periods, when V/C ratios are high, to result in improved traffic flow. The reduced V/C ratios listed in the table above were based on logical achievable reduction of vehicular traffic. As noted above, the calculation model explained under Section 7.4 above was used to establish approximate congestion toll levels.

9.4 Key Model Assumptions

Refer to Section 7.4 of this appendix.

9.5 Selection of Diversion Routes

The primary diversion route for I-95 and Route 15 was assumed to be U.S. Route 1. It was understood that a wide variety of potential roadways might be strung together by travelers to reach the same destination for which they would otherwise have used the tolled highways for the major portion of these trips. This would be especially true for shorter diverted car trips by local area residents with a good knowledge of these types of roadways.

9.6 Source and Application of Traffic Data

Section 7.6 of this appendix outlines the major source of data that were used for the assessment of this and other tolling concepts. The traffic volume data available for these two highways as well as for U.S. Route 1 were somewhat more detailed that for other locations, with hourly volume data in both directions provided by ConnDOT.

Appendix B

Implementation Requirements and Costs

Implementation Requirements and Costs

This appendix is structured as a series of steps, to guide the reader through the approach used to derive the implementation requirements and their costs. A description of each step and the key outputs which arise are detailed.

The approach was to define the components needed to implement a project, calculate the required number of each component – this gives us a quantifiable view of the implementation requirements, then for each component calculate the unit cost and finally combine unit costs with required numbers– this gives us the total costs. From this perspective, the derivation of the implementation requirements is a stepping stone to calculating costs.

1.0 Implementation Requirements – Introduction

Each concept has certain roadside and back office components which are required for implementation. Most of these components are mandatory, while some are optional depending on concept implementation choices.

We assume for the purposes of this study that the implementation requirements are simply the components required should a concept be implemented.

Hence for each project, we calculate the number of each component required to implement the project.

Accordingly, the method used to derive these numbers is:

1. Identify the components required for project implementation, and derive formulae to calculate the required number of each component;
2. Determine values for each factor identified in the formulae from Step 1; and
3. Evaluate the formulae to calculate the required number of components for each project.

Step 1 – Identify Components and Formulae

We first derive the list of roadside and back office components needed to implement a project. We arrive at the following list by extending those identified for each concept in the Phase 2 deliverable. For each component we also identify how to calculate the required number.

Roadside Components

The table below holds all the roadside components.

Component	Description	Number of Each Calculated By…
Tags	RFID transponders placed in vehicles to allow communication with roadside tolling points.	Number of tags per account multiplied by number of accounts.
Gantries (1 lane)	Roadside structure (typically overhead) to hold tag readers, image capture units, DMS, etc. Costs vary depending on size.	Number of gantries per tolling point multiplied by number of tolling points.
Tag reader/antenna units	Reads the tag data of passing vehicles.	Number of units per tolling point multiplied by number of tolling points.
Image capture units	Records images of passing vehicles. Will include ALPR and OCR technology.	Number of units per tolling point multiplied by number of tolling points.
CCTV surveillance cameras	Closed circuit television cameras to allow for roadside monitoring, for incident detection and to confirm traffic levels.	Either: Number of units per mile multiplied by number of miles; or Number of units per tolling point multiplied by number of tolling points.
Vehicle detection unit	Determines traffic congestion levels and performs traffic counts. Especially relevant for dynamically priced toll systems.	Number of units per tolling point multiplied by number of tolling points.
Dynamic messaging signs	Allows communication of variable messages to motorists. Will be used to communicate current toll rates in a dynamically priced system.	Number of units per tolling point multiplied by number of tolling points.
Static signs	Used for telling travelers they are approaching a tolled facility and to communicate static tolling information.	Number of units per tolling point multiplied by number of tolling points.
Vehicle classification units	Classifies passing vehicles based on physical characteristics such as number of axles, or profile.	Number of units per tolling point multiplied by number of tolling points.

Component	Description	Number of Each Calculated By…
Vehicle separation detection units	Concepts which do not require vehicle classification (A and D, as these concepts only allow passenger cars into their lanes), still need a means of detecting distinct vehicles as part of the tolling operations.	Number of units per tolling point x number of tolling points.
Roadside computing	Controls the roadside ITS components such as tag readers, image capture, etc. Includes a rugged and weatherproofed equipment cabinet for holding roadside computing equipment. Includes software for each computer and overall software/central system to manage all roadside computers.	Number of units per tolling point multiplied by number of tolling points.
Power connections	Provides power to the ITS components.	Number of units per tolling point multiplied by number of tolling points.
Communications – fiber	Communications link from roadside computing to back office. Length in miles.	Consulting existing Connecticut fiber network map.
Communications – tolling point switchbox	Tolling point switchbox communications for controlling the fiber link.	Number of units per tolling point multiplied by number of tolling points.
Service truck equivalents	Performs roadside assistance and rescue function for traffic using toll system. Only required for concepts which rely on an improved service to customers (e.g., express and HOT lane tolling).	Number of miles/number of miles covered per truck.
Roadside law enforcement officer equivalents	Enforces toll system rules through visual deterrent and ticketing power.	Number of miles/number of miles covered per officer.

Back Office Components

The table below holds all the back office components.

Component	Description	Number of Each Calculated By…
Pre-implementation staff	Pre go-live staff resource to run procurements and implement project.	Comparing concept against industry estimates.
Post-implementation staff	Staff resources to manage the program once operational (e.g., toll authority staff). This does not include those staff operating the back-office and walk-in centers.	Comparing concept against industry estimates.
Back office	The hardware, software, real estate, staff, and facilities required to operate the tolling system and process the electronic transactions.	Comparing concept against industry estimates.
Walk-in customer service centers	The hardware, software, real estate, staff, and real estate to provide separate walk-in support service to customers at regional locations.	Comparing concept against industry estimates.
Retail channels	Over the counter toll payment and account administration facilities provided at retail outlets. Would be provided by partnering with a store chain such as Stop and Shop or Walgreens.	Number of retail channels per mile multiplied by number of miles.

The third column in the above two tables describes the formulae for calculating the required number of each component. We assign values to each factor in Step 2.

Step 2 – Determine Values for Each Formula Factor

This step assigns a value to each formula factor identified in Step 1 above.

Generic Factors

Generic factors have the same value for all projects. The following table holds the values for these generic factors.

Generic Factor	Value	Notes
Tags per account	1.6	Based on sample E-ZPass experience.
Tolling points per segment	2	Assumed one tolling point per segment for each direction of travel to ensure that even the shortest trips between adjacent exits are tolled. Concept D assumes only one tolling point (per direction of travel) along the whole tolled lane. Used in conjunction with 'number of segments' to calculate 'number of tolling points'.
Gantries per tolling point	2	To allow room for full suite of detection equipment.
Tag readers per tolling point	2L+2	L = number of lanes tolled. Two readers over each lane, plus one on either side to detect vehicles at the extreme sides of the lane.
Image capture units per tolling point	(2L+2)D	As for tag readers, but in addition: D = number of directions for which images are required.
Vehicle classification units per tolling point	L	One required per lane for those concepts which charge by vehicle class. Otherwise 0.
Vehicle separation detection units per tolling point	L	One required per lane for those concepts which do not charge by vehicle class. Otherwise 0.
Roadside computers per tolling point	1	A single computer is required to control all ITS equipment at a tolling point.
Power connections per tolling point	1	A single power source is required to power all ITS equipment at a tolling point.
Static signs per tolling point	3	Assumed three to allow for imparting varied information to motorists.

Project-Specific Factors

Project-specific factors vary in value from project to project. The table below provides justifications for the values assigned to each factors, and the following table provides the values themselves.

Project-Specific Factor	Rationale
Length of tolled road	Lengths in miles, with value given the total for both directions of road.
Number of segments	Defined as section of road between two intersections with no entry or exit possible except at either intersection.
Number of tolling points	Assumed no vehicles can use toll facility for free, so for all concepts (except D) one tolling point per segment per direction of traffic. Total number calculated by number of segments x number of tolling points per segment. For D, assumed a single tolling point per direction of traffic because all vehicles have to pass through this single point.
Lanes tolled (in each direction)	Assumed one (for express or HOT lanes) and three for all others.
Average trip length (miles)	The assumed length of an average trip a vehicle takes on the toll road.
Dynamic pricing	"Yes" for concepts which "sell" capacity (express and HOT lanes), "no" for all others.
DMS per tolling point	Assumed two for all dynamic concepts, one for all others (as one would still be needed for these concepts to convey changing information such as safety messages, or travel times).
CCTV per mile	CCTV cameras per mile for those concepts which offer an optional toll with improved level of service (e.g., HOT lanes). Primarily for traffic monitoring. Modern-day Pan Tilt Zoom (PTZ) cameras can view half a mile in any direction.
CCTV per tolling point	CCTV cameras at every tolling point for those concepts which impose a toll. This is to guard against vandalism or tampering. One per gantry gives two per tolling point.
Toll varies by vehicle class	Assumed "no" for concepts with express and HOT lanes (assumed cars only for these concepts and hence no need for vehicle classification equipment) "yes" for all others
Vehicle detection units per mile	Only required for concepts which offer dynamic pricing, and used to adjust the toll based on traffic volumes and speed (e.g., HOT lanes). Two per mile is common practice.
Miles covered per service truck	Only required for concepts which rely on an improved service to customers (e.g., express and HOT lane tolling.). Value is total tarmac miles covered, e.g., 40 miles means 10 miles from base in either direction.
Miles covered per roadside law enforcement officer	Value is total tarmac miles covered, e.g., 30 miles means 7.5 miles from base in either direction on both directions of roadway.

Project-Specific Factor	Rationale
Pre-implementation staff	Typically more pre-implementation staff are needed than post-implementation staff because of the management of suppliers and the delivery of the program.
Post-implementation staff	Typically fewer post-implementation staff are needed than pre-implementation staff because managing a "steady state" program is less intensive than the delivery of that program.
Back office	Assumed one back office is required for all concepts, which would scale depending on number of accounts and video transactions.
Walk-in customer service centers	Number of CSCs will vary depending on geographical coverage of concept and expected level of customer service.
Retail channels per mile	Number of retail channels per mile would vary depending on expected weight of traffic along with nature and level of customer service required.

The following table identifies the quantities used for each Concept.

Project-Specific Factor	Express Lanes			Bdr	TOT	HOV to HOT			Toll Existing			All LAH	Con-gested
	A1	A2	A3	B	C	D1	D2	D3	F1	F2	F3	G1	H
Length of tolled road	115	64	179	14[a]	1,174	22	16	38	115	64	179	1,174	182
Segments	31	17	48	7	355	8	6	14	31	17	48	355	61
Tolling points	62	34	96	14	710	16	12	28	62	34	96	710	122
Lanes tolled (in each direction)	1	1	1	3	3	1	1	1	3	3	3	3	3
Average trip length (miles)	10	10	10	N/A	10	22	16	38	10	10	10	10	10
Dynamic pricing	Y	Y	Y	N	N	Y	Y	Y	N	N	N	N	N
DMS per tolling point	2	2	2	1	1	2	2	2	1	1	1	1	1
CCTV per mile	1	1	1	0	0	1	1	1	0	0	0	0	0
CCTV per tolling point	0	0	0	2	2	0	0	0	2	2	2	2	2
Toll varies by vehicle class	N	N	N	Y	Y	N	N	N	Y	Y	Y	Y	Y
Vehicle detection units per mile	2	2	2	0	0	2	2	2	0	0	0	0	0
Miles covered per service truck	40	40	40	0	0	40	40	40	0	0	0	0	0

Project-Specific Factor	Express Lanes			Bdr	TOT	HOV to HOT			Toll Existing			All LAH	Con-gested
	A1	A2	A3	B	C	D1	D2	D3	F1	F2	F3	G1	H
Miles covered per roadside law enforcement officer	30	30	30	N/A	30	30	30	30	30	30	30	30	30
Pre-implementation staff	16	16	20	16	16	8	8	10	16	16	20	36	16
Post-implementation staff	4	4	5	8	8	4	4	5	8	8	10	18	8
Back offices	1	1	1	1	1	1	1	1	1	1	1	1	1
Walk-in customer service centers	1	1	3	4	2	1	1	1	1	1	2	6	2
Retail channels per mile	1	1	1	5	0	1	1	1	2	2	2	2	2

[a] Border tolling concept does not have a "Length of Tolled Road," but a number had to be used here for consistency within the cost model. An assumption that one tolling point is 1 mile long needed to made. There are 14 tolling points and hence the equipment and support required is similar to a 14-mile toll road.

Step 3 – Evaluate the Formulae

We then use the values for the factors from Step 2 to calculate the required number of each component, using the formulae defined in Step 1. The required numbers of each component are the implementation requirements for each project.

The following table holds these implementation requirements.

Component Required	Number of each component required												
	Express Lanes		Bdr		TOT	HOV to HOT		Toll existing		All LAH		Congested	
	A1	A2	A3	B	C	D1	D2	D3	F1	F2	F3	G1	H
Tags (millions) – *toll rate 1*	2.26	1.86	4.12	75.19	20.71	1.25	2.79	4.04	83.11	48.67	109.82	97.99	32.50
Tags (millions) – *toll rate 2*	- -	- -	- -	77.59	20.59	- -	- -	- -	75.44	44.40	99.87	97.77	- -
Tags (millions) – *toll rate 3*	- -	- -	- -	63.26	20.53	- -	- -	- -	66.41	39.15	87.96	97.24	- -
Gantries (per lane)	124	68	192	28	1,420	32	24	56	124	68	192	1,420	244
Tag reader/ antenna units	248	136	384	112	5,680	64	48	112	496	272	768	5,680	976
Image capture units	248	136	384	224	11,360	64	48	112	992	544	1,536	11,360	1,952
CCTV surveillance cameras	115	64	179	28	1,420	22	16	38	124	68	192	1,420	244
Vehicle detection unit	230	128	358	0	0	44	32	76	0	0	0	0	0

Component Required	Number of each component required												
	Express Lanes		Bdr		TOT	HOV to HOT		Toll existing		All LAH		Congested	
	A1	A2	A3	B	C	D1	D2	D3	F1	F2	F3	G1	H
Dynamic messaging signs	124	68	192	14	710	4	4	8	62	62	62	710	122
Static signs	186	102	288	42	2,130	48	36	84	186	102	288	2,130	366
Vehicle classification units	0	0	0	42	2,130	0	0	0	186	102	288	2,130	366
Vehicle separation detection units	62	34	96	0	0	2	2	4	0	0	0	0	0
Roadside computing	62	34	96	14	710	16	12	28	62	34	96	710	122
Power connections	62	34	96	14	710	16	12	28	62	34	96	710	122
Communications – fiber	45	32	77	0[b]	700	0	0	0	45	32	77	700	52
Communications – tolling point switchbox	62	34	96	0[b]	710	16	12	28	62	34	96	710	122
Service truck equivalents	2.88	1.60	4.48	0	0	1	1	1	0	0	0	0	0
Roadside law enforcement officer equivalents	3.84	2.13	5.97	7	39.15	1	1	1.27	4	2	6	39	6.06
Pre-implementation staff	16	16	20	16	16	8	8	10	16	16	20	36	16
Pre-implementation staff	4	4	5	8	8	4	4	5	4	6	10	18	8
Back office	1	1	1	1	1	1	1	1	1	1	1	1	1
Walk-in customer service centers	0-1[a]	0-1[a]	0-2[a]	4	2	0	0	0	1	1	2	6	2
Retail channels	115	64	179	70	0	22	16	38	115	1	179	352	364

[a] The number of walk-in centers is variable. In this case, initial account volume does not warrant a separate center; however, by year 24, a walk-in center is projected to be viable.

[b] Communications equipment is 0 for this Concept since it is anticipated that leased lines will be more cost-effective for a geographically spread point tolling concept.

2.0 Costs – Introduction

Once we have calculated the number of each component required, by determining the unit cost of each component, we can arrive at the total implementation cost of each project.

In order to arrive at quantitative costs for the implementation requirements, we first need to define the *cost contributors.* These form the inputs for all subsequent cost calculations and therefore changing these starting inputs will materially affect the resultant costs.

Accordingly, the method adopted is:

1. Identify the things which contribute to the total cost of the project and derive formulae to calculate the cost of each;
2. Determine the values for each factor identified in Step 1; and
3. Evaluate the formulae, and use the component costs and the number of each to determine total costs.

Step 1 – Identify Cost Contributors and Formulae

The cost contributors are all those components identified above, plus any other miscellaneous costs, such as those arriving from third-party service fees.

Cost Contributors

The following table below describes the cost contributors not already described above.

Cost Contributor	Description
Gantries	Gantry sizes vary from project to project depending on the width of the tolled road. Costs are described for each size.
Integration and testing	Cost to install, integrate, test the roadside ITS components. Includes project management and documentation.
Back office – account cost	Cost to maintain a single tag account in the back office. Cost will include the system, staffing overheads, and facilities.
Back office – video cost	Cost to process a single video toll in the back office. Cost will include the system, staffing overheads, and facilities. This cost is higher than the cost for a tag account because of the increased manual nature of the processes (such as image review).
Account acquisition cost	Cost to acquire tag accounts. Includes marketing, correspondence, and account set-up costs.
Payment card processing fee	Fee paid to credit card company to process credit card payments.
DMV lookup (in-state)	Fee to obtain the owner details for a vehicle registered in Connecticut.
DMV lookup (out-of-state)	Fee to obtain the owner details for a vehicle not registered in Connecticut.
Collection agency collection fees	Fee paid to agency to collect unpaid tolls and fines.

Calculating Cost Contributor Costs

The following table holds all the cost contributors for a particular project, along with the formulae used to calculate the capital and operating and maintenance (O&M) costs of each. The total cost of each ITS component is determined by its initial capital costs and replacement capital and O&M costs throughout the lifespan of the project.

Other components have a more complicated formula to calculate their cost, which are also detailed below.

	Cost Contributor	Capital Cost	O&M Cost
Roadside	Tags	Capital cost plus capital replacement cost through project lifespan.	(Yearly O&M cost multiplied by project lifespan.
	HOT lane tags	As above.	As above.
	Gantry	As above.	As above.
	Tag reader/antenna units	As above.	As above.
	Image capture units	As above.	As above.
	CCTV surveillance cameras	As above.	As above.
	Vehicle detection unit	As above.	As above.
	Dynamic messaging signs	As above.	As above.
	Static signs	As above.	As above.
	Vehicle classification units	As above.	As above.
	Vehicle separation detection units	As above.	As above.
	Roadside computing	As above.	As above.
	Power connections	As above.	As above.
	Comms – fiber	As above.	Assumed zero – minimal O&M costs associated with fiber once installed.
	Comms – switch boxes	As above.	Yearly O&M cost multiplied by project lifespan.
	Service trucks	Assume leased trucks and hence no capital cost.	Service truck hourly operational cost multiplied by number of hours operating per day multiplied by number of days a year on which projects charge tolls multiplied by project lifespan.
	Roadside law enforcement officers	Assume no capital cost to hire staff.	Law enforcement hourly operational cost multiplied by number of hours operating per day multiplied by number of days a year on which projects charge tolls multiplied by project lifespan.
	Integration and testing	Assumed 100% of ITS capital costs.	Only applies at installation hence no carries no O&M costs.
Back Office	Pre-implementation staff	Assume no capital cost to hire staff.	Staff salary multiplied by number of years to implement project.
	Post-implementation staff	Assume no capital cost to hire staff.	Staff salary multiplied by project lifespan.
	Back office – account cost	Capital cost plus capital replacement cost through project lifespan.	• This cost rises linearly depending on the number of accounts, but for back offices with very small and very large numbers of accounts we use a slightly amended method. • There is a certain minimum cost of a back office, regardless of number of accounts. This cost covers things that are minimally required like facilities, staff, and systems. • At the other end of the scale, there are a certain number of accounts beyond which economies of scale are achievable and addi-

Cost Contributor	Capital Cost	O&M Cost
		tional accounts beyond this number are cheaper to add. • Thus, this cost is calculated as follows. • If number of accounts is less than or equal to the "Minimum number of accounts for back office," then cost equals Minimum number of accounts for back office multiplied by cost per account. • If between minimum and economy of scale number of accounts threshold, then cost equals number of accounts multiplied by cost per account. • If over economy of scale number of accounts, then cost equals: • (Economy of scale number of accounts multiplied by Charge per account); plus • (Number of accounts over threshold multiplied by Discount Charge per account).
Back office – video cost	Assumed included in the above "back office – account capital cost."	(Number of video transactions multiplied by cost to process a video transaction) plus (Number of video notices sent multiplied by cost per video notice).
Walk-in customer service centers	Capital cost plus capital replacement cost through project lifespan.	Yearly O&M cost multiplied by project lifespan.
Retail channels	Capital cost plus capital replacement cost through project lifespan.	Yearly O&M cost multiplied by project lifespan.
Account acquisition cost	N/A	Number of accounts multiplied by account acquisition fee per account.
Payment card processing fee	Ongoing service, so assume no capital cost.	Credit card processing percentage fee multiplied by percent revenue that is collected via credit card.
DMV lookup (in-state)	Ongoing service, so assume no capital cost.	Number of video transactions multiplied by percentage of video transactions which are looked up at DMV multiplied by percentage of transactions which are from in-state vehicle multiplied by fee applied per DMV in-state lookup.
DMV lookup (out-of-state)	Ongoing service, so assume no capital cost.	As above but for out-of-state vehicles.
Collection agency collection fees	Ongoing service, so assume no capital cost.	Number of video transaction multiplied by percentage of transactions sent to collection agency multiplied by average toll value multiplied by percentage fee taken by toll collection agency.

Step 2 – Determine Values for Each Formula Factor

This step assigns a value to each formula factor identified in Step 1 above.

Generic Factors

Generic factors have the same value for all projects. The table below holds the values for these generic factors which are the unit costs or lifespans of each component.

	Cost Contributor	Factors			
		Unit Capital Cost ($K)	Unit Operating Cost ($K)	Lifespan	Rationale for Unit Costs
Roadside Components	Tags	0.018	0	5	ITS industry estimates
	HOT lane tags	0.023	0	5	
	Gantry (4-6 lanes)	250	0.15	30	
	Gantry (2-3 lanes)	200	0.15	30	
	Gantry (1 lane)	75	0.15	30	
	Tag reader/antenna units[a]	9	10% of capital cost	8	
	Image capture units[a]	8	10% of cap	8	
	CCTV surveillance cameras[a]	9	10% of cap	8	
	Vehicle detection unit[a]	10	10% of cap	8	
	Dynamic messaging signs[a]	50	10% of cap	8	
	Static signs	10	0.5	15	
	Vehicle classification units[a]	20	10% of cap	8	
	Vehicle separation detection unit*	10	10% of cap	8	
	Roadside computing[a]	60	10% of cap	8	
	Power connections	50	12	30	
	Comms – fiber	0.029 per foot[b]	<0.001	30	
	Comms – switch boxes	55	2.5% of cap	8	
	Service trucks	0	0.06 ph	N/A	
	Roadside law enforcement officers	0	0.04 ph	N/A	
	Integration and testing (ITS components only)	100% of capital costs	0	N/A	
Back Office Components	Pre-implementation staff	0	150 pa	N/A	ITS industry estimates
	Post-implementation staff	0	150 pa	N/A	
	Back office	1000	Project-specific (dependent on number of accounts/ transactions)	10	
	Walk-in customer service centers	125	500	10	
	Retail channels	3	1	5	

[a] Denotes ITS component.

[b] There is already an existing network of communications fiber in Connecticut. This costing assumes re-use of this network where possible, with new fiber laid where none exists already. However, the use of this existing fiber is explicitly for Incident Management System purposes only, and unauthorized use of this fiber may result in reimbursement to FHWA of the installation costs.

The following table holds the values for miscellaneous generic factors, for example, those related to third-party services.

Generic Factor	Value	Notes
Credit card processing percentage fee	2.5%	Fee paid to credit card company to process credit card payments. Assumed average fee is 2.5% of toll revenue paid via card, which is a reasonably standard rate across the card industry.
Fee applied per DMV lookup (in-state)	$0	Fee to obtain the owner details for a vehicle registered in Connecticut. Assumed ConnDOT would have arrangement with CT DMV so priced at $0.
Fee applied per DMV lookup (out-of-state)	$0.10	Fee to obtain the owner details for a vehicle not registered in Connecticut. Price would vary, with some states offering free service, others charging. Once a plate has been looked up once, some states allow the data to be retained and used for a period of time if that plate is seen again. Based on these factors a $0.10 average based on industry estimates was used.
Percentage fee taken by toll collection agency	15%	Fee paid to agency to collect unpaid tolls and fines. Assumed 15% of tolls/fines collected based on industry estimates.
Account acquisition cost	$10	Cost to acquire tag accounts. Includes marketing, correspondence and account set-up costs. Cost based on industry estimates.
Service truck number of hours operating per day	12	Service trucks would normally operate during the busiest hours, typically 7:00 a.m.-7:00 p.m.
Law enforcement operating hours per day	12	Law enforcement would normally operate during the busiest hours, although this might be comprised of more than one shift, split up throughout the period.
Number of days a year on which projects charge tolls	313	Assumed on average 6 days a week would be charged.
Minimum number of accounts (for back office)	80,000	Minimum number of accounts beneath which back office account costs cannot be reduced (even if the actual number of accounts is less than this number). For example, a back office with 50,000 accounts will still incur the costs of a back office with 80,000 accounts.
Charge per account (back office)	$1.25	Assuming the back office services are leased from a supplier, this is the cost per tag account administered. Value based on industry estimates.
Economy of scale number of accounts threshold (for back office)	500,000	Beyond this threshold, the per account cost is can be discounted due to the large number of accounts.
Discount charge per account (back office)	$0.95	Discounted charge per account for a back office on a contract basis. When there are a large number of accounts (greater than 500,000 – the Economy of Scale number of accounts threshold) the account charge is this amount.
Cost to process a video transaction (back office)	$0.03	Cost per video transaction processed in the back office.
Cost per video notice (back office)	$2.25	Assuming the back office services are leased from a supplier, this is the cost per video transaction processed. Value based on industry estimates. (A bill is assumed to be sent per two or four trips, depending on concept. A lower number – closer to or equal to two – is indicative of an environment with relatively small number of trips being taken. In other words, violators will likely not take that many trips before a violation notice is sent to them.)
Project lifespan (years)	30	This is the number of years that all projects are currently planned for.

Project-Specific Factors

Project-specific factors vary in value from project to project. The below table provides justifications for the values assigned to each factors, and the following table provides the values themselves.

Project-Specific Factor	Rationale
Number of accounts	The total number of accounts, both tag and video accounts. It is estimated by multiplying the number of estimated daily trips by a concept-specific factor, which varies by concept. This decision is based on observations of the relationship between number of accounts and daily trips across U.S. toll facilities, which suggest an account to daily trip ratio of 1:4. However for concepts with a larger number of trips, then this factor could be closer or equal to 2.
Number of video transactions	The number of transactions that are incurred via video (not tag).
Number of video notices sent	The number of notices sent based on video captured violations. This can be for every two or four trips. (A lower number – closer to or equal to two – is indicative of an environment with relatively small number of trips. In other words, violators will likely not take that many trips before a violation notice is sent to them.)
Number of years to implement project	The number of years required for pre-implementation staff to implement the project in full.
Percent revenue that is collected via credit card	The percentage of revenue that is collected by the back office via credit card.
Percentage of video transactions which are looked up at DMV	The percentage of video transactions that result in a DMV lookup because the back office does not have violator details associated with the captured license plate data.
Percentage of transactions which are from in-state vehicle	The percentage of all transactions which are from Connecticut registered vehicles.
Percentage of transactions which are from out-of-state vehicle	The percentage of all transactions which are from non-Connecticut registered vehicles.
Percentage of transactions sent to collection agency	The percentage of transactions that will need to be sent to a collection agency due to the violator not paying in response to a notice received regarding the violation.
Average toll value	The assumed value of the toll when passing each tolling point.

Project-Specific Factor	Express Lanes			Bdr	TOT	HOV to HOT			Toll Existing			All LAH	Con-gested
	A1	**A2**	**A3**	**B**	**C**	**D1**	**D2**	**D3**	**F1**	**F2**	**F3**	**G1**	**H**
Number of accounts	Varies by year												
Number of video transactions	Varies by year												
Number of video notices sent	Varies by year												
Number of years to implement project	5	5	5	4	7	3	3	3	5	5	5	7	6
Percent revenue that is collected via credit card	85%	85%	85%	85%	75%	85%	85%	85%	85%	85%	85%	85%	85%
Percentage of video transactions which are looked up at DMV	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Percentage of transactions which are from in-state vehicle	50%	50%	50%	50%	34%	75%	75%	75%	50%	50%	50%	75%	50%
Percentage of transactions sent to collection agency	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Average toll value (at year 1)	$0.31	$0.31		$0.31	Varies by toll rate	$0.04		$0.05	$0.05		Varies by toll rate	$4.64	

Step 3 – Use the unit costs and number of components to determine total costs

Overall costs for each concept/project are shown below. In order to arrive at these figures, we simply evaluate the formulas as described in Step 1 for "unit" cost and then multiply by the number of units needed for the project.

Concept A1

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$9,670,662	$0	$9,670,662
	Gantry (1 lane)	$9,300,000	$5,580,000	$14,880,000
	Tag reader/antenna units[a]	$8,928,000	$6,696,000	$15,624,000
	Image capture units[a]	$7,936,000	$5,952,000	$13,888,000
	CCTV surveillance cameras[a]	$4,147,200	$3,110,400	$7,257,600
	Vehicle detection unit[a]	$9,216,000	$6,912,000	$16,128,000
	Dynamic messaging signs[a]	$24,800,000	$9,300,000	$34,100,000
	Static signs	$3,720,000	$2,790,000	$6,510,000
	Vehicle separation detection units*	$2,480,000	$1,860,000	$4,340,000
	Roadside computing[a]	$14,880,000	$11,160,000	$26,040,000
	Power connections	$3,100,000	$22,320,000	$25,420,000
	Communications – fiber	$6,990,400	$0	$6,990,400
	Communications – tolling point switchbox	$1,440,000	$270,000	$1,710,000
	Service trucks	$0	$19,471,104	$19,471,104
	Roadside law enforcement officers	$0	$17,307,648	$17,307,648
	System installation, integration, testing, documentation and project management	$83,917,600	$0	$83,917,600

Back Office Components	Pre-implementation staff	$0	$12,000,000	$12,000,000
	Post-implementation staff	$0	$13,200,000	$13,200,000
	Back office – account cost	$3,000,000	$38,314,750	$41,314,750
	Back office – video cost	$0	$3,149,972	$3,149,972
	Walk-in customer service centers	$125,000	$3,500,000	$3,625,000
	Retail channels	$2,073,600	$3,456,000	$5,529,600
	Account acquisition cost	$0	$1,296,230	$1,296,230
	Payment card processing fee	$0	$3,996,573	$3,996,573
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$494,176	$494,176
	Collection agency collection fees	$0	$152,471	$152,471

	Total Project Cost	**$195,724,462**	**$192,289,324**	**$388,013,786**

Concept A2

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$7,565,634	$0	$7,565,634
	Gantry (1 lane)	$5,100,000	$3,060,000	$8,160,000
	Tag reader/antenna units[a]	$4,896,000	$3,672,000	$8,568,000
	Image capture units[a]	$4,352,000	$3,264,000	$7,616,000
	CCTV surveillance cameras[a]	$2,296,800	$1,722,600	$4,019,400
	Vehicle detection unit[a]	$5,104,000	$3,828,000	$8,932,000
	Dynamic messaging signs[a]	$13,600,000	$5,100,000	$18,700,000
	Static signs	$2,040,000	$1,530,000	$3,570,000
	Vehicle separation detection units*	$1,360,000	$1,020,000	$2,380,000
	Roadside computing[a]	$8,160,000	$6,120,000	$14,280,000
	Power connections	$1,700,000	$12,240,000	$13,940,000
	Communications – fiber	$4,999,840	$0	$4,999,840
	Communications – tolling point switchbox	$880,000	$165,000	$1,045,000
	Service trucks	$0	$10,783,476	$10,783,476
	Roadside law enforcement officers	$0	$9,585,312	$9,585,312
	System installation, integration, testing, documentation and project management	$47,348,640	$0	$47,348,640
Back Office Components	Pre-implementation staff	$0	$12,000,000	$12,000,000
	Post-implementation staff	$0	$13,200,000	$13,200,000
	Back office – account cost	$3,000,000	$36,000,797	$39,000,797
	Back office – video cost	$0	$2,723,513	$2,723,513
	Walk-in customer service centers	$125,000	$500,000	$625,000
	Retail channels	$1,148,400	$1,914,000	$3,062,400
	Account acquisition cost	$0	$800,532	$800,532
	Payment card processing fee	$0	$3,386,931	$3,386,931
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$423,602	$423,602
	Collection agency collection fees	$0	$132,040	$132,040
	Total Project Cost	**$113,676,314**	**$133,171,803**	**$246,848,117**

Concept A All

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$17,236,206	$0	$17,236,206
	Gantry (1 lane)	$14,400,000	$8,640,000	$23,040,000
	Tag reader/antenna units[a]	$13,824,000	$10,368,000	$24,192,000
	Image capture units[a]	$12,288,000	$9,216,000	$21,504,000
	CCTV surveillance cameras[a]	$6,444,000	$4,833,000	$11,277,000
	Vehicle detection unit[a]	$14,320,000	$10,740,000	$25,060,000
	Dynamic messaging signs[a]	$38,400,000	$14,400,000	$52,800,000
	Static signs	$5,760,000	$4,320,000	$10,080,000
	Vehicle separation detection units*	$3,840,000	$2,880,000	$6,720,000
	Roadside computing[a]	$23,040,000	$17,280,000	$40,320,000
	Power connections	$4,800,000	$34,560,000	$39,360,000
	Communications – fiber	$11,990,240	$0	$11,990,240
	Communications – tolling point switchbox	$2,320,000	$435,000	$2,755,000
	Service trucks	$0	$30,254,580	$30,254,580
	Roadside law enforcement officers	$0	$26,892,960	$26,892,960
	System installation, integration, testing, documentation and project management	$131,266,240	$0	$131,266,240
Back Office Components	Pre-implementation staff	$0	$15,000,000	$15,000,000
	Post-implementation staff	$0	$16,500,000	$16,500,000
	Back office – account cost	$3,000,000	$48,704,941	$51,704,941
	Back office – video cost	$0	$5,873,485	$5,873,485
	Walk-in customer service centers	$250,000	$4,000,000	$4,250,000
	Retail channels	$3,222,000	$5,370,000	$8,592,000
	Account acquisition cost	$0	$2,070,837	$2,070,837
	Payment card processing fee	$0	$7,383,504	$7,383,504
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$917,778	$917,778
	Collection agency collection fees	$0	$285,036	$285,036
	Total Project Cost	**$306,400,686**	**$280,925,122**	**$587,325,808**

Concept B

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below holds the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$281,380,698	$0	$281,380,698
	Gantry (3 lane)	$5,600,000	$1,260,000	$6,860,000
	Tag reader/antenna units	$4,032,000	$3,024,000	$7,056,000
	Image capture units	$7,168,000	$5,376,000	$12,544,000
	CCTV surveillance cameras	$1,008,000	$756,000	$1,764,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$2,800,000	$1,050,000	$3,850,000
	Static signs	$840,000	$630,000	$1,470,000
	Vehicle classification units	$3,360,000	$2,520,000	$5,880,000
	Roadside computing	$3,360,000	$2,520,000	$5,880,000
	Power connections	$700,000	$5,040,000	$5,740,000
	Communications – fiber	$0	$3,600,000	$3,600,000
	Communications – tolling point switches	$200,000	$37,500	$237,500
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$31,550,400	$31,550,400
	System installation, integration, testing, documentation and project management	$19,828,000	$0	$19,828,000
Back Office Components	Pre-implementation staff	$0	$9,600,000	$9,600,000
	Post-implementation staff	$0	$26,400,000	$26,400,000
	Back office – account cost	$3,000,000	$589,731,867	$592,731,867
	Back office – video cost	$0	$278,878,936	$278,878,936
	Walk-in customer service centers	$1,500,000	$60,000,000	$61,500,000
	Retail channels	$1,260,000	$2,100,000	$3,360,000
	Account acquisition cost	$0	$19,279,361	$19,279,361
	Payment card processing fee	$0	$193,686,051	$193,686,051
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$17,650,566	$17,650,566
	Collection agency collection fees	$0	$22,725,377	$22,725,377
	Total Project Cost	**$338,836,698**	**$1,277,416,058**	**$1,616,252,756**

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which will differ from those under toll rate 1.

The table below identifies the total costs for the technical components that are different from that calculated for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$296,122,842	$0	$296,122,842
Back Office Components	Back office – account cost	$3,000,000	$606,861,362	$609,861,362
	Back office – video cost	$0	$271,999,690	$271,999,690
	Walk-in customer service centers	$1,500,000	$60,000,000	$61,500,000
	Account acquisition cost	$0	$23,941,406	$23,941,406
	Payment card processing fee	$0	$406,929,548	$406,929,548
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$17,215,170	$17,215,170
	Collection agency collection fees	$0	$51,624,793	$51,624,793

The following table is the new total cost, factoring in the above changed component costs for the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total project cost	**$353,578,842**	**$1,534,035,869**	**$1,887,614,711**

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which will differ from under toll rate 1.

The table below holds the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$236,708,874	$0	$236,708,874
Back Office Components	Back office – account cost	$3,000,000	$504,760,609	$507,760,609
	Back office – video cost	$0	$234,524,093	$234,524,093
	Walk-in customer service centers	$1,500,000	$60,000,000	$61,500,000
	Account acquisition cost	$0	$16,103,259	$16,103,259
	Payment card processing fee	$0	$740,894,255	$740,894,255
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$14,843,297	$14,843,297
	Collection agency collection fees	$0	$95,272,246	$95,272,246

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	**$294,164,874**	**$1,761,861,659**	**$2,056,026,533**

Concept C

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below identifies the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$76,369,950	$0	$76,369,950
	Gantry (3 lane)	$284,000,000	$63,900,000	$347,900,000
	Tag reader/antenna units	$204,480,000	$153,360,000	$357,840,000
	Image capture units	$363,520,000	$272,640,000	$636,160,000
	CCTV surveillance cameras	$51,120,000	$38,340,000	$89,460,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$142,000,000	$53,250,000	$195,250,000
	Static signs	$42,600,000	$31,950,000	$74,550,000
	Vehicle classification units	$170,400,000	$127,800,000	$298,200,000
	Roadside computing	$170,400,000	$127,800,000	$298,200,000
	Power connections	$35,500,000	$255,600,000	$291,100,000
	Communications – fiber	$89,927,376	$0	$89,927,376
	Communications – tolling point switch	$14,600,000	$2,737,500	$17,337,500
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$176,471,904	$176,471,904
	System installation, integration, testing, documentation and project management	$1,099,947,376	$0	$1,099,947,376
Back Office Components	Pre-implementation staff	$0	$16,800,000	$16,800,000
	Post-implementation staff	$0	$26,400,000	$26,400,000
	Back office – account cost	$3,000,000	$194,129,878	$197,129,878
	Back office – video cost	$0	$74,388,582	$74,388,582
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Retail channels	$0	$0	$0
	Account acquisition cost	$0	$5,138,658	$5,138,658
	Payment card processing fee	$0	$222,412,867	$222,412,867
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$48,115,518	$48,115,518
	Collection agency collection fees	$0	$16,983,386	$16,983,386
	Total Project Cost	**$2,890,614,702**	**$1,938,218,292**	**$4,828,832,994**

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which differs from those under toll rate 1.

The below table identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$75,927,690	$0	$75,927,690
Back Office Components	Back office – account cost	$3,000,000	$193,015,696	$196,015,696
	Back office – video cost	$0	$73,957,334	$73,957,334
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Account acquisition cost	$0	$5,108,946	$5,108,946
	Payment card processing fee	$0	$329,180,767	$329,180,767
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$47,836,581	$47,836,581
	Collection agency collection fees	$0	$25,136,317	$25,136,317

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	**$2,890,172,442**	$2,051,285,044	$4,941,457,486

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which differs from those under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$75,695,040	$0	$75,695,040
Back Office Components	Back office – account cost	$3,000,000	$192,428,265	$195,428,265
	Back office – video cost	$0	$73,732,077	$73,732,077
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Account acquisition cost	$0	$5,093,163	$5,093,163
	Payment card processing fee	$0	$447,913,063	$447,913,063
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$47,690,882	$47,690,882
	Collection agency collection fees	$0	$34,202,459	$34,202,459

The following table provides the total cost for toll rate 3, factoring in the changed component costs, given the different toll rate.

	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	**$2,889,939,792**	$2,178,109,313	$5,068,049,105

Concept D1

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$6,052,703	$0	$6,052,703
	Gantry (1 lane)	$300,000	$180,000	$480,000
	Tag reader/antenna units	$288,000	$216,000	$504,000
	Image capture units	$256,000	$192,000	$448,000
	CCTV surveillance cameras	$792,000	$594,000	$1,386,000
	Vehicle detection unit	$1,760,000	$1,320,000	$3,080,000
	Dynamic messaging signs	$800,000	$300,000	$1,100,000
	Static signs	$120,000	$90,000	$210,000
	Vehicle separation detection units	$80,000	$60,000	$140,000
	Roadside computing	$480,000	$360,000	$840,000
	Power connections	$100,000	$720,000	$820,000
	Communications – fiber	$0	$0	$0
	Communications – tolling point switches	$240,000	$45,000	$285,000
	Service trucks	$0	$6,760,800	$6,760,800
	Roadside law enforcement officers	$0	$4,507,200	$4,507,200
	System installation, integration, testing, documentation and project management	$4,796,000	$0	$4,796,000
Back Office Components	Pre-implementation staff	$0	$3,600,000	$3,600,000
	Post-implementation staff	$0	$13,200,000	$13,200,000
	Back office – account cost	$3,000,000	$36,000,000	$39,000,000
	Back office – video cost	$0	$1,905,961	$1,905,961
	Walk-in customer service centers	$0	$0	$0
	Retail channels	$396,000	$660,000	$1,056,000
	Account acquisition cost	$0	$356,808	$356,808
	Payment card processing fee	$0	$1,302,413	$1,302,413
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$60,315	$60,315
	Collection agency collection fees	$0	$41,436	$41,436
	Total Project Cost	**$19,460,703**	**$72,471,932**	**$91,932,635**

Concept D2

	Component Required	Total Capital Cost	Total O&M Cost	Total cost
Roadside Components	Tags	$13,416,889	$0	$13,416,889
	Gantry (1 lane)	$300,000	$180,000	$480,000
	Tag reader/antenna units	$288,000	$216,000	$504,000
	Image capture units	$256,000	$192,000	$448,000
	CCTV surveillance cameras	$576,000	$432,000	$1,008,000
	Vehicle detection unit	$1,280,000	$960,000	$2,240,000
	Dynamic messaging signs	$800,000	$300,000	$1,100,000
	Static signs	$120,000	$90,000	$210,000
	Vehicle separation detection units	$80,000	$60,000	$140,000
	Roadside computing	$480,000	$360,000	$840,000
	Power connections	$100,000	$720,000	$820,000
	Communications – fiber	$0	$0	$0
	Communications – tolling point switch	$240,000	$45,000	$285,000
	Service trucks	$0	$6,760,800	$6,760,800
	Roadside law enforcement officers	$0	$4,507,200	$4,507,200
	System installation, integration, testing, documentation and project management	$4,100,000	$0	$4,100,000
Back Office Components	Pre-implementation staff	$0	$3,600,000	$3,600,000
	Post-implementation staff	$0	$13,200,000	$13,200,000
	Back office – account cost	$3,000,000	$36,000,000	$39,000,000
	Back office – video cost	$0	$4,283,734	$4,283,734
	Walk-in customer service centers	$0	$0	$0
	Retail channels	$288,000	$480,000	$768,000
	Account acquisition cost	$0	$780,118	$780,118
	Payment card processing fee	$0	$2,677,840	$2,677,840
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$135,561	$135,561
	Collection agency collection fees	$0	$84,658	$84,658
	Total Project Cost	**$25,324,889**	**$76,064,910**	**$101,389,799**

Concept D All

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$19,469,569	$0	$19,469,569
	Gantry (1 lane)	$600,000	$360,000	$960,000
	Tag reader/antenna units	$576,000	$432,000	$1,008,000
	Image capture units	$512,000	$384,000	$896,000
	CCTV surveillance cameras	$1,368,000	$1,026,000	$2,394,000
	Vehicle detection unit	$3,040,000	$2,280,000	$5,320,000
	Dynamic messaging signs	$1,600,000	$600,000	$2,200,000
	Static signs	$240,000	$180,000	$420,000
	Vehicle separation detection units	$160,000	$120,000	$280,000
	Roadside computing	$960,000	$720,000	$1,680,000
	Power connections	$200,000	$1,440,000	$1,640,000
	Communications – fiber	$0	$0	$0
	Communications – tolling point switchbox	$480,000	$90,000	$570,000
	Service trucks	$0	$6,760,800	$6,760,800
	Roadside law enforcement officers	$0	$5,709,120	$5,709,120
	System installation, integration, testing, documentation and project management	$8,896,000	$0	$8,896,000
Back Office Components	Pre-implementation staff	$0	$4,500,000	$4,500,000
	Post-implementation staff	$0	$16,500,000	$16,500,000
	Back office – account cost	$3,000,000	$40,427,829	$43,427,829
	Back office – video cost	$0	$6,189,694	$6,189,694
	Walk-in customer service centers	$0	$0	$0
	Retail channels	$684,000	$1,140,000	$1,824,000
	Account acquisition cost	$0	$1,136,925	$1,136,925
	Payment card processing fee	$0	$3,980,253	$3,980,253
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$195,876	$195,876
	Collection agency collection fees	$0	$126,410	$126,410
	Total Project Cost	**$41,785,569**	**$94,298,442**	**$136,084,011**

Concept F1

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below identifies the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$309,487,842	$0	$309,487,842
	Gantry (3 lane)	$24,800,000	$5,580,000	$30,380,000
	Tag reader/antenna units	$17,856,000	$13,392,000	$31,248,000
	Image capture units	$31,744,000	$23,808,000	$55,552,000
	CCTV surveillance cameras	$4,464,000	$3,348,000	$7,812,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$12,400,000	$4,650,000	$17,050,000
	Static signs	$3,720,000	$2,790,000	$6,510,000
	Vehicle classification units	$14,880,000	$11,160,000	$26,040,000
	Roadside computing	$14,880,000	$11,160,000	$26,040,000
	Power connections	$3,100,000	$22,320,000	$25,420,000
	Communications – fiber	$6,990,400	$0	$6,990,400
	Communications – tolling point switch	$1,440,000	$270,000	$1,710,000
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$17,307,648	$17,307,648
	System installation, integration, testing, documentation and project management	$95,354,400	$0	$95,354,400
Back Office Components	Pre-implementation staff	$0	$12,000,000	$12,000,000
	Post-implementation staff	$0	$26,400,000	$26,400,000
	Back office – account cost	$3,000,000	$646,132,093	$649,132,093
	Back office – video cost	$0	$250,377,648	$250,377,648
	Walk-in Customer Service Centers	$375,000	$15,000,000	$15,375,000
	Retail channels	$2,073,600	$3,456,000	$5,529,600
	Account acquisition cost	$0	$20,923,031	$20,923,031
	Payment card processing fee	$0	$138,432,806	$138,432,806
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$69,799,524	$69,799,524
	Collection agency collection fees	$0	$14,655,144	$14,655,144
	Total Project Cost	$558,965,242	$1,312,961,894	$1,871,927,136

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which will differ from those under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$280,940,940	$0	$280,940,940

Back Office Components	Back office – account cost	$3,000,000	$591,514,922	$594,514,922
	Back office – video cost	$0	$227,284,029	$227,284,029
	Walk-in customer service centers	$375,000	$15,000,000	$15,375,000
	Account acquisition cost	$0	$18,993,058	$18,993,058
	Payment card processing fee	$0	$251,330,423	$251,330,423
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$63,361,555	$63,361,555
	Collection agency collection fees	$0	$26,606,975	$26,606,975

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$530,418,340	$1,351,732,609	$1,882,150,949

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$247,298,832	$0	$247,298,832
Back Office Components	Back office – account cost	$3,000,000	$527,148,072	$530,148,072
	Back office – video cost	$0	$200,067,125	$200,067,125
	Walk-in customer service centers	$375,000	$15,000,000	$15,375,000
	Account acquisition cost	$0	$16,718,643	$16,718,643
	Payment card processing fee	$0	$331,850,646	$331,850,646
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$55,774,109	$55,774,109
	Collection agency collection fees	$0	$35,131,289	$35,131,289

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$496,776,232	$1,339,331,533	$1,836,107,765

Concept F2

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below holds the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$181,118,394	$0	$181,118,394
	Gantry (3 lane)	$13,600,000	$3,060,000	$16,660,000
	Tag reader/antenna units	$9,792,000	$7,344,000	$17,136,000
	Image capture units	$17,408,000	$13,056,000	$30,464,000
	CCTV surveillance cameras	$2,448,000	$1,836,000	$4,284,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$6,800,000	$2,550,000	$9,350,000
	Static signs	$2,040,000	$1,530,000	$3,570,000
	Vehicle classification units	$8,160,000	$6,120,000	$14,280,000
	Roadside computing	$8,160,000	$6,120,000	$14,280,000
	Power connections	$1,700,000	$12,240,000	$13,940,000
	Communications – fiber	$5,099,840	$0	$5,099,840
	Communications – tolling point switchbox	$880,000	$165,000	$1,045,000
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$9,585,312	$9,585,312
	System installation, integration, testing, documentation and project management	$60,447,840	$0	$60,447,840
Back Office Components	Pre-implementation staff	$0	$12,000,000	$12,000,000
	Post-implementation staff	$0	$26,400,000	$26,400,000
	Back office – account cost	$3,000,000	$400,802,770	$403,802,770
	Back office – video cost	$0	$147,037,781	$147,037,781
	Walk-in customer service centers	$375,000	$15,000,000	$15,375,000
	Retail channels	$1,148,400	$1,914,000	$3,062,400
	Account acquisition cost	$190,365,462	$0	$190,365,462
	Payment card processing fee	$0	$81,102,091	$81,102,091
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$40,677,661	$40,677,661
	Collection agency collection fees	$0	$8,625,336	$8,625,336
	Total Project Cost	$306,262,630	$835,301,015	$1,141,563,645

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which could differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$165,203,550	$0	$165,203,550
Back Office Components	Back office – account cost	$3,000,000	$370,330,686	$373,330,686
	Back office – video cost	$0	$134,118,065	$134,118,065
	Walk-in customer service centers	$375,000	$15,000,000	$15,375,000
	Account acquisition cost	$0	$11,141,285	$11,141,285
	Payment card processing fee	$0	$147,952,275	$147,952,275
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$37,103,452	$37,103,452
	Collection agency collection fees	$0	$15,734,941	$15,734,941

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$286,725,322	$829,131,846	$1,115,857,168

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$145,666,242	$0	$145,666,242
Back Office Components	Back office – account cost	$3,000,000	$332,920,429	$335,920,429
	Back office – video cost	$0	$118,257,194	$118,257,194
	Walk-in customer service centers	$375,000	$15,000,000	$15,375,000
	Account acquisition cost	$0	$9,823,545	$9,823,545
	Payment card processing fee	$0	$195,683,579	$195,683,579
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$32,715,578	$32,715,578
	Collection agency collection fees	$0	$20,811,210	$20,811,210

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total cost
Total Project Cost	**$273,125,322**	**$826,581,846**	**$1,099,707,168**

Concept F All

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below identifies the total costs for the technical components identified above

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$408,838,464	$0	$408,838,464
	Gantry (3 lane)	$38,400,000	$8,640,000	$47,040,000
	Tag reader/antenna units	$27,648,000	$20,736,000	$48,384,000
	Image capture units	$49,152,000	$36,864,000	$86,016,000
	CCTV surveillance cameras	$6,912,000	$5,184,000	$12,096,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$19,200,000	$7,200,000	$26,400,000
	Static signs	$5,760,000	$4,320,000	$10,080,000
	Vehicle classification units	$23,040,000	$17,280,000	$40,320,000
	Roadside computing	$23,040,000	$17,280,000	$40,320,000
	Power connections	$4,800,000	$34,560,000	$39,360,000
	Communications – fiber	$12,090,240	$0	$12,090,240
	Communications – tolling point switchbox	$2,320,000	$435,000	$2,755,000
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$26,892,960	$26,892,960
	System installation, integration, testing, documentation and project management	$149,002,240	$0	$149,002,240
Back Office Components	Pre-implementation staff	$0	$15,000,000	$15,000,000
	Post-implementation staff	$0	$33,000,000	$33,000,000
	Back office – account cost	$3,000,000	$836,445,719	$839,445,719
	Back office – video cost	$0	$397,415,429	$397,415,429
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Retail channels	$3,222,000	$5,370,000	$8,592,000
	Account acquisition cost	$0	$27,614,709	$27,614,709
	Payment card processing fee	$0	$219,534,898	$219,534,898
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$110,477,185	$110,477,185
	Collection agency collection fees	$0	$23,280,838	$23,280,838
	Total Project Cost	$796,374,944	$1,877,530,738	$2,673,905,682

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$371,787,048	$0	$371,787,048

Back Office Components	Back office – account cost	$3,000,000	$765,538,007	$768,538,007
	Back office – video cost	$0	$361,402,093	$361,402,093
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Account acquisition cost	$0	$25,111,952	$25,111,952
	Payment card processing fee	$0	$399,282,698	$399,282,698
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$100,465,006	$100,465,006
	Collection agency collection fees	$0	$42,342,569	$42,342,569

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$759,323,528	$1,956,904,285	$2,716,227,813

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$327,470,850	$0	$327,470,850
Back Office Components	Back office – account cost	$3,000,000	$836,445,719	$839,445,719
	Back office – video cost	$0	$318,324,319	$318,324,319
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Account acquisition cost	$0	$27,614,709	$27,614,709
	Payment card processing fee	$0	$219,534,898	$219,534,898
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$110,477,185	$110,477,185
	Collection agency collection fees	$0	$23,280,838	$23,280,838

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$715,007,330	$1,955,895,794	$2,670,903,124

Concept G1

Toll Rate 1

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 1 ($0.10).

The table below identifies the total costs for the technical components identified above.

	Component Required	Total capital Cost	Total O&M Cost	Total cost
Roadside Components	Tags	$363,938,670	$0	$363,938,670
	Gantry (3 lane)	$284,000,000	$63,900,000	$347,900,000
	Tag reader/antenna units	$204,480,000	$153,360,000	$357,840,000
	Image capture units	$363,520,000	$272,640,000	$636,160,000
	CCTV surveillance cameras	$51,120,000	$38,340,000	$89,460,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$142,000,000	$53,250,000	$195,250,000
	Static signs	$42,600,000	$31,950,000	$74,550,000
	Vehicle classification units	$170,400,000	$127,800,000	$298,200,000
	Roadside computing	$170,400,000	$127,800,000	$298,200,000
	Power connections	$35,500,000	$255,600,000	$291,100,000
	Communications – fiber	$89,927,376	$0	$89,927,376
	Communications – tolling point switch	$14,600,000	$2,737,500	$17,337,500
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$176,471,904	$176,471,904
	System installation, integration, testing, documentation and project management	$1,099,947,376	$0	$1,099,947,376
Back Office Components	Pre-implementation staff	$0	$37,800,000	$37,800,000
	Post-implementation staff	$0	$59,400,000	$59,400,000
	Back office – account cost	$3,000,000	$752,338,577	$755,338,577
	Back office – video cost	$0	$462,418,392	$462,418,392
	Walk-in customer service centers	$2,250,000	$90,000,000	$92,250,000
	Retail channels	$6,342,840	$10,571,400	$16,914,240
	Account acquisition cost	$0	$24,909,201	$24,909,201
	Payment card processing fee	$0	$509,465,534	$509,465,534
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$70,467,012	$70,467,012
	Collection agency collection fees	$0	$54,756,221	$54,756,221
	Total Project Cost	$3,186,026,262	$3,375,784,084	$6,561,810,346

Toll Rate 2

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 2 ($0.20), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$363,138,552	$0	$363,138,552
Back Office Components	Back office – account cost	$3,000,000	$750,624,548	$753,624,548
	Back office – video cost	$0	$461,344,960	$461,344,960
	Walk-in customer service centers	$2,250,000	$90,000,000	$92,250,000
	Account acquisition cost	$0	$24,848,115	$24,848,115
	Payment card processing fee	$0	$758,388,810	$758,388,810
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$70,293,773	$70,293,773
	Collection agency collection fees	$0	$81,510,390	$81,510,390

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$3,185,226,144	$3,648,631,400	$6,833,857,544

Toll Rate 3

This section identifies the total technology costs to implement and operate the project over 30 years under toll rate 3 ($0.30), which will differ from under toll rate 1.

The table below identifies the total costs for the technical components that are different from that identified for toll rate 1 above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$361,164,456	$0	$361,164,456
Back Office Components	Back office – account cost	$3,000,000	$746,837,656	$749,837,656
	Back office – video cost	$0	$458,837,073	$458,837,073
	Walk-in customer service centers	$2,250,000	$90,000,000	$92,250,000
	Account acquisition cost	$0	$24,713,035	$24,713,035
	Payment card processing fee	$0	$1,018,132,328	$1,018,132,328
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$69,911,653	$69,911,653
	Collection agency collection fees	$0	$109,427,223	$109,427,223

The following table is the new total cost, factoring in the changed component costs, given the different toll rate.

Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Total Project Cost	$3,183,252,048	$3,929,479,773	$7,112,731,821

Concept H

The table below identifies the total costs for the technical components identified above.

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$107,908,614	$0	$107,908,614
	Gantries (3 lane)	$48,800,000	$10,980,000	$59,780,000
	Tag reader/antenna units	$35,136,000	$26,352,000	$61,488,000
	Image capture units	$62,464,000	$46,848,000	$109,312,000
	CCTV surveillance cameras	$8,784,000	$6,588,000	$15,372,000
	Vehicle detection unit	$0	$0	$0
	Dynamic messaging signs	$24,400,000	$9,150,000	$33,550,000
	Static signs	$7,320,000	$5,490,000	$12,810,000
	Vehicle classification units	$29,280,000	$21,960,000	$51,240,000
	Roadside computing	$29,280,000	$21,960,000	$51,240,000
	Power connections	$6,100,000	$43,920,000	$50,020,000
	Communications – fiber	$8,162,240	$0	$8,162,240
	Communications – tolling point switchbox	$2,640,000	$495,000	$3,135,000
	Service trucks	$0	$0	$0
	Roadside law enforcement officers	$0	$27,313,632	$27,313,632
	System installation, integration, testing, documentation and project management	$206,246,240	$0	$206,246,240
Back Office Components	Pre-implementation staff	$0	$14,400,000	$14,400,000
	Post-implementation staff	$0	$26,400,000	$26,400,000
	Back office – account cost	$3,000,000	$285,570,714	$288,570,714
	Back office – video cost	$0	$133,909,084	$133,909,084
	Walk-in customer service centers	$750,000	$30,000,000	$30,750,000
	Retail channels	$6,544,800	$10,908,000	$17,452,800
	Account acquisition cost	$0	$7,321,758	$7,321,758
	Payment card processing fee	$0	$1,493,637,949	$1,493,637,949
	DMV lookups (in-state)	$0	$0	$0
	DMV lookups (out-of-state)	$0	$22,608,200	$22,608,200
	Collection agency collection fees	$0	$98,448,602	$98,448,602
	Total Project Cost	**$586,815,894**	**$2,303,353,221**	**$2,890,169,115**

Appendix C

Environmental Impacts

Environmental Impacts

■ 1.0 Introduction

Connecticut is a comparatively small State with diverse communities and abundant natural resources. The implementation of tolling is being considered along the State's interstate routes and state routes, along which there are a half-dozen urban areas with outlying suburban communities, which in turn have forests, farmlands, and rural towns and villages in between them. The most rural parts of Connecticut are its northeast and northwest corners, where access to interstate and state routes is more limited. A key congested interstate, I-95, follows Connecticut's coastline, often within view of the invaluable coastal resources of Long Island Sound and historic coastal villages.

The following is a preliminary environmental screening performed for each of the key resources of concern that may be affected by the tolling and congestion pricing alternatives. The document discusses the potential for environmental impacts at a macro level. The conclusions regarding the potential for impacts are intended to assist in the decision-making process as part of a comparative ranking of the project alternatives, to identify any potentially significant impacts which may be considered a 'fatal-flaw' for implementation of this alternative, and to assist in determining what level of formal environmental documentation may be appropriate if the alternative is carried forward to the next stage of design. If one or more alternatives are carried out to the conceptual design stage, a more in-depth environmental analysis will be required to comply with the National Environmental Policy Act and determine what, if any mitigation of impacts may be called-for.

Possible impacts to natural, social, and cultural resources were considered for each tolling alternative. For all alternatives, toll collection gantries are expected to be located within the highway right-of-way. It is assumed that the footprints of the individual gantries will be limited such that the potential for construction-related impacts to environmental resources will be minimal and/or there will be an opportunity to avoid any sensitive resources. However, as drivers take local alternate routes to avoid tolls, the diversion of traffic to local roads has a broad potential for adverse effects to resources and communities.

■ 2.0 Natural Resources

Because the study area associated with the electronic tolling and congestion pricing alternatives feasibility assessment essentially encompasses the entire State of Connecticut, the evaluation of natural resources relied entirely upon a review of GIS data and documentation maintained by the Connecticut Department of Environmental Protection (CTDEP). No site visits were conducted.

The physical infrastructure required for many of the identified electronic tolling and congestion pricing alternatives would be limited, and primarily includes:

- Installation of overhead gantries with minimal foundation requirements;
- Installation of fiber optic cables to allow for important communication linkages; and
- Construction of small pullout areas at select locations along toll routes to allow enforcement vehicle staging near tolling infrastructure.

None of the alternatives involve construction of toll booths capable of accommodating on-site cash transactions. This is because all financial transactions will occur electronically and will be processed by employees at a centralized office located off-site. This eliminates the need to expand the footprint of the highway at identified tolling locations, thereby significantly reducing potential impacts to nearby natural resources. Direct physical impacts to natural resources from electronic tolling alternatives would essentially be limited to spot locations where a gantry foundation could potentially encroach into a wetland or where trenching for fiber-optic cables may impact wetlands or other natural features. It is very likely that these types of natural resource impacts could be significantly avoided through appropriate planning during site selection studies.

Toll avoidance may result in indirect impacts to natural resources. To avoid paying a toll, some drivers will seek out diversion routes that bypass the toll. It is along these diversion routes that potential indirect impacts to natural resources may occur. The impacts may not be realized immediately, but over time, the addition of traffic along certain routes due to toll avoidance could potentially degrade water quality, wetlands, wildlife habitat, and other natural resources. These impacts are generally discussed below.

Natural resources considered in this technical appendix include:

- Water Resources (Surface Water Reservoirs, Rivers and Streams, Wetlands);
- Wild and Scenic Rivers, Navigable Waterways, and Coastal Resources;
- Floodplains and Stream Channel Encroachment Lines;
- Farmlands; and
- Threatened and Endangered Species.

It should be noted that some widening of I-84 and I-95 is expected in the future, which would accommodate tolling, and the construction of which may have substantive direct impacts on natural resources. Those impacts are not considered in this document because the impacts of those reconstruction projects will be addressed and mitigated as a part of formal environmental documentation during their development. Consequently, impacts of *Concept F – Toll for Highways Needing New Capacity* are only addressed in the context of the addition of tolling facilities to these roads.

Water Resources

Existing Conditions Overview

Connecticut is a State with abundant surface water resources. According to the *2006 Integrated Water Quality Report* (CTDEP, December 2006), Connecticut has approximately 5,830 miles of rivers and streams, 2,300 lakes, ponds, and reservoirs, 435,000 acres of inland wetlands, and 17,500 acres of tidal wetlands. Almost all of the State's freshwater resources are tributary to the Long Island Sound estuary. A very small portion (less than 100 square miles) is tributary to the Hudson River in New York. The following summarizes surface water resources and wetlands in Connecticut:

- Eight major drainage basins;
- Approximately 5,830 total river miles;
- 5,484 perennial stream miles;
- Intermittent stream miles;
- Two miles of ditches and canal;
- Border rivers include Byram River – New York, Pawcatuck River – Rhode Island;
- Major interstate rivers include:
  - French River – Massachusetts;
  - Quinebaug River – Massachusetts;
  - Connecticut River – Massachusetts, Vermont, New Hampshire;
  - Housatonic River – Massachusetts;
  - Tenmile River – Massachusetts; and
  - Farmington River – Massachusetts.
- 2,267 lakes/ponds/reservoir;
- 116 significant publicly owned lakes totaling 27,107 acres;
- 179 drinking water reservoirs totaling 18,604 acres;
- Approximately 64,973 acres of lakes/ponds/reservoirs;

- Approximately 613 square miles of estuaries/harbors;
- Approximately 435,000 acres of freshwater wetlands (approximately 13.6 percent of state area); and
- Approximately 17,500 acres of tidal wetlands.

Surface waters and wetlands in Connecticut are shown in Figure 1. Notable surface water resources by subarea are summarized in Table 1.

Table 1. Notable Surface Water Resources

Roadway Corridor	Geographic Subarea	Major Surface Waters
I-84 Corridor	1,000 Feet of Corridor	Housatonic River; Lake Zoar; Pomperaug River; Eightmile River; Long Meadow Pond; Quinnipiac River; Park River; Connecticut River; Hockanum River; Skungamaug River; Willimantic River; Mashapaug Pong/Bigelow River
	Danbury Metro Area	Candlewood Lake; Housatonic River, Still River
	Southbury	Pomperaug River
	Bristol/Southington	Pequabuck River; Quinnipiac River
	Hartford Metro Area	Park River; Connecticut River; Batterson Park Pond
	Manchester/Vernon	Hockanum River; Shenipsit Lake
	Tolland	Skungamaug River; Willimantic River
I-91Corridor	1,000 Feet of Corridor	Quinnipiac River; Fall River; Connecticut River; Podunk River; Poquonock River; Stony River
	New Haven Metro Area	Quinnipiac Ricer; Farm River; Lake Saltonstall; Indian River; Lake Whitney; Lake Gaillard
	Meriden	Silver Lake; Belcher River; Community Lake
	Newington	None
	Windsor Locks	Stony River; Poquonock River
I-95 Corridor	1,000 Feet of Corridor	Horseneck River; Norwalk River; Silvermine River; Housatonic River; Quinnipiac River; Lake Saltonstall; East River; Hammonasett River; Menunketesuck River; Oyster River; Connecticut River; Fourmile River; Niantic River; Thames River; Great River; Mystic River; Anguilla River; Pawcatuck River
	Stamford Metro Area	Putnam Lake; Horseneck River;
	Norwalk Metro Area	Norwalk River; Silvermine River;
	Stratford/Milford	Housatonic River; Wepawaug River
	Clinton/Madison	Deer Lake; Foster Pond; Menunketesuck River
	New London/Groton	Great River; Thames River; Latimer River; Mystic River
	Stonington	Pawcatuck River; Anguilla River;

Table 1. Notable Surface Water Resources (continued)

Roadway Corridor	Geographic Subarea	Major Surface Waters
I-395	1,000 Feet of Corridor	Whetstone River; Five Mile River; Alexander Lake; Quinnebaug River; Little Pond; Lake Konomoc; Aspinook Pond; West Thompson Lake
	Windham/Putnam	Quinebaug River; Muddy River; Roseland Lake
Route 2 Corridor	1,000 Feet of Corridor	Salmon River; Blackledge River; Lake Terramugus; Jeremy River; Bartlett River; Gardener River
	Norwich	Quinebaug River; Stony River
Route 8 Corridor	1,000 Feet of Corridor	Mill River; Aspetuck River; Housatonic River; Naugatuck River; Mad River; Hancock Brook; Leadmine Brook; Still River; Colebrook Reservoir Lake; Lake McDonough
	Bridgeport Metro Area	Mill River; Pequonnock River; Lake Forest; Aspetuck River
	Waterbury Metro Area	Hancock River; Mad River; Hitchcock Lake; Lake Winnemaug; Naugatuck River
	Torrington	Naugatuck River; Leadmine Brook; Still River
	Winchester/Winsted	Still River; Highland Lake
Route 9 Corridor	1,000 Feet of Corridor	Connecticut River; Summer River; Shebethe River; Belcher River; Rogero Lake
	Middletown/East Hampton	Shebethe River; Connecticut River; Lake Pocotopaug
Merritt Parkway	1,000 Feet of Corridor	Putnam Lake; Horseneck River; Norwalk River; Saugatuck River; Aspetuck River; Mill River; Pequonnock River; Wepawaug River; Konolds Pond; Quinnipiac River; Muddy River;

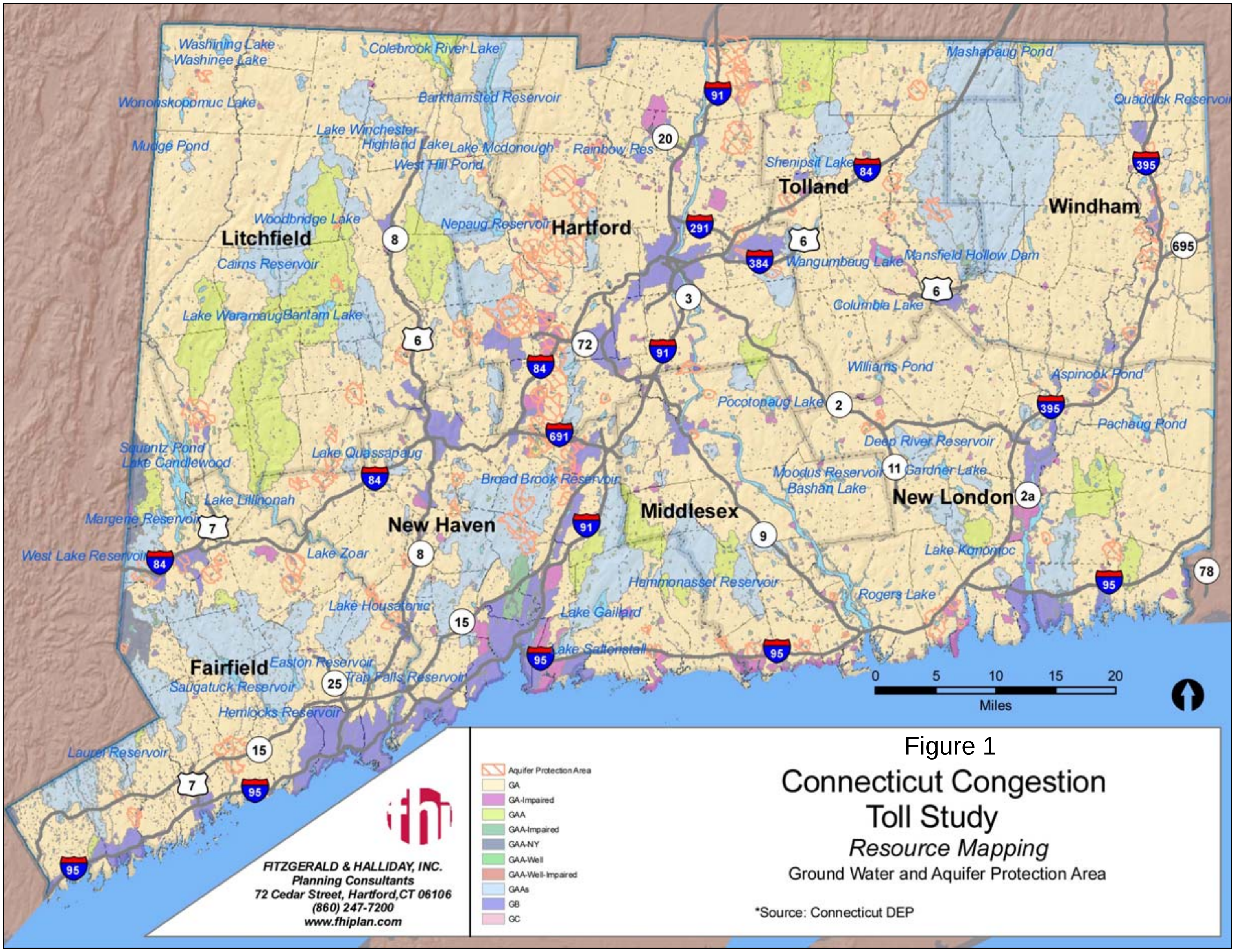

Figure 1
Connecticut Congestion Toll Study
Resource Mapping
Ground Water and Aquifer Protection Area

Impacts

Impacts to surface water resources are generally assessed in terms of potential changes in storm water runoff volume or quality, physical water body modifications, or fill. Impacts to wetlands are generally assessed in similar terms and include potential for displacement or loss of wetlands and their associated functions and values due to project construction. Potential physical direct impacts to surface waters and wetlands from the proposed tolling alternatives are expected to be minor and localized, since the tolling infrastructure foot-print is generally very limited in size as previously mentioned. The potential does exist; however, for indirect impacts to these resources due to an increased volume of traffic along diversion routes. Of particular concern would be those diversion routes that run parallel to important high-quality water resources such as surface drinking water reser-voirs, headwaters or other reaches of high-quality cold water streams capable of supporting a diversity of fish and wildlife species, or other important water resources notable for their high-quality and community importance. Increased traffic along these diversion routes could lead to increased deposition of vehicular contaminants on roadway surfaces which could be carried by storm water runoff into receiving waters. The drain-age systems along many of these secondary roadways often do not have the same level of engineering sophistication as the drainage systems associated with the State's limited access highways. As a result, drainage from some of these diversion routes may discharge directly into receiving waters with little or no pretreatment.

There may also be a concern that increased traffic along potential diversion routes, par-ticularly heavy truck traffic, could increase the probability of vehicular accidents. This could increase the potential for localized water quality degradation from spills of hazard-ous materials. Lastly, there is also the potential that increased traffic due to toll avoidance could reduce public safety along a particular diversion route. This could lead to localized actions, such as roadway construction to improve safety. Depending on the types of local roadway improvements, potential impacts to adjacent surface waters and wetlands could occur, which would also be an indirect impact of the original tolling project.

Overall, the direct physical impacts to wetlands and surface water resources from each of the tolling and congestion pricing alternatives will be minimal and extremely limited. However, the potential for indirect impacts to these resources does exist, due to toll avoid-ance behavior that leads to increased traffic along diversion routes. The assessment of indi-rect impacts is, therefore, a much more complicated issue. The following is a brief summary of the anticipated water quality and wetland impacts associated with each of the proposed tolling and congestion pricing alternatives. Impacts are subdivided into three categories; No Effect, Potential Minor Adverse Effects, and Potential Significant Adverse Effects.

- **No Effect – Primarily Due to No Diversion of Traffic**
  - *Concept A – New Toll Express Lanes on I-84 and I-95* – New express toll lanes will attract traffic, but general purpose lanes will remain available. There will be a need to lay fiber optic cables to support communications with field equipment; however, direct physical impacts to wetlands and water resources can be effec-tively avoided with proper planning and appropriate best management practices and erosion/sedimentation control measures during construction/trenching.

  - *Concept D – HOV to HOT Lane Conversion* – New HOT lanes will attract traffic, but general purpose lanes will remain available. There will be a need to lay fiber optic cables to support communications with field equipment; however, direct physical impacts to wetlands and water resources can be effectively avoided with proper planning and appropriate best management practices and erosion/sedimentation control measures during construction/trenching.
  - *Concept G2 – Tax on all Vehicle Miles of Travel* – The impacts of tolling will be felt statewide and distributed across the State such that diversions of traffic are not expected to occur.

- **Potential Minor Adverse Effects:**
  - *Concept B – Border Tolling at Major Highways* – This alternative would result in the diversion of traffic to local alternate routes. While the diversion routes would not be any longer than the main highway routes, traffic diversion could have minor indirect adverse impacts to wetlands and water resources located along these diversion routes for the reasons described above. Notable rivers that could be affected based on identified diversion routes include the Byram River (I-95 Connecticut/New York), Mashapaug Pond (I-84 Connecticut/Massachusetts), Little Pond (I-395 Connecticut/Massachusetts), Still River (I-84 Connecticut/New York), Bog Meadow Reservoir, and Alva Chase Reservoir (Route 6 Connecticut/Rhode Island). In addition to these notable water resources, countless wetlands and small streams exist along identified diversion routes.

    In terms of direct physical impacts, some fiber optic cables will be laid to support communication with field equipment. This will not be required at every border toll location as leased data lines may be used where available. Regardless, the laying of fiber optic lines can effectively avoid impacting wetlands and water resources with proper planning and appropriate best management practices and erosion/sedimentation control measures during construction/trenching.
  - *Concept C – Toll Trucks on Limited Access Highways* – Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Nonetheless, additional truck traffic on local roads, especially tractor trailers, can pose traffic safety issues that can lead to increased accident frequency. During accidents, the potential exists for hazardous materials to spill onto the roadway and adjacent surroundings, thereby potentially affecting surface waters and wetlands. Less traveled local roadways are often not as well maintained as major highways and, due to their age, often do not have contemporary storm water treatment facilities. In terms of direct physical impacts from the tolling alternative, there will be a need to lay fiber optic cables to support communications with field equipment, however, direct physical impacts to wetlands and water resources can be effectively avoided with proper planning and appropriate best management practices and erosion/sedimentation control measures during construction/trenching.
  - *Concept F – Tolling for Highways Needing New Capacity* – This concept diverts considerable traffic to free parallel alternate routes – Route 1 along I-95 and a series of routes in the I-84 corridor. Route 1 essentially parallels the shoreline and crosses 14 major water bodies along its route from Branford to the Rhode Island border. In

the I-84 corridor west of Waterbury, diversion routes identified in this study cross and/or directly parallel eight major water bodies. In addition to these major water resources, countless wetlands and small streams also exist along the identified diversion routes. As previously mentioned throughout this section, increased traffic precipitated by toll avoidance could potentially increase contaminant loading and hazardous material spills to surface waters and wetlands located along diversion routes, thereby affecting the quality of these resources.

In terms of direct physical impacts from the tolling alternative, there will be a need to lay fiber optic cables to support communications with field equipment; however, direct physical impacts to wetlands and water resources can be effectively avoided with proper planning and appropriate best management practices and erosion/sedimentation control measures during construction/trenching. The addition of new lanes to the I-95 and I-84 highway corridors would occur under separate projects, thus wetland and water quality impacts from those projects would be assessed in environmental documents and permit applications prepared specifically for those projects.

– *Concept G1 – Toll All Limited Access Highways* – Similar to Concept C, this concept would result in some vehicle diversion from all of the tolled routes to parallel local routes, with the exception that all vehicles (not just trucks) would be involved in diversion. Increased traffic along diversion routes will contribute to increased deposition of vehicular contaminants such as oils onto the roadway surface. These contaminants will be carried via storm water runoff to nearby wetlands and receiving waters. As previously mentioned, less traveled local roadways are often not as well maintained as major highways and, due to their age, often do not have contemporary storm water treatment facilities.

– *Concept H – Congested Corridor Tolling* – This concept has only been developed for I-95 and Route 15, which are Connecticut's most congested routes. The largest diversion would occur from I-95 southbound in the A.M. peak period. There would be lower diversion levels on Route 15, and during the P.M. peak period on both roadways. Approximately 10 major water bodies and countless wetlands and smaller streams exist along the identified diversion routes. These resources would have increased exposure to hazardous materials spills and degraded storm water runoff as a consequence of the increased traffic along these routes precipitated by the toll avoidance behavior of drivers.

- **Potential Significant Adverse Effects**

None of the proposed concepts are anticipated to have potentially significant adverse affects to water resources or wetlands.

3.0 Wild and Scenic Rivers, Navigable Waterways, and Coastal Resources

Wild and Scenic Rivers

The National Wild and Scenic Rivers System was created by Public Law 90-542 in 1968 to preserve rivers recognized as having outstanding natural, cultural, and recreational values. The designation is intended to preserve these rivers in a free-flowing condition. Rivers may be so designated if certain requirements are met in terms of physical conditions and community support. Connecticut has two rivers that have portions designated as Wild and Scenic Rivers: the west branch of the Farmington River and the Eightmile River.

In August 1994, Congress added 14 miles of the Farmington River's west branch to the National Wild and Scenic Rivers System. The designated portion includes a segment of the West Branch and main stem extending from the Goodwin Dam and Hydroelectric Project in Hartland to the downstream end of the New Hartford/Canton town line.

The Eightmile River was designated as a Wild and Scenic River on May 8, 2008. Designated segments include the main stem and several tributaries. The main stem flows from its confluence with Lake Hayward Brook in Colchester to its confluence with the Connecticut River at the mouth of Hamburg Cove in Lyme. Tributaries in the designation include the 8-mile segment of the East Branch, the 4-mile segment of Harris Brook, a 2-mile segment of Beaver Brook, and a 0.7-mile segment of Falls Brook.

Navigable Rivers

The U.S. Army Corps of Engineers (ACOE) is responsible for identifying navigable waterways throughout the United States under Section 10 of the Rivers and Harbors Act of 1899. Navigable waterways officially determined to fall under the ACOE jurisdiction in Connecticut include:

- The Connecticut River; and
- All tidal waters; this includes lower portions (up to the first dam) of the:
  - Norwalk River;
  - Housatonic River;
  - Quinnipiac River;
  - Niantic River; and
  - Thames River.

Coastal Resources

Connecticut has approximately 380 miles of coastline. Resources within the State's coastal area are protected through the Coastal Area Management Program administered by CTDEP under the Connecticut Coastal Management Act (CCMA), enacted in 1980. Sensitive coastal resources are mapped, and land use and development are regulated within the coastal zone area.

Navigable Rivers, Wild and Scenic Rivers, and Coastal Resources in Connecticut are shown in Figure 2. These water resources by subarea are summarized in Table 2.

Table 2. Navigable Rivers, Wild and Scenic Rivers, and Coastal Resources

Roadway Corridor	Geographic Subarea	Navigable Waters (NV), Wild and Scenic Rivers (WS), and Coastal Area (CA)
I-84 Corridor	Within 1,000 Feet of Corridor	None
	Danbury Metro Area	None
	Southbury	None
	Bristol/Southington	None
	Hartford Metro Area	None
	Manchester/Vernon	None
	Tolland	None
I-91Corridor	Within 1,000 Feet of Corridor	**CA**
	New Haven Metro Area	**NV; CA**
	Meriden	None
	Newington	None
	Windsor Locks	None
I-95 Corridor	Within 1,000 Feet of Corridor	**CA**
	Stamford Metro Area	**NV; CA**
	Norwalk Metro Area	**NV; CA**
	Stratford/Milford	**NV; CA**
	Clinton/Madison	**CA**
	Old Saybrook	**NV; WS; CA**
	Niantic	**NV; CA**
	New London/Groton	**NV; CA**
	Stonington	**CA**
I-395	Within 1,000 Feet of Corridor	None
	Windham/Putnam	None
Route 2 Corridor	Within 1,000 Feet of Corridor	None
	Norwich	**NV**

Table 2. Navigable Rivers, Wild and Scenic Rivers, and Coastal Resources (continued)

Roadway Corridor	Geographic Subarea	Navigable Waters (NV), Wild and Scenic Rivers (WS), and Coastal Area (CA)
Route 8 Corridor	Within 1,000 Feet of Corridor	None
	Bridgeport Metro Area	**CA**
	Waterbury Metro Area	None
	Torrington	None
	Winchester/Winsted	None
Route 9 Corridor	Within 1,000 Feet of Corridor	**WS**
	Middletown/East Hampton	None
Merritt Parkway	Within 1,000 Feet of Corridor	**NV; CA**

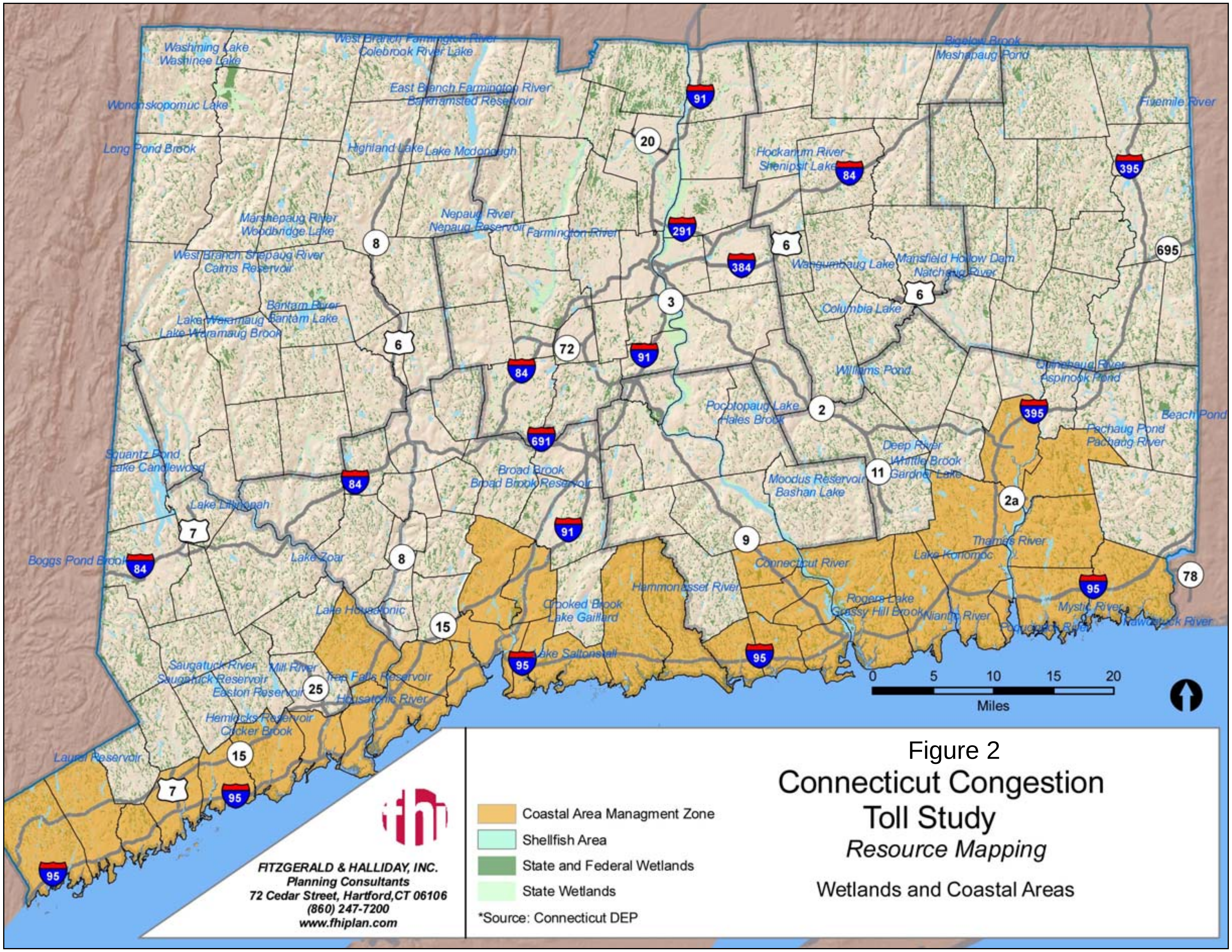
Figure 2
Connecticut Congestion
Toll Study
Resource Mapping
Wetlands and Coastal Areas
Coastal Area Managment Zone
Shellfish Area
State and Federal Wetlands
State Wetlands
*Source: Connecticut DEP
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Bantam Lake
Lake Waramaug
Hockanum River
Shenipsit Lake
Mashapaug Pond
Fivemile River
Wangumbaug Lake
Mansfield Hollow Dam
Natchaug River
Columbia Lake
Williams Pond
Pocotopaug Lake
Hales Brook
Aspinook Pond
Beach Pond
Pachaug Pond
Pachaug River
Deep River
Moodus Reservoir
Bashan Lake
Broad Brook
Broad Brook Reservoir
Squantz Pond
Lake Candlewood
Lake Lillinonah
Boggs Pond Brook
Lake Zoar
Lake Housatonic
Crooked Brook
Lake Gaillard
Lake Saltonstall
Hammonasset River
Connecticut River
Lake Konomoc
Thames River
Rogers Lake
Mystic River
Saugatuck River
Saugatuck Reservoir
Easton Reservoir
Mill River
Trap Falls Reservoir
Housatonic River
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Impacts

Impacts to wild and scenic rivers, navigable waterways, and coastal resources are generally regulated through permitting programs pertinent to each resource. Potential impacts to these sensitive resources from the proposed tolling and congestion pricing alternatives are expected to be limited and localized, since the tolling infrastructure footprint is generally very limited in size. There will be no direct adverse impacts to any Wild and Scenic River as none of the alternatives would be located near these resources. Similarly, none of the tolling and congestion pricing alternatives will adversely affect the navigability of the State's existing navigable waterways. The greatest potential for adverse effects from any of the tolling and congestion pricing alternatives on coastal resources will be from increased traffic along identified diversion routes located south of I-95 (namely Route 1). Locations where Route 1 crosses tidally influenced streams and rivers (e.g., the Lieutenant River in Old Lyme), or where it runs parallel to tidal wetlands, could be most impacted by hazardous materials spills during accidents or from vehicular pollutants carried in storm water runoff. The following characterizes the potential impacts to coastal resources for each tolling and congestion pricing alternative. Impacts are subdivided into three categories; No Effect, Potential Minor Adverse Effects, and Potential Significant Adverse Effects.

- **No Effect** – The following tolling alternatives either do not result in traffic diversions, or the infrastructure associated with the tolling alternative and any potential diversion routes do not occur within Connecticut's designated coast zone.
  - *Concept A – New Toll Express Lanes on I-84 and I-95;*
  - *Concept D – HOV to HOT Lane Conversion; and*
  - *Concept G2 – Tax on all Vehicle Miles of Travel.*
- **Potential Minor Adverse Effects –** The following tolling and congestion pricing alternatives may trigger toll avoidance along diversion routes that are wholly or partially located within Connecticut's designated coastal zone and thus could have potential indirect impacts to coastal waters and tidal wetlands.
  - *Concept B – Border Tolling at Major Highways;*
  - *Concept C – Toll Trucks on Limited Access Highways;*
  - *Concept F – Tolling for Highways Needing New Capacity;*
  - *Concept G1 – Toll All Limited Access Highways; and*
  - *Concept H – Congested Corridor Tolling.*
- **Potential Significant Adverse Effects**

  None of the proposed concepts are anticipated to have potentially significant adverse affects to coastal resources.

4.0 Floodplains and Stream Channel Encroachment Lines

Floodplains in each municipality in Connecticut are mapped through a Flood Insurance Study (FIS), conducted by the Federal Emergency Management Agency (FEMA). The maps, called Flood Insurance Rate Maps (FIRM), define the location of floodways, as well as the location and extent of 100- and 500-year floodplains. Floodways are located within floodplains and consist of the river or stream channel plus any portion of the floodplain which carries stream flows during flood events. A "100-year floodplain" is the area that has a one-percent chance of being inundated in a given year. Similarly, a "500-year floodplain" is an area that has one-five hundredth chance (0.02 percent) of being inundated in a given year. These floodplain hazard areas apply to both inland freshwater systems as well as coastal areas.

Stream channel encroachment lines (SCEL) are mapped by CTDEP for permitting purposes. SCEL have been established for about 270 linear miles of riverine floodplain throughout the State of Connecticut, and are shown on stream channel encroachment maps maintained by the CTDEP.

Floodplains in Connecticut are shown in Figure 3. In general terms, their locations will correspond to the locations of streams and rivers as discussed in Table 2 above.

Impacts

The proposed tolling alternatives would be considered an "activity" per CGS Section 25-68b 1) of Connecticut's Flood Management Statutes and subject to the 100-year floodplain requirements in those locations where tolling facilities would be located within the floodplain. The CTDEP Bureau of Water Protection and Land Reuse's Inland Water Resources Division regulates the placement of encroachments and obstructions riverward of stream channel encroachment lines, to lessen the hazards to life and property due to flooding.

Since none of the alternatives involve a significant construction footprint and would likely involve little or no fill being placed in floodplains, impacts to floodplains and SCEL are anticipated to be minor and/or insignificant for all alternatives. It is expected that an appropriate level of site planning would be involved prior to the placement of individual toll gantries associated with chosen alternatives. That planning would ensure that the foundations of the gantries or other infrastructure required for the tolling alternative would not impact floodplains or SCEL.

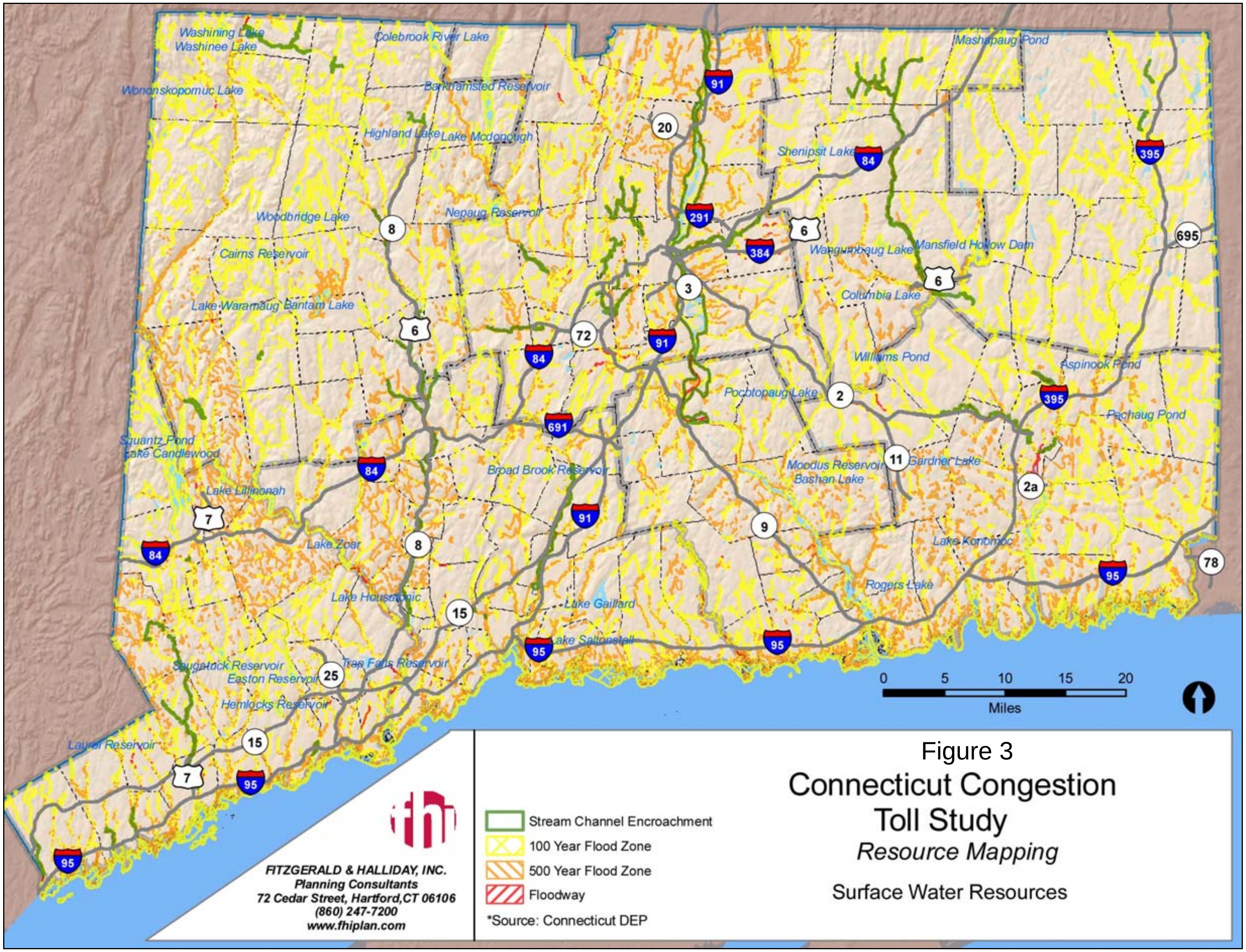
Figure 3
Connecticut Congestion Toll Study
Resource Mapping
Surface Water Resources
Stream Channel Encroachment
100 Year Flood Zone
500 Year Flood Zone
Floodway
*Source: Connecticut DEP
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Nepaug Reservoir
Cairns Reservoir
Mansfield Hollow Dam
Columbia Lake
Lake Waramaug
Bantam Lake
Williams Pond
Aspinook Pond
Pocotopaug Lake
Pachaug Pond
Squantz Pond
Lake Candlewood
Broad Brook Reservoir
Moodus Reservoir
Bashan Lake
Gardner Lake
Lake Lillinonah
Lake Zoar
Lake Konomoc
Rogers Lake
Lake Housatonic
Lake Gaillard
Lake Saltonstall
Saugatuck Reservoir
Easton Reservoir
Trap Falls Reservoir
Hemlocks Reservoir
Laurel Reservoir

5.0 Farmlands

Existing Conditions Overview

The U.S. Department of Agriculture (USDA) recognizes several categories of important farmlands based on vicinity, conditions, and soil characteristics. Prime farmlands are of major importance in the production of the nation's food supplies. Unique farmlands are farmlands, other than prime farmlands, that are used for the production of specific high-value food and fiber crops. Farmlands of Statewide Importance are similar to prime farmlands, but have certain characteristics, such as soils that are wetter or slopes that are steeper, that require greater inputs of energy or resources to maintain high yield crops. Prime and statewide important farmland soils in Connecticut were identified using USDA Natural Resource Conservation Service (NRCS) data, as mapped by CTDEP. Connecticut has an abundance of areas of farmland soils with potential for crop production. Regions of active agriculture tend to be concentrated in north central Connecticut along the Connecticut River Valley, as well as in the northern corners of the State. The soils data does not indicate locations of active agriculture. Impacts to farming as a land use activity are addressed in the Land Use section of this environmental screening.

Farmland soils in Connecticut are shown in Figure 4. These resources by subarea are summarized in Table 3.

Table 3. Farmland Soils by Subarea

Roadway Corridor	Geographic Subarea	General Locales of Farmland Soils
I-84 Corridor	Within 1,000 Feet of the Road along the Corridor	Scattered pockets of farmland soils north of Danbury, though this area is mostly suburban in development; more concentrated areas of farmland soils north of Hartford and west of the corridor in the tobacco growing region of the State
	Danbury Metro Area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Southbury	Fully developed near the interstate with areas of farmland soils west of the community core
	Bristol/Southington	Highly developed suburban to urban development; some pockets of farmland soils southeast of these communities
	Hartford Metro Area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Manchester/Vernon	Highly developed retail/commercial centers with areas of farmland soils occurring throughout the area, particularly along the Connecticut River valley
	Tolland	Limited pockets of farmland soils throughout the community

Table 3. Farmland Soils by Subarea (continued)

Roadway Corridor	Geographic Subarea	General Locales of Farmland Soils
I-91Corridor	Within 1,000 Feet of the Road along the Corridor	Concentrated areas of farmland soils from Meriden northward, particularly along the Connecticut River valley; north of Windsor Locks
	New Haven Metro area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Meriden	Developed suburban community with limited pockets of farmland soils
	Newington	Developed suburban community with limited pockets of farmland soils
	Windsor Locks	The tobacco farming area of Connecticut; highest concentration of farmland soils in the State in this region
I-95 Corridor	Within 1,000 Feet of the Road along the Corridor	Coastal area of the State with many developed centers; very limited pockets of farmland soils along this highway corridor
	Stamford Metro Area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Stratford/Milford	Concentrated area of farmland soils north of the interstate, north of Milford
	Clinton/Madison	Limited scattered pockets of farmland soils
	New London/Groton	Due to the urban nature of the region, very limited areas of farmland soils occur or remain undeveloped, there is a concentrated area of farmland soils along the coastline
	Stonington	Limited scattered pockets of farmland soils
I-395 Corridor	Within 1,000 Feet of the Road along the Corridor	Numerous areas of farmland soils west of the interstate and north of Norwich
	Windham	Numerous areas of farmland soils west of the interstate and along the Quinnebaug and Shetucket River corridors
Route 2 Corridor	Within 1,000 Feet of the Road along the Corridor	Concentrated areas of farmland soils near the Connecticut River corridor and near Colchester
	Norwich	Due to the urban nature of the city, very limited areas of farmland soils occur or remain undeveloped
Route 8 Corridor	Within 1,000 Feet of the Road along the Corridor	Numerous yet scattered areas of farmland soils north of Bridgeport, west of the highway, and between Southbury and Litchfield
	Bridgeport Metro Area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Waterbury Metro Area	Due to the urban nature of the region, very limited areas of farmland soils remain undeveloped
	Torrington	Numerous yet scattered areas of farmland soils
	Winchester/Winsted	Numerous yet scattered areas of farmland soils

Table 3. Farmland Soils by Subarea (continued)

Roadway Corridor	Geographic Subarea	General Locales of Farmland Soils
Route 9 Corridor	Within 1,000 Feet of the Road along the Corridor	Concentrated areas of farmland soils near Connecticut River and in the vicinity of Middletown
	Middletown	Concentrated areas of farmland soils near Connecticut River and southwest of the city core
Merritt Parkway	Within 1,000 Feet of the Road along the Corridor	Traverses heavily suburban area of the State; pockets of concentrations of farmland soils from Darien to Trumbull and near Milford and Wallingford

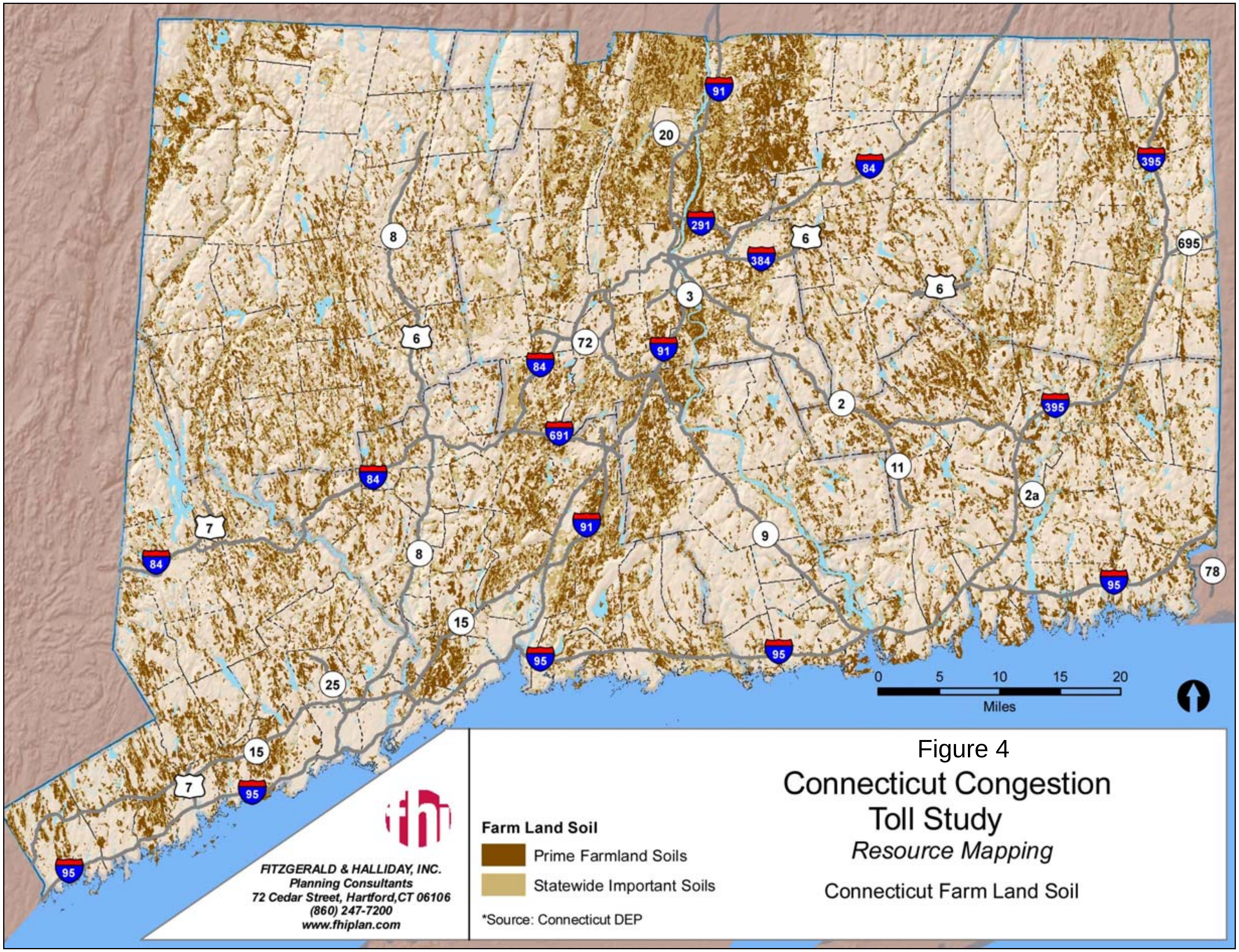
Figure 4
Connecticut Congestion Toll Study
Resource Mapping
Connecticut Farm Land Soil
Farm Land Soil
Prime Farmland Soils
Statewide Important Soils
*Source: Connecticut DEP
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Impacts

No adverse impacts to farmland soils are anticipated with any of the tolling and congestion pricing alternatives. This is due to the fact that the tolling facilities are anticipated to be located within the existing highway rights-of-way which have already been disturbed for highway construction. The value of the farmland soils for agricultural use has already been compromised.

6.0 Threatened and Endangered Species and Critical Habitats

Habitat types are generally characterized by plant communities and vary widely across Connecticut. The location of the highway corridors within both historically developed areas and along undeveloped, open spaces means they traverse both high-quality habitats and occur in areas with limited or reduced habitat value. The locations of populations of threatened and endangered species as well as critical habitat areas are monitored as part of the CTDEP Natural Diversity Data Base (NDDB). These areas are generally found all along Connecticut's coastal area, along the less developed portions of major river corridors, and in the more rural northern corners of the State.

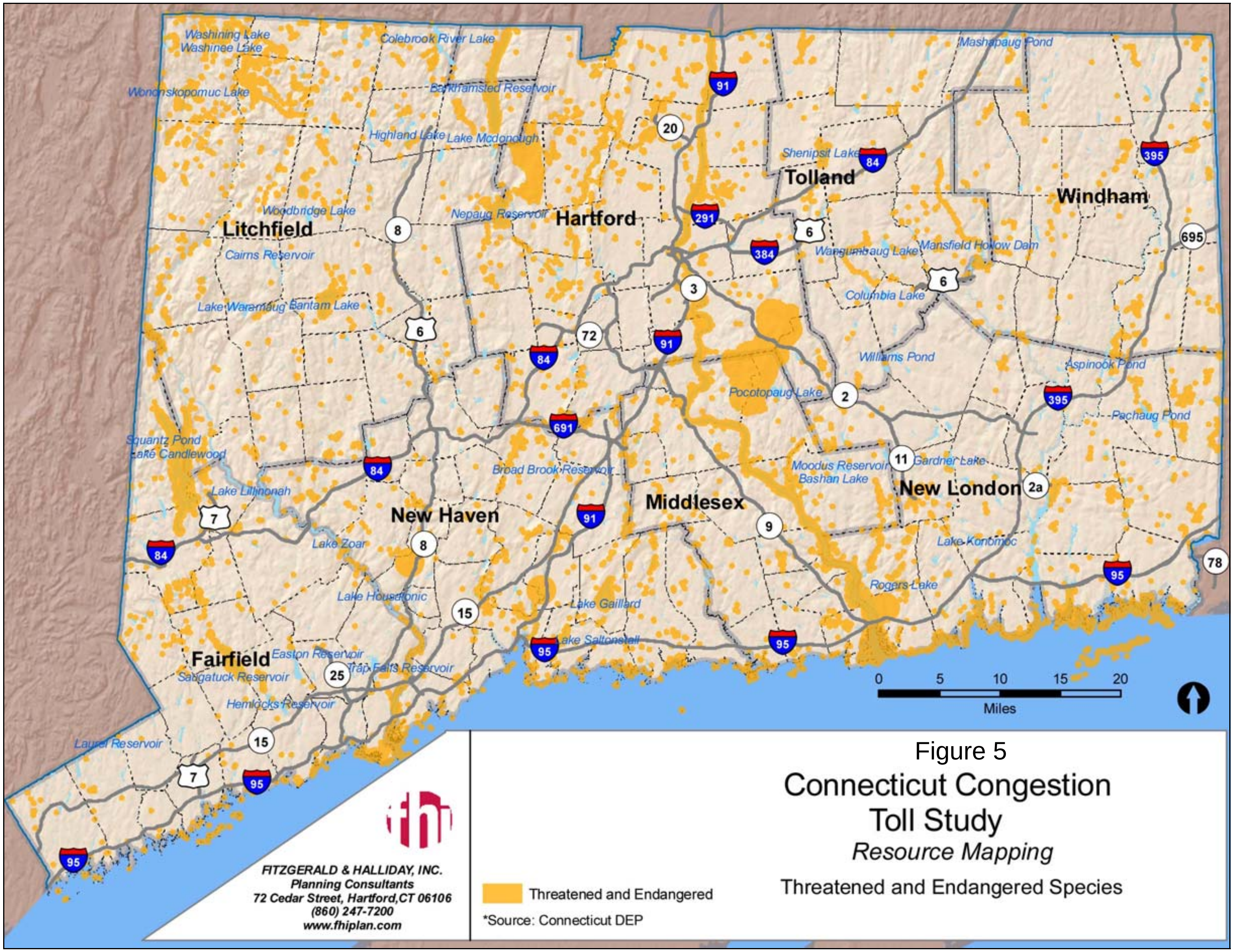
The general locations of threatened and endangered species in Connecticut as provided by the Natural Diversity Database are shown in Figure 5. Areas where these resources are clustered generally include:

- Around Candlewood Lake near Danbury;
- Along the Housatonic River near Lake Zoar and between Shelton and Stratford;
- Along the entire length of the Connecticut River;
- Coastal Connecticut particularly near Stratford, and from Old Saybrook north to Stonington;
- Route 2 in the vicinity of Marlborough and East Hampton;
- Route 8 near Beacon Falls and in Stratford and Milford;
- Route 9 near Middletown; and
- Merritt Parkway/Route 15 from Hamden to Meriden.

Impacts

All of the tolling and congestion pricing alternatives will be located within existing highway corridors and new infrastructure is anticipated to be built within existing rights-of-way. Consequently, direct impacts to any critical habitats or threatened and endangered species are expected to be minimal. It is expected that an appropriate level of site planning and coordination would be undertaken prior to the placement of individual toll gantries. That planning and coordination (with the CTDEP NDDB) during project design would help ensure that the foundations of the gantries and other infrastructure required for tolling would be located so as not to impact known critical habitats or threatened or endangered species.

In terms of diversion routes, increased traffic on those roadways due to toll avoidance will have no adverse affect on threatened and endangered plant species. However, increased traffic volumes could potentially contribute to increased roadway mortality among endangered mammals, amphibians, reptiles, and insects. The potential for this type of impact would need to be assessed on a case-by-case basis as species-specific information is made available by the CTDEP for a defined tolling project.


Litchfield
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Barkhamsted Reservoir
Highland Lake
Lake Mcdonough
Shenipsit Lake
Woodbridge Lake
Nepaug Reservoir
Cairns Reservoir
Wangumbaug Lake
Mansfield Hollow Dam
Columbia Lake
Lake Waramaug
Bantam Lake
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Lake Konomoc
Rogers Lake
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Lake Saltonstall
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Trap Falls Reservoir
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Threatened and Endangered
*Source: Connecticut DEP
Figure 5
Connecticut Congestion
Toll Study
Resource Mapping
Threatened and Endangered Species

■ 7.0 Other Important Topics for Consideration

Hazardous Waste Sites

There is a long history of intensive industrial land use in and around Connecticut's major cities and along its rail and highway corridors. It is not unusual for urban soils and transportation corridors to be impacted by generally widespread use of petroleum products or other contaminants in motor vehicle operations and/or associated with commercial land uses over many years. Some of these soils also have the potential to be hazardous given the potential presence of leaking underground storage tanks (LUST), hazardous waste generators, and sites subject to remedial response actions.

Areas of leachate wastewater and/or hazardous materials in Connecticut are shown in Figure 6. Areas where these resources are clustered along the highway corridors include:

- I-84 near Danbury; also between East Hartford and Tolland;
- I-91 from Hartford north; also from Meriden to New Haven;
- I-95 between Stamford and New Haven; also near Madison, Westbrook, Old Saybrook and New London;
- Route 8 from Watertown to Derby and then in Bridgeport;
- Route 9 near Middletown; and
- Merritt Parkway/Route 15 from Hamden to Meriden.

Impacts

All of the tolling alternatives will be located within existing highway corridors and new infrastructure is anticipated to be built within existing rights-of-way. Each location will need to be screened for the presence of hazardous materials, since there is commonly some potential for hazardous runoff containing oil and other petroleum products in these areas, as well as spills from the transport of hazardous waste and materials.

If determined appropriate, a Remedial Action Plan (RAP) to ensure the proper handling and disposal of any hazardous materials encountered will be developed for the selected alternative and fully coordinated with the CTDEP. If called for, a Health and Safety Plan will also be developed for the selected alternative in accordance with Occupational Safety and Health Administration (OSHA) guidelines, and will be communicated to construction workers to ensure their protection during construction. As such, the tolling and congestion pricing alternatives are expected to have no adverse impact on hazardous materials or waste dispersal.

With respect to diversion routes, increased traffic along these routes resulting from toll avoidance will not unearth or cause existing contamination sources and/or conditions to become exacerbated or more widespread. There is the potential for hazardous materials spills attributed to traffic accidents, which may become more prevalent on some diversion routes where traffic volumes are projected to substantially increase.

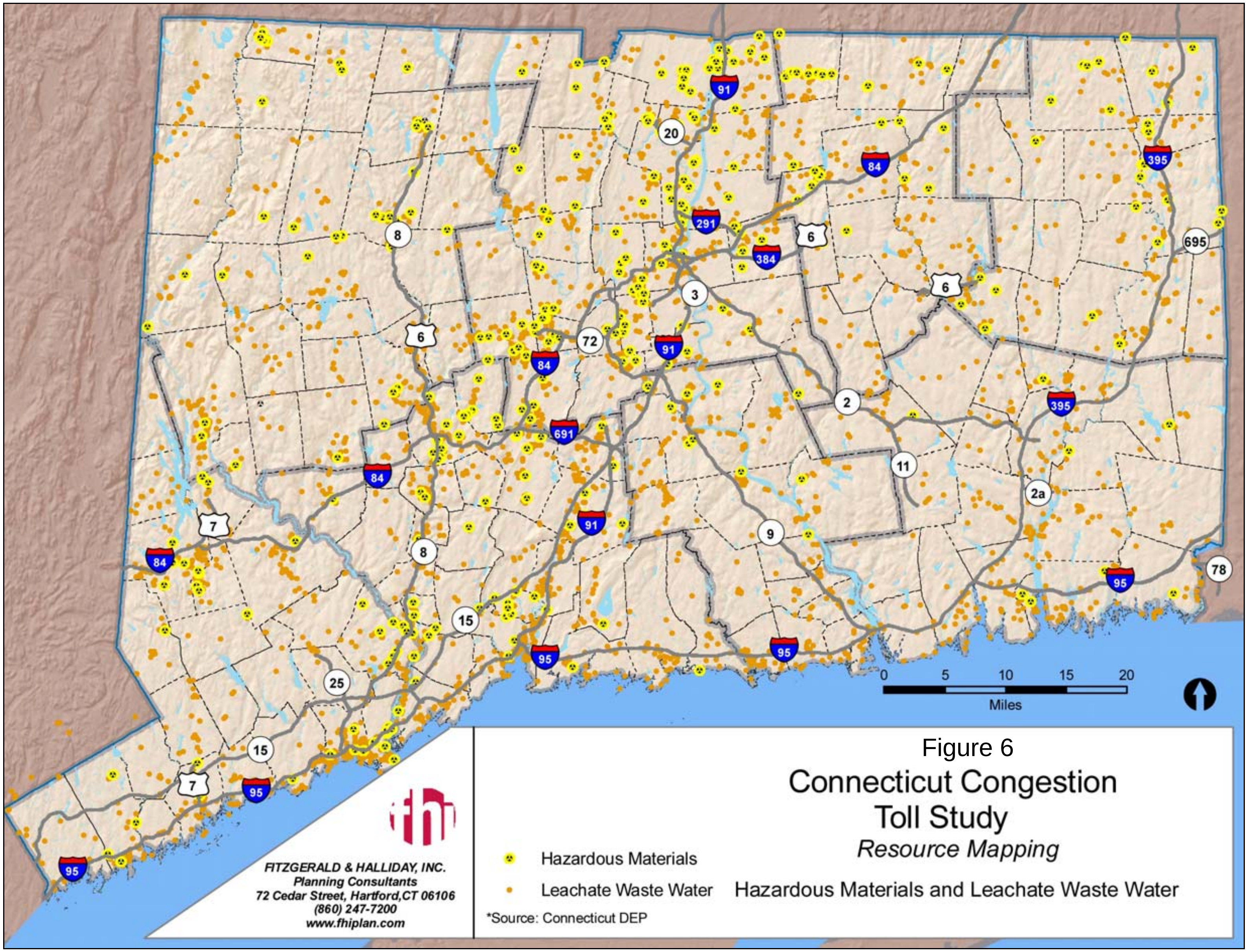
Figure 6
Connecticut Congestion
Toll Study
Resource Mapping
Hazardous Materials and Leachate Waste Water
Hazardous Materials
Leachate Waste Water
*Source: Connecticut DEP
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8.0 Noise

Noise-sensitive land uses include: a) residences, hotels, and other buildings where people sleep; 2) institutional resources, such as churches, schools, hospitals, and libraries; and 3) various tracts of land where quiet is an essential element of the land's intended purpose, such as a National Historic Landmark where outdoor interpretation routinely takes place. These land uses are termed "Class A Land Uses" under Connecticut Noise Regulations, contained in Section 22a-69-1 through 22a-69-7.4 of the Regulations of Connecticut State Agencies (RCSA). The scope of this study did not permit field verification of noise sensitive resources along all of the interstates, state routes, and potential traffic diversion routes. However, available GIS databases do provide information on the locations of churches, schools, hospitals, and libraries. Unfortunately, residences, which are the most common type of noise sensitive receptor, could not be feasibly verified or mapped for this broad-based planning study. Therefore, it was generally assumed that all state routes and potential diversion routes have some level of residential development.

Using available GIS data, the general location of nonresidential noise sensitive receptors within 500 feet of the interstates and state routes were mapped and are shown in Figure 7. The distance of 500 feet was selected for this screening analysis because noise sensitive receptors located more than 500 feet from a highway are less likely to be impacted by traffic noise. In general, the Federal Highway Administration (FHWA) considers a noise impact to have occurred when traffic noise exceeds the Noise Abatement Criteria (NAC) of 67 a-weighted decibels (dBA).

Areas where the nonresidential noise sensitive resources are clustered generally include:

- I-84 from Danbury to the New York border;
- The approaches to Waterbury on Route 8 and I-84;
- Hartford metropolitan area;
- Vicinity of New Britain;
- Route 8 at Ansonia, Derby, and Shelton;
- Merritt Parkway/Route 15 from Milford; and
- I-95 from the New York border to New Haven.

Population centers and residential neighborhoods in close proximity to the interstates and state routes, and locations where traffic diversions are expected to occur may also be impacted by project alternatives. The locations of major population centers, including point locations of Connecticut cities, are shown in Figure 8, which provides some insight into potential locations of noise impacts from the tolling and congestion pricing alternatives.

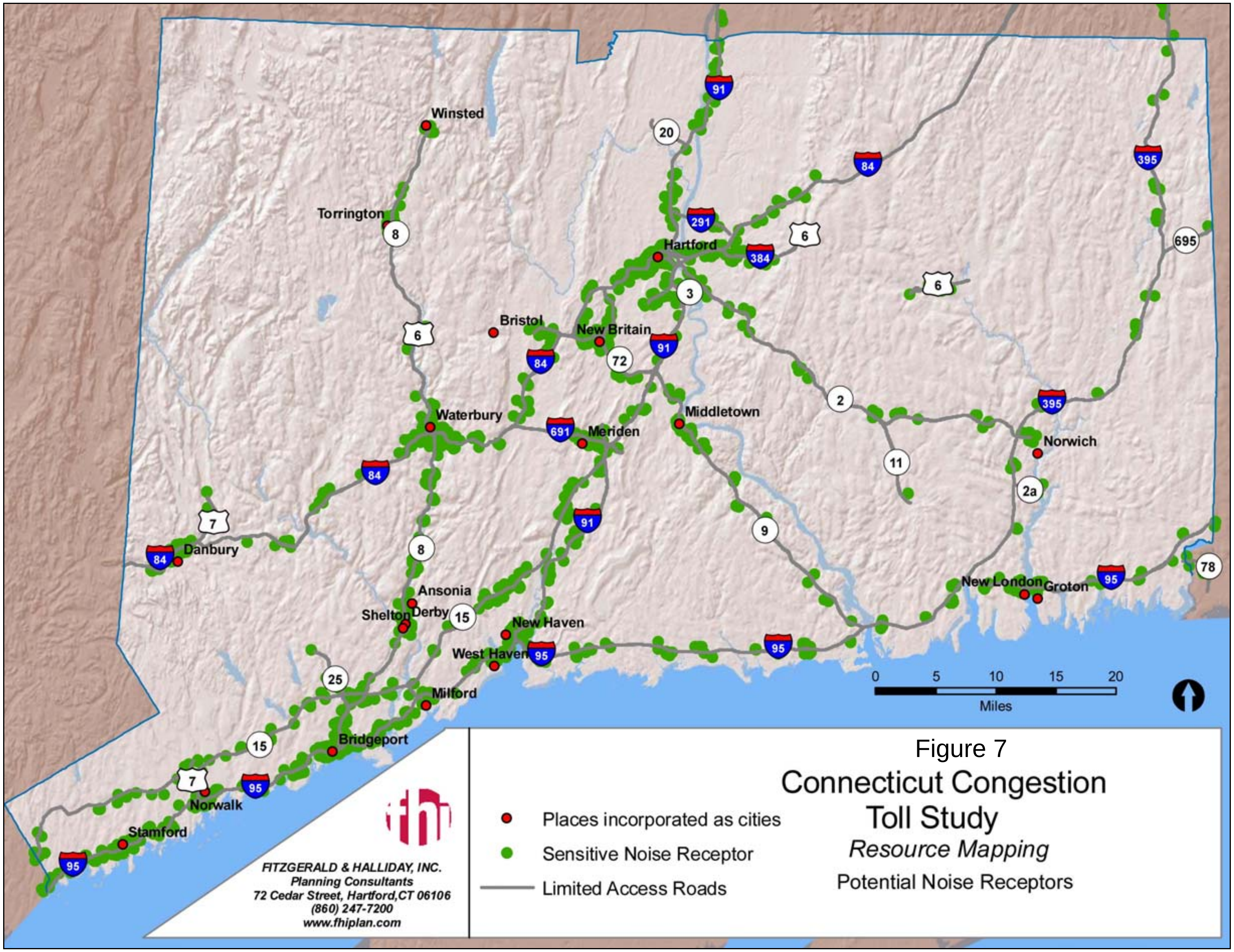
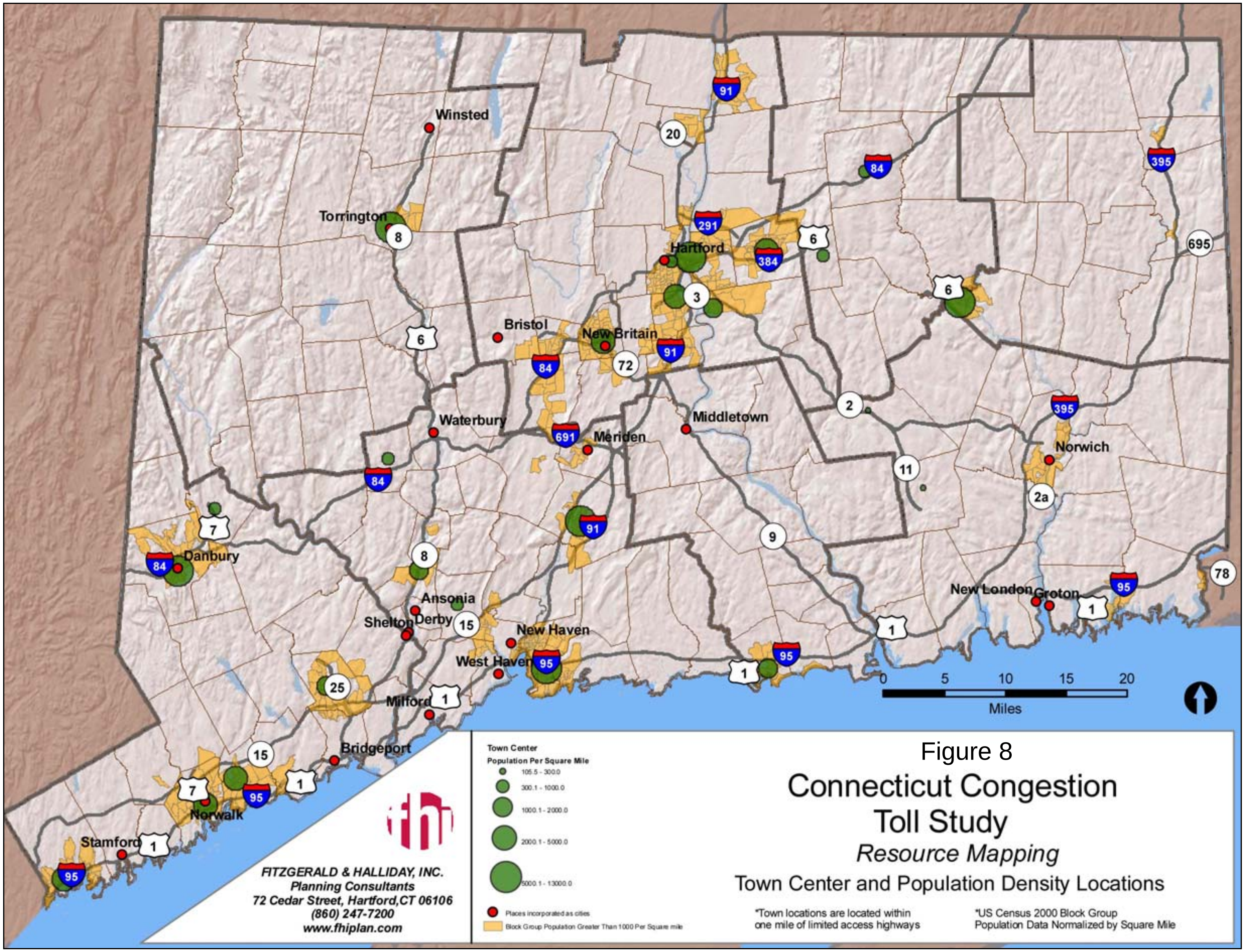


Figure 7
Connecticut Congestion Toll Study
Resource Mapping
Potential Noise Receptors


Winsted
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Ansonia
Shelton
Derby
New Haven
West Haven
Milford
Bridgeport
Norwalk
Stamford
New London
Groton
91
20
84
395
291
6
384
695
8
3
72
84
2
691
11
7
2a
9
78
95
1
15
25
0
5
10
15
20
Miles
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Town Center
Population Per Square Mile
105.5 - 300.0
300.1 - 1000.0
1000.1 - 2000.0
2000.1 - 5000.0
5000.1 - 13000.0
Places incorporated as cities
Block Group Population Greater Than 1000 Per Square mile
Figure 8
Connecticut Congestion
Toll Study
Resource Mapping
Town Center and Population Density Locations
*Town locations are located within one mile of limited access highways
*US Census 2000 Block Group Population Data Normalized by Square Mile

Impacts

Noise impacts are generally measured in terms of a change in noise levels from the ambient or background noise levels occurring today. As previously mentioned, the FHWA generally identifies a noise impact as having occurred when traffic noise levels at a receptor approach or exceed the NAC of 67 dBA. Existing noise levels have not been measured for this study. Despite the lack of quantitative noise data for the project, suburban and urban environments similar to most of the population centers and clusters of nonresidential noise sensitive receptors in Connecticut are considered moderately noisy places, with noise predominantly generated by traffic on local streets and highways. In general, noise levels within suburban environments typically range from 55 dBA (A-weighted decibels) to 60 dBA (*Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006). Noise levels within urban environments typically range from 60 dBA (A-weighted decibels) to 80 dBA (*Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006).

To roughly estimate noise impacts at a receptor, noise levels are reduced by 6 dBA for each doubling of distance from a noise source. For example, a dump truck with a noise level of 85 dBA at 50 feet will have a noise level of 79 dBA at 100 feet, 73 dBA at 200 feet, 67 dBA at 400 feet, 61 dBA at 800 feet, and so forth, assuming that no barriers or shields exist between the noise source and receptor. A 10 decibel increase is essentially a doubling of loudness. Consequently, it can be expected that a substantial change in traffic volumes, particularly with a heavy mix of trucks, on local streets may have an adverse effect on noise sensitive receptors within 500 feet.

All of the tolling and congestion pricing alternatives will be located within existing highway corridors and new infrastructure is anticipated to be built within existing rights-of-way. They will only affect noise levels to the extent that they induce a change in traffic volumes or result in a slowdown in traffic which may in turn result in more truck noise from braking and downshifting.

Conclusions which can be drawn about the relative noise impacts of the tolling and congestion pricing alternatives are stated below.

- **No Effect – Primarily Due to No Diversion of Traffic:**
  - *Concept A – New Toll Express Lanes on I-84 and I-95* – New express toll lanes will attract traffic, but general purpose lanes will remain available. There may be some reduction of congestion with this alternative and an overall benefit to noise levels.
  - *Concept D – HOV to HOT Lane Conversion* – New HOT lanes will attract traffic, but general purpose lanes will remain available. There may be some reduction of congestion with this alternative and an overall benefit to noise levels.
  - *Concept G2 – Tax on all Vehicle Miles of Travel* – The impacts of tolling will be felt statewide and distributed across the State such that diversions of traffic are not expected to occur. Increases in congestion are not expected, and overall noise levels will remain about the same.

- **Potential Minor Adverse Effects:**

  – *Concept B – Border Tolling at Major Highways* – This alternative would result in the diversion of traffic to local alternate routes, which could impact local traffic conditions. While the diversion routes would not be any longer than the main highway routes, drivers would still be expected to choose free routes to some degree.

  The highest percentage of vehicles diverted under Concept B would be expected at the more rural crossings at the Massachusetts and Rhode Island borders. This might impact traffic in Enfield, Union, Thompson, Killingly, and North Stonington. As these are more rural and quiet areas, the effects of increased traffic noise may be felt more acutely.

  The greatest number of vehicles divert at the more congested crossings on the New York border in southwestern Connecticut, impacting the communities of Danbury and Greenwich. Routes that might be used for diversion in Greenwich could increase traffic in Greenwich's downtown, thereby potentially increasing noise levels in that community.

  The border of Connecticut at I-84 near Danbury is a mixture of medium density suburban uses, with several large, undeveloped properties or vacant properties proposed for redevelopment. Traffic diversions at this border may have adverse noise effects on the numerous nonresidential sensitive noise receptors in the area, as well as on relatively new housing developments along Route 6.

  – *Concept C – Toll Trucks on Limited Access Highways* – Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Nonetheless, additional truck traffic on local roads can pose a particular noise issue, especially to homes and other noise sensitive land uses that front the route. All communities where diversions might occur would be impacted. In particular, village centers and downtowns along Route 1 and in southwestern Connecticut may be affected. This is an area in Connecticut's 'Gold Coast' that is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. Noise generated by traffic diverted through these community centers can be expected to have a substantial adverse effect on residents' experience of their community.

  – *Concept F – Tolling for Highways Needing New Capacity* – This concept diverts considerable traffic to free parallel alternate routes – Route 1 along I-95 and a series of routes in the I-84 corridor. Route 1 is a major corridor linking Connecticut's shoreline communities and already experiences peak-period congestion in a number of locales. It traverses a number of cohesive, historic, and aesthetic village and town centers. Traffic diverted through each of these communities between Branford and North Stonington could adversely impact noise levels at adjacent noise sensitive receptors. Communities that would be most affected along the I-84 corridor include Danbury, Newtown, Southbury, and Middlebury.

  – *Concept G1 – Toll All Limited Access Highways* – This concept would result in some vehicle diversion from all of the tolled routes to parallel local routes. Impacts would be similar to those described for Alternative C. The greatest diversion would occur on I-91 between Hartford and New Haven. Changes in localized noise levels in the I-91 corridor due to additional congestion on local roads could occur primarily in Wethersfield, Meriden, Wallingford, and Hamden. The greatest cluster of neighborhoods in close proximity to the interstates is along I-95 from New Haven to Stamford. Changes in localized noise levels in the I-95 corridor due to additional congestion on local roads could include West Haven, Bridgeport, Milford, Stratford, and Darien.

– *Concept H – Congested Corridor Tolling* – This concept has only been developed for I-95 and Route 15 as Connecticut's most congested routes. The largest diversion would occur from I-95 southbound in the A.M. peak period. There would be lower diversion levels on Route 15, and during the P.M. peak period on both roadways. There could be substantive adverse impacts to local traffic conditions throughout Connecticut's 'Gold Coast', as most of the communities there already experience peak-period congestion and, in particular, congested travel through downtowns and village centers. There may be increased localized noise from added traffic in these locales.

■ 9.0 Air Quality

Primary Transportation-Related Air Pollutants

There are a number of pollutants produced by transportation sources that affect the quality of the ambient air. Ambient air is a general term for outdoor air which the public is exposed to. The primary transportation-related pollutants of concern to human health include carbon monoxide, nitrogen dioxide, volatile organic compounds, ozone, particulate matter, and Mobile Source Air Toxics. How these pollutants form and how they affect human health are described below.

Carbon monoxide (CO) is a colorless, odorless gas formed from incomplete combustion of carbon-containing fuels and from oxidation of Volatile Organic Compounds (VOC) in the atmosphere. CO typically converts by natural processes to carbon dioxide quickly enough to prevent buildup. However, CO can reach dangerously high levels in local areas, such as city street "canyons" with heavy auto traffic and little wind. These high levels are often referred to as CO hotspots. Exposure to high levels of CO can affect mental alertness and vision in healthy persons and may cause severe chest pains and other cardiovascular symptoms in people with cardiovascular diseases.

Nitrogen dioxide (NO_2) is a byproduct of nitric oxide, a colorless gas formed during combustion of fuels at high temperatures and pressures. Motor vehicle exhaust is the primary source of NO_2. NO_2 is one of the substances that react to form ozone. NO_2 reduces the oxygen carrying capacity of blood.

VOC are emitted from fuel through evaporation and combustion. VOC are another category of substances that react to form ozone. Some VOC cause cancer, while others are harmful to plants.

Ozone is a gas with a slightly bluish color. Ozone is formed when NO_2 reacts with VOC and sunlight. Ozone is the principal component of smog. At high levels, ozone irritates the mucous membranes of the respiratory system and can cause impaired lung function.

Particulate matter (PM) is a mixture of particles – solid, liquid or both – that are suspended in the air. PM is the main cause of visibility impairment in the nation's cities and national parks. Sources of PM include diesel and petroleum engine combustion, erosion of the pavement by road traffic, and abrasion of brakes and tires. The finest particles, called $PM_{2.5}$ because the particles are less than 2.5 microns in size, are the most dangerous, as they can penetrate furthest into the lungs. PM is linked to a variety of significant health problems, particularly respiratory ones.

Carbon dioxide (CO_2) is a colorless, odorless gas. It is a greenhouse gas, called such because it allows sunlight to pass to the earth freely and then absorbs the heat that bounces off the earth trapping it in the atmosphere. Levels of CO_2 are increasing, largely as a result of fossil fuel combustion. CO_2 emissions represented 82 percent of total U.S. anthropogenic greenhouse gas emissions in 2006. An estimated 4.1 billion metric tons of CO_2 are added to the atmosphere annually.[1] Ultimately, the increase levels of CO_2 and other greenhouse gases can produce an increase in the average surface temperature of the Earth over time, referred to as climate change.

Federal Air Quality Regulations

Under the Clean Air Act and 1990 Clean Air Act Amendments, Federal standards have been established to define acceptable levels of certain air pollutants. Several regulatory programs have been established to monitor, estimate, and control air pollution. The Federal ambient air standards and the regulatory programs pertinent to transportation projects are described below.

National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) established National Ambient Air Quality Standards (NAAQS) for six commonly found air pollutants, called criteria pollutants, in the Clean Air Act and 1990 Clean Air Act Amendments. The six criteria pollutants are CO, ozone, PM, NO_2, sulfur dioxide (SO_2), and lead.

Criteria air pollutants are called such because EPA has set standards for them based on human health-based and/or environmentally based criteria. Primary standards set maximum limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards are set to protect public welfare and the environment, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings. With the exception of sulfur dioxide, all criteria pollutants have secondary standards that are equal to the primary standards.

[1] Energy Information Administration, *Greenhouse Gases, Climate Change, and Energy*, Brochure #: DOE/EIA-X012, May 2008.

The criteria pollutants and their NAAQS are displayed in Table 4. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

Table 4. National Ambient Air Quality Standards

Pollutant	Primary Standards	Averaging Times	Secondary Standards
CO	9 ppm (10 mg/m^3)	8-hour[a]	None
	35 ppm (40 mg/m^3)	1-hour[a]	None
Lead	1.5 $\mu g/m^3$	Quarterly Average	Same as Primary
Nitrogen Dioxide	0.053 ppm (100 $\mu g/m^3$)	Annual (Arithmetic Mean)	Same as Primary
Particulate Matter (PM_{10})	150 ug/m^3	24-hour[a]	
Particulate Matter ($PM_{2.5}$)	15 $\mu g/m^3$	Annual[b] (Arithmetic Mean)	Same as Primary
	35 ug/m^3	24-hour[c]	
Ozone	0.075 ppm	8-hour[d]	Same as Primary
Sulfur Oxides	0.03 ppm	Annual (Arithmetic Mean)	–
	0.14 ppm	24-hour[a]	–
	–	3-hour[1]	0.5 ppm (1300 ug/m^3)

[a] Not to be exceeded more than once per year.

[b] To attain this standard, the three-year average of the annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15 ug/m^3.

[c] To attain this standard, the three-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 ug/m^3.

[d] To attain this standard, the three-year average of the fourth highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

The Clean Air Act Amendments require each state to monitor air quality to determine whether the NAAQS are being met. Connecticut has a system of air sampling stations across the states to monitor the criteria pollutants. Results are evaluated in order to identify regions which may have air pollution problems. If air pollutant levels do not exceed the standard for any pollutant, a region is considered in attainment of the NAAQS. However, if even one sampling location (monitor) in a region shows a pollutant level higher than the standard (called an exceedance of the standard), the region is then classified as nonattainment for that pollutant. Once a region is classified as nonattainment for an air pollutant, the State must develop a plan to bring the region back to attainment status, called a State Implementation Plan.

General Conformity Rule

Federal regulations were established to ensure that emissions from proposed transportation plans and projects will not exceed levels set in a state's State Implementation Plan and will not interfere with the State's ability to meet the NAAQS. These regulations are defined in 40 CFR 6, 51, and 93, *Determining Conformity of General Federal Activities to State or Federal Implementation Plans, Final Rule*, also called the General Conformity Rule. Conforming transportation projects and plans are those that meet the requirements of a State Implementation Plan's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards. As outlined in 40 CFR 93.114-116, a project must meet the following conditions to be in conformity:

- There must be a currently conforming Regional Transportation Plan and currently conforming Transportation Improvement Program in the project area at the time of project approval;
- The project must be identified in a currently conforming Regional Transportation Plan and Transportation Improvement Program;
- The project must not cause or contribute to any new localized CO and PM_{10} violations or increase the frequency or severity of any existing CO and PM_{10} violations in CO and PM_{10} nonattainment and maintenance areas; and
- The FHWA/FTA project must comply with PM_{10} control measures in the applicable implementation plan.

Monitoring Overview and Air Quality Designations

The effects of the tolling and congestion pricing alternatives are located throughout all counties in Connecticut. An exceedance in a county would cause an area of that county, or the entire county depending upon the pollutant, to become classified as nonattainment for that pollutant. The current air quality monitor locations, exceedances, and attainment designations for the six criteria pollutants in all counties in Connecticut are displayed in Table 5.

Table 5. CT Air Quality Status[a]

Pollutant	Number of Connecticut Monitors	Exceedance (2006)	Attainment Status
CO	5	None	Attainment.
Ozone	11	At 10 monitors	Nonattainment in all areas of Connecticut.
PM_{10}	6	None	Attainment
$PM_{2.5}$	13	At six monitors	Nonattainment in Fairfield and New Haven counties. Attainment in all other areas.
NO_2	3	None	Attainment.
SO_2	7	None	Attainment.
Lead[b]	0	–	Attainment.

a EPA Region 1, *2006 Annual Report on Air Quality in New England*, July 2007.

b As a result of extremely low ambient levels, lead monitoring ceased in Connecticut in 2002. Only one monitoring site remains in Massachusetts (Kenmore Square, Boston).

For transportation projects, the criteria pollutants of greatest concern are CO, ozone, and PM. CO and ozone are predominantly influenced by motor vehicle activity. In addition, the entire State is listed as nonattainment for ozone. Thus, projects or programs that reduce overall vehicular pollutant emissions will have a positive effect on air quality. Projects or programs that result in increased emissions will have a negative effect on the ambient air quality.

The NAAQS for CO are a one-hour average concentration of 35 parts per million (ppm) and an eight-hour average concentration of 9 ppm. CO monitors are located throughout the State specifically to measure CO levels from high traffic areas in populated locations. EPA's air quality summary demonstrates that CO concentrations are not problematic in Connecticut. In 2006, the highest recorded eight-hour concentration (4.4 ppm) at all Connecticut monitors was at the Hartford monitoring site (155 Court Street) and was well below the NAAQS of 9 ppm. In addition to being listed as attainment, trend graphs indicate a continued downward trend in concentrations for CO.

The NAAQS for ozone is a three-year average of the fourth highest daily recorded eight-hour concentration of 0.075 ppm. A large percentage of the peak ozone concentrations in Connecticut and Massachusetts are caused by the transport of ozone and its precursors from the New York City area and from other points west and south of Connecticut. In 2006, the maximum recorded fourth highest eight-hour concentration (0.119 ppm) in the study corridor counties was at the Westport monitor. Although NAAQS exceedances correspond to changing summer weather conditions, overall trends are downward.

MOBILE6.2 Air Quality Model

Air pollution dispersion models are utilized to confirm that a new transportation project or program will not exceed the NAAQS or cause a serious degradation in air quality. MOBILE6.2 is the model used in this analysis to estimate the concentration of air pollutants emitted from the various proposed tolling concepts.

MOBILE6.2 was created by the U.S. Environmental Protection Agency to address a wide variety of air pollution modeling needs. The model calculates emission rates for three of the six criteria pollutants: CO, VOC, and NO_2. The rates are calculated under various conditions, such as ambient temperatures and average traffic speeds, which are specified by the modeler. All parameters entered into MOBILE6.2 by the modeler include:

- Calendar year;
- Month (January, July);
- Hourly Temperature;
- Altitude (high, low);
- Weekend/weekday;
- Fuel characteristics (Reid vapor pressure, sulfur content, oxygenate content, etc.);
- Humidity and solar load;
- Registration (age) distribution by vehicle class;
- Annual mileage accumulation by vehicle class;
- Diesel sales fractions by vehicle class and model year;
- Average speed distribution by hour and roadway;
- Distribution of vehicle miles traveled by roadway type;
- Engine starts per day by vehicle class and distribution by hour;
- Engine start soak time distribution by hour;
- Trip end distribution by hour;
- Average trip length distribution;
- Hot soak duration;
- Distribution of vehicle miles traveled by vehicle class;
- Full, partial, and multiple diurnal distribution by hour;
- Inspection and maintenance (I/M) program description;
- Anti-tampering inspection program description;
- Stage II refueling emissions inspection program description;
- Natural gas vehicle fractions;

- HC species output;
- Particle size cutoff;
- Emission factors for PM and Hazardous Air Pollutants; and
- Output format specifications and selections.

In addition, the model is regularly updated to incorporate changes in vehicle, engine, and emission control system technologies as well as changes in regulations, emission standards, and test procedures.[2]

MOBILE6.2 Results

Using MOBILE6.2, year 2015 emission rates were first calculated for each of the four roadway classifications (expressway, arterial/collector, local, and ramp) in each of the eight counties in Connecticut. The mean of the eight counties' emission rates was then calculated to determine a statewide average per roadway type. Emissions rates were calculated for the three criteria pollutants using July weather conditions. July conditions were used because ozone, one of the two pollutants of high concern in Connecticut (described earlier), levels tend to be highest in the summertime. Though CO levels are often highest in wintertime, CO is listed as attainment and trend graphs indicate a continued downward trend in concentrations for CO. Table 6 displays the 2015 emission rates for all vehicle classes. Units of measurement are grams per mile.

[2] U.S. Environmental Protection Agency, User's guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model, August 2003.

Table 6. 2015 Emission Rates for All Vehicle Classes (Grams/Mile)

	County								
	Fairfield	Hartford	Litchfield	Middlesex	New Haven	New London	Tolland	Windham	Statewide Average
Expressway									
VOC	0.236	0.233	0.230	0.230	0.233	0.234	0.230	0.230	0.232
CO	4.411	4.732	4.837	4.781	4.733	4.738	4.825	4.837	4.737
NO_x	0.529	0.558	0.578	0.566	0.558	0.560	0.575	0.578	0.563
Arterials/Collector									
VOC	0.295	0.289	0.257	0.267	0.284	0.278	0.258	0.259	0.273
CO	3.983	4.170	4.211	4.188	4.156	4.173	4.175	4.188	4.156
NO_x	0.327	0.331	0.323	0.325	0.329	0.328	0.322	0.322	0.326
Local									
VOC	0.392	0.391	0.391	0.391	0.391	0.391	0.391	0.391	0.391
CO	3.853	4.072	4.072	4.072	4.072	4.072	4.072	4.072	4.045
NO_x	0.300	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.305
Ramp									
VOC	0.270	0.272	0.272	0.272	0.272	0.272	0.272	0.272	0.272
CO	5.348	5.560	5.560	5.560	5.560	5.560	5.560	5.560	5.534
NO_x	0.431	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.439

Next for seven of the tolling and congestion pricing concepts, the 2015 highway vehicle miles of travel were multiplied by the statewide average expressway emission rates for the No-Build and the Build scenarios (the statewide average was used for consistency as many of the tolling concepts are dispersed geographically throughout the State.) The result was the total highway grams emitted per year for No-Build and Build alternatives.

For concepts where traffic leaves the expressway to avoid paying tolls (Concepts B, C, F, G1, and H), the pollutant's emissions on the diversion routes were also calculated. Here, the vehicle miles of travel from the diverted traffic was multiplied by the statewide average arterial/collector emission rates. This total emission pollutant (grams/year) was then added to the Build alternative highway pollutant total.

The difference between the No-Build and the Build pollutant levels for each concept illustrates the potential for air quality benefits or negative impacts. Table 7 displays differences in the Build and No-Build pollutant levels for each concept.

Table 7. 2015 Pollutant Emissions (Grams/Year)

Concept	Description	Projects	Toll Rate 1	Toll Rate 2	Toll Rate 3	VOC	CO	NO_x
A	New Toll Express Lanes	A1	●			No change in VMT.		
		A2	●			No change in VMT.		
		All	●			No change in VMT.		
B	Border Tolling – Major Only	All	●			11,593	115,467	(635)
		All		●		24,560	125,056	(29,715)
		All			●	34,193	138,886	(49,725)
C	TOT on LAH	All	●			8,588	(85,849)	(41,181)
		All		●		11,354	(91,672)	(49,206)
		All			●	12,836	(105,810)	(56,147)
D	HOV to HOT Conversion	D1	●			No change in VMT.		
		D2	●			No change in VMT.		
		All	●			No change in VMT.		
F	Toll Existing Highways	F1	●			8	(184,963)	(43,906)
		F1		●		19	(463,334)	(109,986)
		F1			●	33	(805,046)	(191,102)
		F2	●			12	(289,860)	(68,807)
		F2		●		33	(782,989)	(185,866)
		F2			●	57	(1,364,200)	(323,833)
		All	●			20	(474,823)	(112,713)
		All		●		52	(1,246,324)	(295,852)
		All			●	90	(2,169,246)	(514,935)
G1	Statewide Tolling – All LAH	G1	●			27,641	(201,862)	(114,737)
		G1		●		33,134	(244,020)	(138,023)
		G1			●	43,299	(335,804)	(184,380)
H	Congested Corridors Only	H2	●					

Generally, where there is an increase in emissions from the No-Build scenario to the Build scenario, there can be a negative impact to air quality. Where there is a decrease in emissions from the No-Build scenario to the Build scenario, there can be a positive impact to air quality. It is important to note that VOC and NO_x, while both precursors to ozone, have varying ratios in the formation of ozone depending on atmospheric conditions. Depending upon the ratio of the VOC to NO_x in the atmosphere at any one time, ozone formation could be caused or limited by VOC only (called VOC-limited) or by NO_x only (called NO_x limited). Sites can be consistently VOC-limited or consistently NO_x limited.

Finally, Concepts A and D do not have changes in vehicle miles of travel (VMT). Thus, changes in pollutant emissions cannot be calculated using the above methodology. In these instances, a qualitative discussion is provided.

A summary of the potential impacts of each of the concepts is below.

Conclusions

- *Concept A – New Toll Express Lanes on I-84 and I-95* – While vehicle miles of travel remains constant between the no-build and build alternatives, vehicle hours of travel and vehicle hours of delay both decrease (reducing emissions) with the construction of toll express lanes in this alternative. In addition, average speeds increase with the implementation of Concept A. These factors would have the effect of reducing emissions. Thus, there is the potential for a beneficial impact from *Concept A*.

- *Concept B – Border Tolling at Major Highways* – Some increase in congestion on local roads; large numbers of motorists may travel fairly short distances on local roads to avoid paying border tolls. VOC, a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. Carbon monoxide emissions increase as well. Thus, there is the potential for a minor adverse impact from Concept B.

- *Concept C – Toll Trucks on Limited Access Highways* – The diversion routes with Concept C are generally longer than traveling on the LAH to reach the same destination. Therefore, as trucks travel longer distances, they will have more vehicle miles of travel and slight increase in emissions. VOC, a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. In addition, if there are delays along the diversion routes in part due to added traffic, this could increase overall vehicle emissions somewhat. Thus, there is the potential for a minor adverse impact from Concept C.

- *Concept D – HOV to HOT Lane Conversion* – While vehicle miles of travel remains constant between the no-build and build alternatives, vehicle hours of travel and vehicle hours of delay both decrease (reducing emissions) with the conversion to HOT lanes in this alternative. In addition, average speeds increase with the implementation of Concept D. These factors would have the effect of reducing emissions. Thus, there is the potential for a beneficial impact from Concept D.

- *Concept F – Tolling for Highways Needing New Capacity* – Motorists divert from limited access highways to arterials to avoid paying tolls. VOC, a precursor to ozone, levels increase in this build concept largely because the VOC emissions rate is higher for arterials than for freeways. Thus, there is the potential for a minor adverse impact from Concept F.

- *Concept G1 – Toll All Limited Access Highways* – The diversion routes with Concept G1 are generally longer than traveling on the LAH to reach the same destination. Therefore, as vehicles travel longer distances, they will have more vehicle miles of travel and slight increase in emissions. VOC, a precursor to ozone, emissions increase with this concept largely because the VOC emissions rate is higher for arterials than for freeways. In addition, if there are delays along the diversion routes in part due to added traffic, this could increase overall vehicle emissions somewhat. Thus, there is the potential for potentially significant impacts from Concept G1.

- *Concept G2 – Tax on all Vehicle Miles of Travel* – An effect of this concept is an overall reduction of VMT on all state and limited access highways. Thus, there is the potential for a beneficial impact from Concept G2.

- *Concept H – Congested Corridor Tolling* – This concept may result in some increase in congestion on local roads, because large numbers of motorists may travel fairly short distances on local roads to avoid paying tolls. Thus, there is the potential for minor adverse impacts from Concept H. Table 8 displays the impacts of each of the concepts.

Table 8. Tolling Concepts Impacts

Concept	Description	Diversions	Potential Impact	Order of Magnitude[a]
A	New Toll Express Lanes	No	Yes	B
B	Border Tolling – Major Only	Yes	Yes	M
C	TOT on LAH	Yes	Yes	M
D	HOV to HOT Conversion	No	Yes	B
F	Toll Existing Highways	Yes	Yes	M
G1	Statewide Tolling – All LAH	Yes	Yes	PS
G2	Tax on All VMT	No	Yes	B
H	Congested Corridors Only	Yes	Yes	M

[a] B = Beneficial; M = Minor Adverse; PS = Potentially Significant.

Based on the previous analysis, Concepts A, D, and G2 have the potential to most significantly benefit air quality. Concept G1 has the greatest potential to decrease the ambient air quality.

In addition, the greenhouse gas CO_2 emissions increase as motor vehicle VMT increases. The Energy Information Administration of the Department of Energy states that 7.9 moles of CO_2 are emitted per VMT.[3] Thus, concepts that show an increase in VMT (Concepts B, C, F, G1, and H) will likely increase CO_2 emissions, having a negative impact on the environment. Concepts that show no change in VMT (Concepts A and D) will likely have no effect on CO_2 emissions, having no impact on the environment. Concepts that show a decrease in VMT (Concept G2) will likely decrease CO_2 emissions, having a positive impact on the environment.

Other traffic-related factors also effect emissions, including idling and the frequent starting/stopping (e.g., in a traffic jam) of vehicles. Idling is not measured in the VMT calculations because the vehicles remain stationary while running. An example of engine idling is warming up a vehicle for 5 to 10 minutes on a cold day. Emissions from a cold, idling engine contain high levels of VOC, NO_x, CO, and CO_2. Stop-and-go traffic creates significantly more emissions than free flow traffic because motor vehicles burn more fuel to perform the stop-and-go operations. The overall VMT in such a case is no greater than if there was free flow traffic. For tolling concepts that divert traffic from relatively uncongested highways to congested arterial roads, the effects of vehicular emissions can be even more pronounced.

10.0 Energy Use and Conservation

The majority of existing energy utilization is the consumption of fossil fuels for motor vehicles using the existing roadway system. Existing energy consumption also includes the use of electricity associated with highway lighting. Electricity service is provided by United Illuminating and Connecticut Light & Power.

Impacts and Mitigation

The following is a summary of the potential impacts of each of the concepts.

- *Concept A – New Toll Express Lanes on I-84 and I-95* – Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be expected to be consumed due to vehicles sitting in traffic yet

[3] Energy Information Administration, http://www.eia.doe.gov/cneaf/alternate/page/environment/exec2.html , 1994.

speeds will not increase to a degree that would result in an overall drop in miles-per-gallon achieved. Thus, there is the potential for a beneficial impact from Concept A.

- *Concept B – Border Tolling at Major Highways* – The average speed of travel decreases for vehicles traveling on local roads while increases for vehicles traveling on limited-access highways. However, if there are delays on local roads due to added congestion, fuel consumption may increase. Thus, there is the potential for a minor adverse impact from Concept B.

- *Concept C – Toll Trucks on Limited Access Highways* – The average speed of travel decreases for trucks traveling on local roads as opposed to on a limited-access highway. However, as trucks travel longer distances, they will have more vehicle miles of travel and slight increase in energy use. If there are delays on local roads due to added congestion, causing trucks to idle in place, fuel consumption may also increase. Thus, there is the potential for a minor adverse impact from Concept C.

- *Concept D – HOV to HOT Lane Conversion* – Average travel speeds are expected to increase with this alternative, and travel delay will be reduced. Consequently, less fuel can be expected to be consumed due to vehicles sitting in traffic, yet speeds will not increase to a degree that would result in an overall drop in miles-per-gallon achieved. Thus, there is the potential for a beneficial impact from Concept D.

- *Concept F – Tolling for Highways Needing New Capacity* – The average speed of travel decreases for vehicles traveling on local roads while increasing for vehicles on limited-access highways. However, if there are delays on local roads due to added congestion, fuel consumption may increase. Thus, there is the potential for a minor adverse impact from Concept F.

- *Concept G1 – Toll All Limited Access Highways* – The average speed of travel decreases for vehicles traveling on local roads as opposed to on a limited-access highway. However, as they travel longer distances, they will have more vehicle miles of travel and a slight increase in energy use. If there are delays on local roads due to added congestion, causing cars and trucks to idle in place, fuel consumption may also increase. Thus, there is the potential for minor adverse impacts from Concept G1.

- *Concept G2 – Tax on All Vehicle Miles of Travel* – An effect of this concept is an overall reduction of VMT on all state and limited access highways, reducing fuel consumption. Thus, there is the potential for a beneficial impact from Concept G2.

- *Concept H – Congested Corridor Tolling* – The average speed of travel decreases for vehicles traveling on local roads while increasing for vehicles on a limited-access highway. However, if there are delays on local roads due to added congestion, causing cars and trucks to idle in place, fuel consumption may also increase. Thus, there is the potential for minor adverse impacts from Concept H. Table 9 displays the impacts of each of the concepts.

Table 9. Tolling Concepts Impacts

Concept	Description	Diversions	Potential Impact	Order of Magnitude[a]
A	New Toll Express Lanes	No	Yes	B
B	Border Tolling – Major Only	Yes	Yes	M
C	TOT on LAH	Yes	Yes	M
D	HOV to HOT Conversion	No	Yes	B
F	Toll Existing Highways	Yes	Yes	M
G1	Statewide Tolling – All LAH	Yes	Yes	M
G2	Tax on All VMT	No	Yes	B
H	Congested Corridors Only	Yes	Yes	M

[a] B = Beneficial; M = Minor Adverse; PS = Potentially Significant.

Based on the above analysis, Concepts A, D, and G2 have the potential to most reduce energy use. Alternatives B, C, F, G1, and H have the most potential to increase energy use. In addition, any additional lighting and/or power required at the tolling gantries may increase energy use. Any new lighting installed near gantries should incorporate the use of energy efficient lighting fixtures.

11.0 Bicycle and Pedestrian Facility Impacts

Bicycling and walking are active forms of transportation in Connecticut. Travelers use their bicycles for utilitarian, commuting, fitness, and recreational uses. Currently, bicyclists are permitted to ride on all roads in Connecticut, with the exception of limited access highways. Pedestrian activities are often highest in village centers, commercial areas, transit areas, and near neighborhood schools and parks. The Connecticut Department of Transportation has identified recommended cross-stated bicycle routes in their 2002 State Bike Map. These routes are identified in Figure 9.

Impacts and Mitigation

The following is a summary of the potential impacts of each of the concepts.

- *Concept A – New Toll Express Lanes on I-84 and I-95* – Bicyclists and pedestrians are not permitted on limited access highways, which are the only routes that would be affected by this alternative. Thus, there is likely no potential impact from Concept A.

- *Concept B – Border Tolling at Major Highways* – An effect of this concept would be that motorists leave the tolled route, a limited access highway, to avoid paying the toll. While bicyclists and pedestrians are not allowed on limited access highways, they are permitted on all other roadways in the State of Connecticut. The motorists that are leaving the highway to avoid the toll would most likely be moving to routes that bicycles and pedestrians can and likely do use. As toll rates rise, the number of motorist finding alternative routes would rise. The additional motor vehicles on the diversion routes would have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns. Thus, there is the potential for a minor adverse impact from Concept B.

- *Concept C – Toll Trucks on Limited Access Highways* – An effect of this concept would be that truckers leave the tolled route, a limited access highway, to avoid paying the toll. While bicyclists and pedestrians are not allowed on limited access highways, they are permitted on all other roadways in the State of Connecticut. The truckers that are leaving the highway to avoid the toll would be moving to routes that bicycles and pedestrians can and likely do use. As toll rates rise, the number of truckers seeking alternative routes would rise. The additional trucks on the diversion routes would have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns. The diversion routes identified for this alternative are located on portions of Connecticut Department of Transportation cross-state bicycle routes. In addition, where trucks would be diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel. Thus, there is the potential for a significant impact from Concept C.

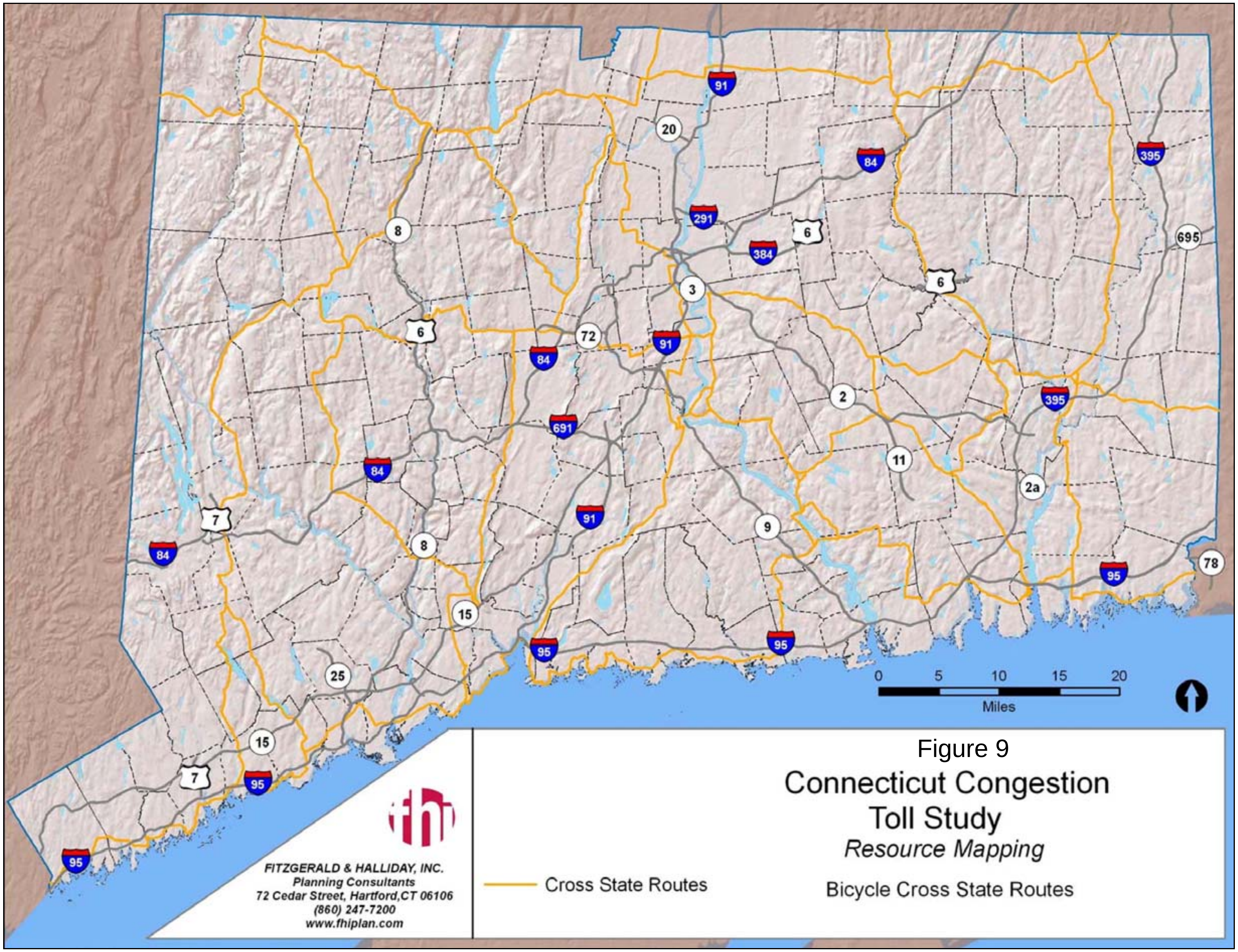

Figure 9
Connecticut Congestion Toll Study
Resource Mapping
Bicycle Cross State Routes

- *Concept D – HOV to HOT Lane Conversion* – Bicyclists and pedestrians are not permitted on limited access highways, which are the only routes that would be affected by this alternative. Thus, there is likely no potential for impact from Concept D.

- *Concept F – Tolling for Highways Needing New Capacity* – An effect of this concept would be that motorists leave the tolled route, a limited access highway, to avoid paying the toll. While bicyclists and pedestrians are not allowed on limited access highways, they are permitted on all other roadways in the State of Connecticut. The motorists that would be leaving the highway to avoid the toll would be moving to routes that bicycles and pedestrians can and likely do use. As toll rates rise, the number of motorists seeking alternative routes would rise. The additional motor vehicles on the diversion routes would have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns. The diversion routes (Route 1) identified for this alternative are located on portions of Connecticut Department of Transportation cross-state bicycle routes. In addition, where motorists would be diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel. Portions of Route 1 are designated as a cross-state bicycle route. Thus, there is the potential for a significant impact from Concept F.

- *Concept G1 – Toll All Limited Access Highways* – An effect of this concept would be that motorists leave the tolled route, a limited access highway, to avoid paying the toll. While bicyclists and pedestrians are not allowed on limited access highways, they are permitted on all other roadways in the State of Connecticut. The motorists that would be leaving the highway to avoid the toll would be moving to routes that bicycles and pedestrians can and likely do use. As toll rates rise, the number of motorists seeking alternative routes would rise. The additional motor vehicles on the diversion routes would have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns. The diversion routes identified for this alternative are located on portions of Connecticut Department of Transportation cross-state bicycle routes. In addition, where motorists would be diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel. Thus, there is the potential for potentially significant impacts from Concept G1.

- *Concept G2 – Tax on all Vehicle Miles of Travel* – An effect of this concept would be an overall reduction of VMT on all state and limited access highways, making bicycle and pedestrian travel safer and more pleasant. Thus, there is the potential for beneficial impacts from Concept G2.

- *Concept H – Congested Corridor Tolling* – An effect of this concept would be that motorists leave the tolled route, a limited access highway, to avoid paying the toll. While bicyclists and pedestrians are not allowed on limited access highways, they are permitted on all other roadways in the State of Connecticut. The motorists that would be leaving the highway to avoid the toll would be moving to routes that bicycles and pedestrians can and likely do use. As toll rates rise, the number of motorists seeking alternative routes would rise. The additional motor vehicles on the diversion routes would have a negative impact on bicyclists and pedestrians, creating additional travel time, noise, air pollution, and safety concerns. The diversion routes identified for this alternative are located on portions of Connecticut Department of Transportation cross-state bicycle routes. In addition, where motorists would be diverted to routes that serve as a 'Main Street' within a village center, they may impact safety and convenient access where pedestrian activity is a common mode of travel. Thus, there is the potential for potentially significant impacts from Concept H. Table 10 displays the impacts of each of the concepts.

Table 10. Tolling Concepts Impacts

Concept	Description	Diversions	Potential Impact	Order of Magnitude[a]
A	New Toll Express Lanes	No	No	
B	Border Tolling – Major Only	Yes	Yes	M
C	TOT on LAH	Yes	Yes	PS
D	HOV to HOT Conversion	No	No	
F	Toll Existing Highways	Yes	Yes	PS
G1	Statewide Tolling – All LAH	Yes	Yes	PS
G2	Tax on All VMT	No	Yes	B
H	Congested Corridors Only	Yes	Yes	PS

[a] B = Beneficial; M = Minor Adverse; PS = Potentially Significant.

Based on the above analysis, Concepts C, F, G1, and H have the potential to most negatively impact bicyclists and pedestrians. Alternative G2 has the most potential positively impact bicyclists and pedestrians. Alternatives A and D would likely not impact bicyclists and pedestrians. If an alternative that has the potential to negatively impact bicyclists and pedestrians is selected for implementation, improvement measures, such as bike lanes, signage, markings, sidewalks, and marked crossings, should be considered on diversion routes.

12.0 Social/Community Resources

Social and community resources considered for this environmental screening were limited to those directly related to quality of life for state residents. Economic effects of the tolling and congestion pricing alternatives, including potential impacts to employment and cost of living have been addressed separately in the technical appendix on financial issues and economic costs and benefits. The resources considered here include potential project impacts to:

- **Land Use, Zoning, and Development Patterns –** Local land use patterns;
- **Implementation of the State Plan of Conservation and Development –** Statewide development patterns;
- **Community Cohesion –** Neighborhoods and their defining characteristics, including resources such as schools, libraries, and community centers;
- **Environmental Justice –** Disproportionate effects on locations with concentrations of low-income and minority populations; and
- **Cultural Resources –** Direct project effects to historic and/or archeological resources or changes to the visual setting and access to historic sites and resources.

It should be noted that there is expected to be some widening of I-84 and I-95 in the future which would accommodate tolling and the construction of which may have substantive direct impacts to social and community resources. Those impacts are not considered here since the impacts of those reconstruction projects will be addressed and mitigated as a part of formal environmental documentation during their development. Consequently, impacts of *Concept F – Tolling for Highways Needing New Capacity* are only addressed in the context of the addition of tolling facilities to these roads.

Land Use and Zoning

Land Use

Land use in Connecticut has generally been mapped in two ways. Existing land use is mapped by political subboundary by Connecticut municipalities and/or planning regions. These maps vary greatly in terms of land use categories, level of detail, and the date of the most recent mapping. However, these maps generally distinguish among major types of land development (open space, residential, commercial, and industrial) and call out transportation infrastructure as a separate land use category.

A statewide land cover map has also been developed by the University of Connecticut Center for Land Use Education and Research (CLEAR). This map focuses on broad categories of land cover associated with different types of land use from developed land to agricultural lands to forested areas to wetlands and water bodies. Thus, all human development that results in coverage other than natural features or farmland, regardless of type (such as residential versus commercial versus industrial) falls into the all-encompassing 'developed' land category. The most recent 2002 map shows a pattern of the most intense development in a wide band north to south through central Connecticut and along the shoreline, particularly in southwestern Connecticut. The Hartford metropolitan area in the near center of the State is also particularly densely developed, extending roughly 10 miles in a wide circle from the urban core. Northwestern and northeastern Connecticut tend to be the most rural and undeveloped areas of the State. A comparison of changes in land cover from 1985 to 2002 indicates some intensification of development in existing developed areas with no substantive change in patterns statewide. Figure 10 displays the CLEAR 2006 statewide land-cover map.

When viewed aerially, land use in Connecticut can be seen to very generally follow traditional New England development patterns with urban areas surrounded by less dense suburban land uses dominated by single-family housing, with commercial activity clustered along major arterial roads and small rural towns and villages surrounded by very low-density residential areas, agriculture, and undeveloped lands. Land use along the interstate and state route corridors tend to mirror this pattern. The interstate routes link and are linked by the major metropolitan areas. Land in between the urban centers along these highways is generally suburban with more rural stretches of roadway near the Massachusetts and Rhode Island borders. Connecticut's state routes link the smaller cities with the less suburban, more rural areas in between them. The exception is Route 15, which traverses one of the most densely developed areas of the State, connecting the wealthy 'Gold Coast' small-town communities such as Greenwich, Darien, New Canaan, Westport, and Fairfield with suburban towns such as Hamden, Cromwell, and Rocky Hill, and the central Connecticut small cities of Wallingford and Meriden. Connecticut's 'Gold Coast' is a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers.

Zoning

The authority to zone in Connecticut is derived from the Connecticut General Statutes (CGS) Chapter 124. Each of Connecticut's municipalities has adopted their own set of zoning regulations tailored to their community needs and vision. In most communities, zoning districts encompass the arterial road system. In addition, zoning districts often follow the highways such that the interstate and state route system serves as zoning district boundaries.

State transportation system projects are not subject to local zoning authority. However, Connecticut Department of Transportation considers local zoning as a part of its efforts to achieve context-sensitive design. Environmental documentation of state transportation projects also considers the consistency of a project with local zoning to gain an understanding of its potential conflict with the local municipality's land development vision.

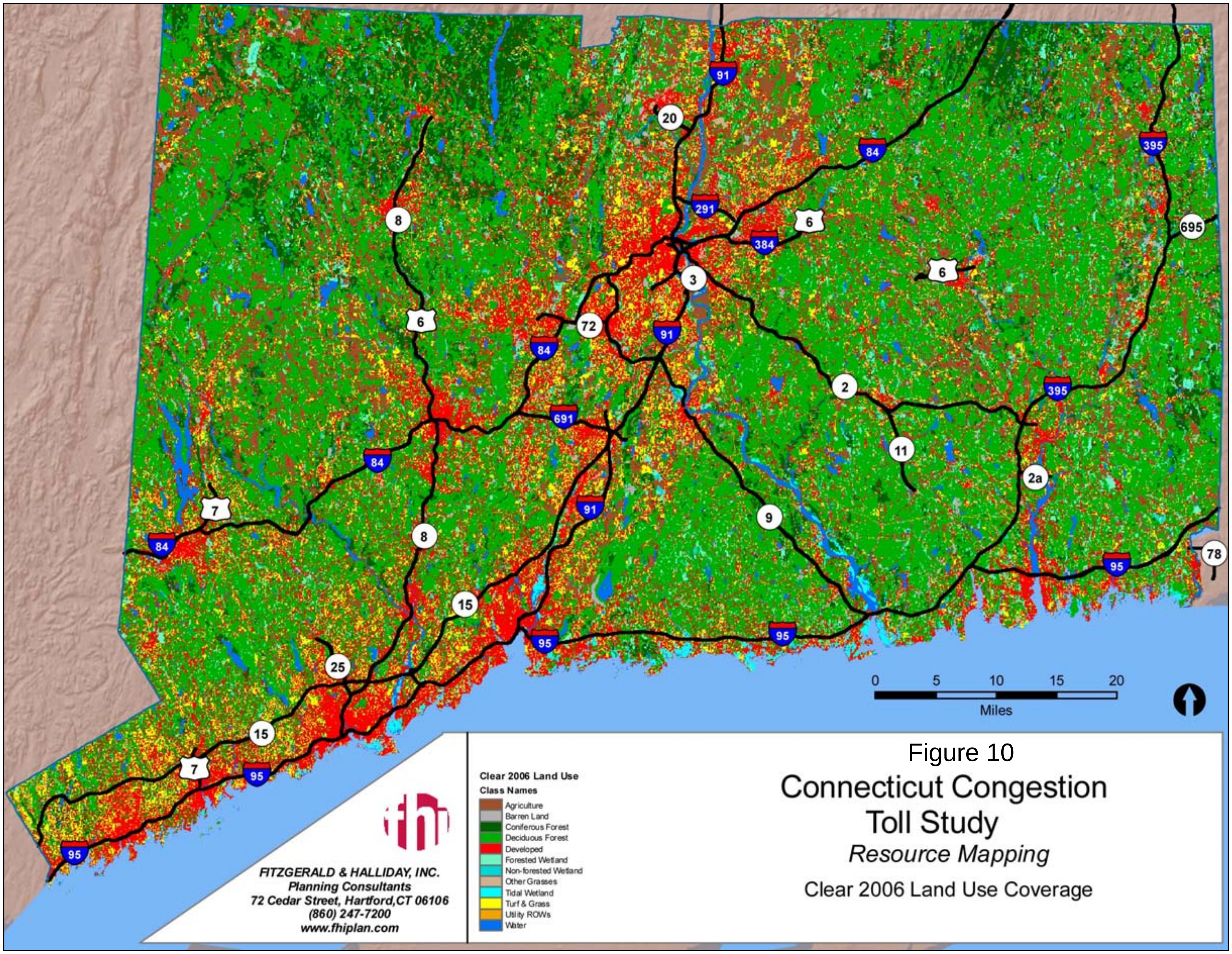
Figure 10
Connecticut Congestion
Toll Study
Resource Mapping
Clear 2006 Land Use Coverage
Clear 2006 Land Use
Class Names
Agriculture
Barren Land
Coniferous Forest
Deciduous Forest
Developed
Forested Wetland
Non-forested Wetland
Other Grasses
Tidal Wetland
Turf & Grass
Utility ROWs
Water
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Impacts

Impacts to land use are generally assessed in terms of the following factors:

- Land acquisitions and displacements;
- Encroachments on existing land use;
- Compatibility of the project with existing land use;
- Changes in access to land; and
- Changes to the pattern of land use.

It is anticipated that all of the tolling gantries/facilities will be located within the existing right-of-way of the tolled interstates and routes. As such, they are not expected to have any direct adverse effect on land. No land acquisitions or displacements are anticipated. There will be no encroachments on existing developments. Also, they will be an addition to existing roadway infrastructure, and will not alter the compatibility of those roadways with surrounding land uses.

Substantial alterations to the accessibility of land can induce changes on land use patterns. New highway interchanges, for example, can make it much easier to get to undeveloped parcels that abut the roadway, making them much more economically attractive for investment. While the tolling alternatives will not add any new access points along the tolled roads, they can discourage the use of some roadways due to cost, and divert some traffic to local roads. Impediments to access along local roads could include traffic congestion that makes direct turning movements difficult or more hazardous. Conversely, a reduction in congestion will make travel on some roadways easier, encouraging infill development near interchange areas. The potential impacts to development patterns in response to travel costs, the easing of congestion, and the diversion of traffic for the individual alternatives can be expected to be as follows:

- No effect, primarily due to no diversion of traffic:
  - *Concept A – New Toll Express Lanes on I-84 and I-95* – New express toll lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept D – HOV to HOT Lane Conversion* – New HOT lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept G2 – Tax on all Vehicle Miles of Travel* – The impacts of tolling will be felt statewide and distributed across the State such that diversions of traffic are not expected to occur and overall development patterns unaffected.
- Potential Adverse Effects:
  - *Concept B – Border Tolling at Major Highways* – This alternative would result in diversion of traffic to local alternate routes. This could impact local traffic conditions and access to businesses and homes along those local routes. It may also degrade the ambience of the communities through which the diverted vehicles travel, making them less attractive for economic development. While the diversion

routes would not be any longer than the main highway routes, drivers are still expected to choose free routes to some degree. The highest percentage of vehicles is expected to divert at the more rural crossings at the Massachusetts and Rhode Island borders. This might impact traffic through Enfield, Union, Thompson, Killingly, and North Stonington. The greatest number of vehicles divert at the more congested crossings on the New York border in southwestern Connecticut, impacting the communities of Danbury and Greenwich.

– *Concept C – Toll Trucks on Limited Access Highways* – Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Nonetheless, additional truck traffic on local roads can pose traffic safety issues and make turning movements more hazardous and challenging. All communities where diversions might occur would be impacted.

– *Concept F – Tolling for Highways Needing New Capacity* – This concept diverts considerable traffic to free parallel alternate routes, such as Route 1 along I-95 and a series of routes in the I-84 corridor. There also would likely be some diversion of trips to transit with relatively more diversion in the I-84 corridor than in the I-95 corridor. Route 1 is a major commercial corridor along Connecticut's shoreline and already experiences peak-period congestion in a number of locales. It traverses a number of village and town centers and is a tourist destination. Access for all of these land uses between Branford and North Stonington could be adversely affected by added local traffic congestion. Communities that would be most affected along the I-84 corridor include Danbury, Newtown, Brookfield, Southbury, and Middlebury.

– *Concept G1 – Toll All Limited Access Highways* – 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. Communities that would be most affected in the I-91 corridor due to additional congestion on local roads include Wethersfield, Cromwell, Wallingford, Hamden, Orange and all the cities and small towns of Connecticut's 'Gold Coast'.

– *Concept H – Congested Corridor Tolling* – This concept has only been developed for I-95 and Route 15 as Connecticut's most congested routes. The largest diversion would occur from I-95 southbound in the A.M. peak period. There would be lower diversion levels on Route 15, and during the P.M. peak period on both roadways. There could be substantive adverse impacts to local traffic conditions throughout Connecticut's 'Gold Coast', as most of the communities there already experience peak-period congestion and, in particular, congested travel through downtowns and village centers.

Zoning impacts are assessed in terms of whether the proposed project would be an allowable land use within the zones where it is located. As noted above, state transportation projects do not have to comply with local zoning. Nonetheless, Tolling and congestion pricing alternatives are not expected to conflict with any existing zoning as the tolling facilities will be located within the current highway right-of-way. As part of the existing roadway infrastructure, they will not conflict with intended land use as indicated through zoning and will not change the type of use of any existing development.

Consistency with State Plan of Conservation and Development

The Connecticut Office of Policy and Management (OPM) Conservation and Development Policies Plan for Connecticut 2005–2010 (C&D Plan) contains growth management, economic, environmental quality, and public service infrastructure guidelines and goals for the State of Connecticut. The overall strategy of the C&D Plan is to reinforce and conserve existing urban areas, to promote staged, appropriate, sustainable development, and to preserve areas of significant environmental value. The Locational Guide Map which accompanies the C&D Plan provides a geographical interpretation of the State's conservation and development policies. The six principles which provide the framework for the plan include:

1. Redevelop and revitalize regional centers and areas with existing or currently planned physical infrastructure;

2. Expand housing opportunities and design choices to accommodate a variety of household types and needs;

3. Concentrate development around transportation nodes and along major transportation corridors to support the viability of transportation options;

4. Conserve and restore the natural environment, cultural and historical resources, and traditional rural lands;

5. Protect and ensure the integrity of environmental assets critical to public health and safety; and

6. Promote integrated planning across all levels of government to address issues on a statewide, regional, and local basis.

Impacts

The tolling and congestion pricing alternatives could be inconsistent with the statewide vision for future land use only under those conditions where they might induce broad changes to land use patterns that conflict with the goals of the C&D Plan. As noted in the section on land use above, impacts to the pattern of land use may occur where traffic diversions to local roads adversely affect access to land. While added local roadway congestion might inhibit economic development in some already heavily traveled areas, it may also encourage sprawl along some more rural routes. This sprawl would represent the most potential for conflict with the C&D Plan. It would conflict with the C&D Plan designation of lands to be preserved as rural or conservation areas. All alternatives with some potential to divert traffic through village centers or rural lands have potential to conflict with the C&D Plan land use policies map.

Community Cohesion

Community cohesion refers to the sense of togetherness exhibited by members of a community. It is characterized by resident's expression of common belonging or unity within a specific geographic area and is typically related to common experiences such as similar lifestyles, similar family structure, common values, and shared goals for their community.

Areas reflecting community cohesion considered for this environmental screening include:

- Residential clusters (indicating potential neighborhoods);
- Community downtowns; and/or
- Other recognized village centers.

Only those cohesive areas abutting or adjacent to the routes to be tolled or along routes receiving diverted traffic were considered. The scope of this analysis did not permit a comprehensive documentation of recognized neighborhoods.

The locations of communities and neighborhoods along the interstate and state route corridors generally follow the patterns of land use as described above. In addition to village, town, and city centers that abut these roadways, there are some clusters of residential development/neighborhoods outside those centers also in close proximity (within 500 feet) to these roads. These were identified as part of the mapping of noise sensitive receptors in Section 8.0 of this technical appendix. These neighborhood pockets are most notable in southwestern and coastal Connecticut, between Danbury and Waterbury along I-84, all along Route 15, Route 8 between Derby and Waterbury and along I-395.

Impacts

Impacts to community cohesion are considered changes to quality of life affecting neighborhoods and/or whole communities. Those potential impacts are considered to include substantive changes to:

- Community institutions;
- Structures important to the cohesive architectural or historical fabric of the neighborhood;
- Introduction of physical barriers to resident interaction within a neighborhood;
- Convenient access within the neighborhood for vehicles;
- Connectivity and access for pedestrians or bicyclists – This access is addressed in a separate section of this technical appendix; and
- Air quality or noise levels – These are addressed in separate sections of this technical appendix.

None of the tolling and congestion pricing alternatives will result in any removal of any structures, as all construction is expected to occur within the existing roadway rights-of-way. Consequently, no community impacts in terms of institutions or elements of cohesive architecture or historic community fabric are anticipated. As no new roadway elements will be constructed, no new physical barriers to resident interaction will occur. Other potential effects on community cohesion by alternative are stated below.

- No effect, primarily due to no diversion of traffic:
  - *Concept A – New Toll Express Lanes on I-84 and I-95* – New express toll lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept D – HOV to HOT Lane Conversion* – New HOT lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept G2 – Tax on all Vehicle Miles of Travel* – The impacts of tolling will be felt statewide and distributed across the State such that diversions of traffic are not expected to occur and overall community cohesion unaffected.
- Potential Adverse Effects:
  - *Concept B – Border Tolling at Major Highways* – This alternative would result in the diversion of traffic to local alternate routes. This could impact local traffic conditions and access to businesses and homes along those local routes. It may also make travel by bicycle and on foot more difficult, particularly for roadway crossings. Finally, it may degrade the ambience of the communities through which the diverted vehicles travel, including increased noise levels. While the diversion routes would not be any longer than the main highway routes, drivers are still expected to choose free routes to some degree.

    The highest percentage of vehicles diverted under Concept B is expected to be at the more rural crossings at the Massachusetts and Rhode Island borders. This might impact traffic through Enfield, Union, Thompson, Killingly, and North Stonington.

    The greatest number of vehicles divert at the more congested crossings on the New York border in southwestern Connecticut, impacting the communities of Danbury and Greenwich. Routes that might be used for diversion in Greenwich could increase traffic in Greenwich's downtown.

    The border of Connecticut at I-84 near Danbury is a mixture of medium density suburban uses with several large undeveloped properties or vacant properties proposed for redevelopment. Traffic diversions at this border are not expected to have any negative community effects.
  - *Concept C – Toll Trucks on Limited Access Highways* – Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Nonetheless, additional truck traffic on local roads can pose pedestrian and bicyclist safety issues, increase noise levels, and impact visual character. All communities where diversions might occur would be impacted. In particular, village centers and downtowns along Route 1 and in southwestern Connecticut may be affected. This is an area in Connecticut's 'Gold Coast', a highly developed suburban area with compact communities featuring cohesive, pedestrian-scale and aesthetic village centers. Traffic diverted through these communities' centers can be expected to have a substantial adverse effect of residents' experience of their community.
  - *Concept F – Tolling for Highways Needing New Capacity* – This concept diverts considerable traffic to free parallel alternate routes, including Route 1 along I-95 and a series of routes in the I-84 corridor. There also would likely be some diversion of

trips to transit with relatively more diversion in the I-84 corridor than in the I-95 corridor. Route 1 is a major corridor linking Connecticut's shoreline communities and already experiences peak-period congestion in a number of locales. It traverses a number of cohesive, historic, and aesthetic village and town centers and is a tourist destination. Traffic diverted through these communities between Branford and North Stonington could be adversely affected by added local traffic congestion. Communities that would be most affected along the I-84 corridor include Danbury, Newtown, Brookfield, Southbury, and Middlebury, with Danbury and Newtown most likely to benefit from additional transit trips.

– *Concept G1 – Toll All Limited Access Highways* – This concept would result in some vehicle diversion from all of the tolled routes to parallel local routes. Impacts would be similar to those described for Alternative C. The greatest diversion would occur on I-91 between Hartford and New Haven. Community cohesion that would be most affected in the I-91 corridor due to additional congestion on local roads could occur in Wethersfield, Meriden, Cromwell, Wallingford, and Hamden. The greatest cluster of neighborhoods in close proximity to the interstates is along I-95 from New Haven to Stamford. Community cohesion that would be most affected in the I-95 corridor due to additional congestion on local roads could include West Haven, Bridgeport, Milford, Stratford, and Darien.

– *Concept H – Congested Corridor Tolling* – This concept has only been developed for I-95 and Route 15 as Connecticut's most congested routes. The largest diversion would occur from I-95 southbound in the A.M. peak period. There would be lower diversion levels on Route 15, and during the P.M. peak period on both roadways. There could be substantive adverse impacts to local traffic conditions throughout Connecticut's 'Gold Coast', as most of the communities there already experience peak-period congestion and, in particular, congested travel through downtowns and village centers.

Environmental Justice

Title VI of the Civil Rights Act of 1964 specifies that *no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.* Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued in 1998, states that each Federal agency *shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations*.

In order to evaluate the tolling alternatives for the purposes of environmental justice, U.S. Census Bureau (Census) data (2000) were used to determine the presence or concentration of minority and low-income populations within the major interstate and state route corridors. The data collection effort focused on the census tracts (survey areas for the Census) that fall within or partially within those corridors. Figure 11 shows the locations of the census tracts with environmental justice populations statewide. A concentration of environmental justice populations is considered to exist where the percentage of those populations in a given Census Tract are 10 percent higher or more than either the municipality or region where it is located or where the concentration of low-income or minority populations is 25 percent or higher. Minority populations are those classified in any category but White by the U.S. Census. Low income is any individual or family at or below the Federally definition of poverty level. The Federal Department of Health and Human Services calculated the 2000 U.S. poverty rate at an income of $14,150 or less for a family of three.

Impacts

Impacts to environmental justice populations may stem from actions or projects that disproportionately affect these individuals. The issue of financial equity (who would pay the tolls and how that would be distributed among different groups) is addressed in another technical appendix to this study. Key factors analyzed to assess environmental justice equity impacts include:

- Availability and ease of travel by alternate modes – transit, walking and bicycling;
- Availability of convenient alternate travel routes for local travel; and
- Community disruption for environmental justice neighborhoods.

Figure 11 shows the concentrations of environmental justice populations throughout the State.

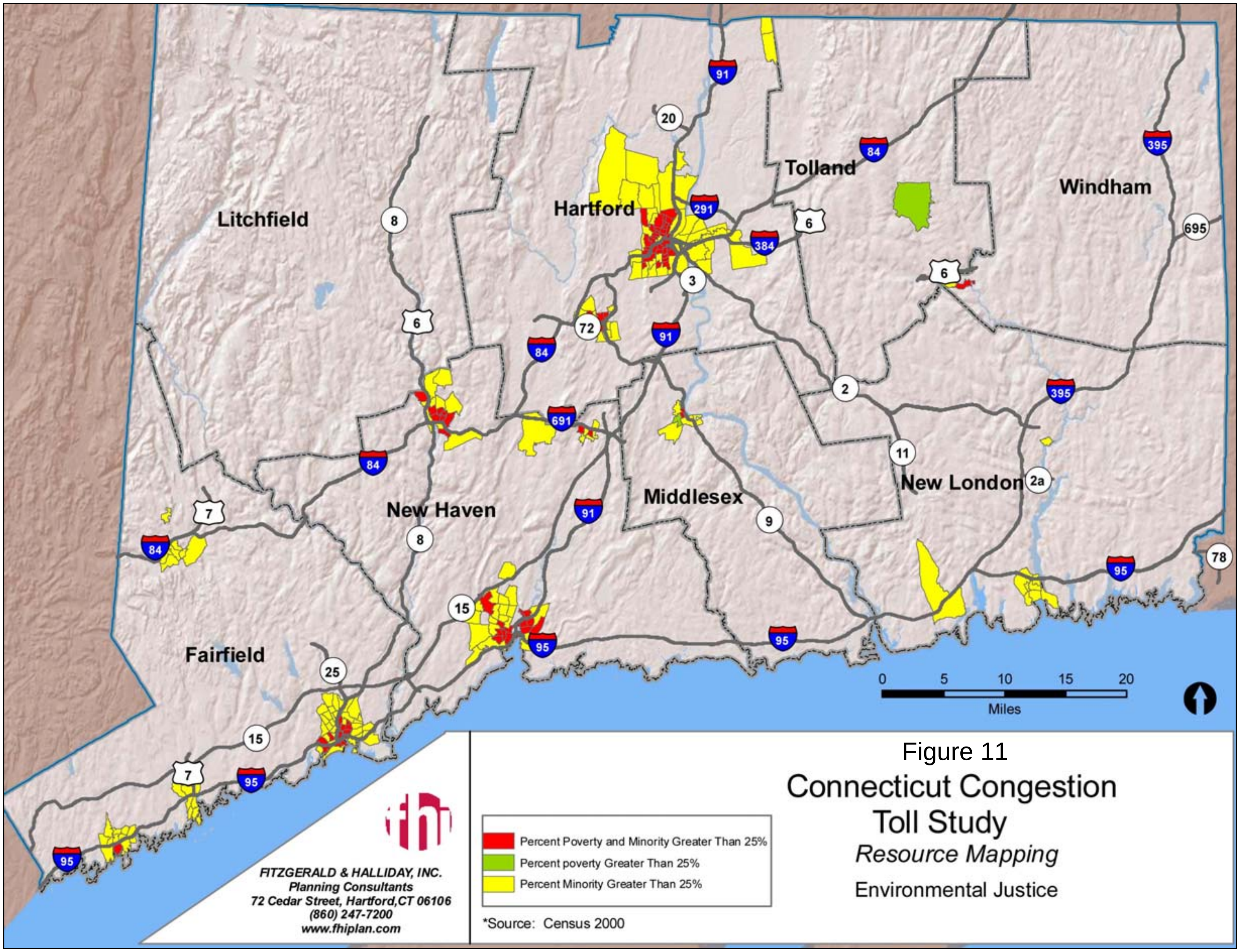

Figure 11
Connecticut Congestion Toll Study
Resource Mapping
Environmental Justice

Potential impacts to environmental justice population by alternative is summarized below.

- No effect, primarily due to no diversion of traffic:
  - *Concept A – New Toll Express Lanes on I-84 and I-95* – New express toll lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept B – Border Tolling at Major Highways* – This alternative would result in diversion of traffic to local alternate routes. However, there are no concentrations of environmental justice populations at the border in the communities where the diversions are expected to occur.
  - *Concept D – HOV to HOT Lane Conversion* – New HOT lanes will attract traffic, but general purpose lanes will remain available.
  - *Concept G2 – Tax on All Vehicle Miles of Travel* – The impacts of tolling will be felt statewide and distributed across the State such that diversions of traffic are not expected to occur and environmental justice populations not affected.
- Potential Adverse Effects:

  Tolls in the vicinity of disadvantaged populations may discourage highway use and make travel more expensive and/or more inconvenient. Added traffic congestion in a neighborhood with an environmental justice population has a potential to expose them to a higher burden of community impacts.

  - *Concept C – Toll Trucks on Limited Access Highways* – Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Nonetheless, additional truck traffic on local roads can pose pedestrian and bicyclist safety issues, increase noise levels, and impact visual character. Communities where diversions might occur include:
    - Numerous environmental justice populations are located along the I-95 diversion routes in southwestern Connecticut, including Stamford, Norwalk, Bridgeport and New Haven;
    - Environmental justice populations are located along I-84 and I-91 in the Greater Hartford area; and
    - Environmental justice populations are located along the diversion routes in the Danbury area.
  - *Concept F – Tolling for Highways Needing New Capacity* – This concept diverts considerable traffic to free parallel alternate routes, including Route 1 along I-95 and a series of routes in the I-84 corridor. There also would likely be some diversion of trips to transit with relatively more diversion in the I-84 corridor than in the I-95 corridor. Route 1 is a major corridor linking Connecticut's shoreline communities and there is potential for impacts to environmental justice populations in Niantic and New London. In addition, diversion routes in the Danbury area may impact environmental justice populations there.

– *Concept G1 – Toll All Limited Access Highways* – This concept would result in some vehicle diversion from all of the tolled routes to parallel local routes. Impacts would be similar to those described for Alternative C. The greatest diversion would occur on I-91 between Hartford and New Haven. Environmental justice populations in Meriden and New Haven may be impacted by use of diversion routes in those communities. There are also environmental justice populations along diversion routes on I-95 in Stamford, Norwalk, and Bridgeport.

– *Concept H – Congested Corridor Tolling* – This concept has only been developed for I-95 and Route 15 as Connecticut's most congested routes. The largest diversion would occur from I-95 southbound in the A.M. peak period. There would be lower diversion levels on Route 15, and during the P.M. peak period on both roadways. There could be impacts to environmental justice populations in Bridgeport, Norwalk, and Stamford.

Cultural Resources

As a state with a history dating back to the founding of the United States, Connecticut has an abundance of historic resources, both standing structures and as part of historic period archeological sites. In addition, the presence of Native American populations and settlement patterns predating and continuing throughout the settlement of Connecticut by Europeans means there is also strong potential for the presence of prehistoric archeological remains throughout the State. While the greatest concentrations of historic resources in Connecticut that have been included on or determined eligible for the National Register of Historic Places (NRHP, National Register) are in traditional urban centers, they are also clustered all along Connecticut's coastline. In addition, Connecticut has an historic parkway. The length of the Merritt Parkway (Route 15) is on the NRHP and is noted for its historic architecture and landscape as well as individually unique bridges.

Impacts

Impacts to historic resources are assessed in terms of direct impacts to historic structures and sites that have been placed on or deemed eligible for inclusion on the National Register. Indirect impacts to historic resources may also occur where access to a resource is impaired or the visual setting is altered.

Potential direct impacts to historic and archeological resources from the proposed tolling and congestion pricing alternatives are expected to be limited and localized, since the tolling infrastructure footprint is generally very limited in size. In addition, since construction will be limited to existing roadway rights-of-way where the ground has been previously disturbed for roadway construction, it is less likely that intact archeological resources of value remain there.

Indirect impacts to historic resources have the potential to occur where tolling gantries, due to their height, intrude on the visual landscape in scenic historic areas that abut the tolled roads. This potential can only be accurately evaluated at such time that one or more of the tolling options are forwarded to design. However, any tolling on the Merritt Parkway (Route 15) is anticipated to have an adverse effect on the visual setting of this resource. It would also directly impact the historic landscape by virtue of the construction within the parkway right-of-way. Coordination with the State Historic Preservation Office will be essential to a definitive determination of effect on this resource and relevant mitigation.

Appendix D

Economic Impacts

Economic Impacts

1.0 Approach to Economic Impact Assessment

The economic impacts of tolling and congestion pricing on local, regional, and state economies will likely be a critical component of upcoming public discussions about such proposals. A number of issues are critical to this topic:

- Is congestion perceived to be a significant economic problem in its own right, and something that residents and businesses would like the government to address; surveys in London in the late 1990s, when the implementation of cordon tolling around central London was being considered – rated public transportation and congestion as the two most important problems for government to address.

- Are the tolling and congestion pricing proposals aimed at addressing these congestion problems, and (equally important) are they perceived by the public as: 1) part of the solution to congestion – would they actually reduce congestion and provide tolled travelers with a faster, more reliable trip; or 2) merely as a way of raising funds with little impact on congestion levels.

- Are there any "earmarked" programs linked to the tolling or congestion pricing proposal that would: 1) help address potential impacts of those proposals (e.g., using pricing revenues to substantially improve transit in the same travel markets); or 2) be directed toward other public investments that the newly tolled travelers would view as beneficial (e.g., road or bridge maintenance). The London plan was tied to a significant improvement in public transit services within London, and similar transit investments were tied to the New York City proposal.

Like the extent of traffic diversion, modal shifting, equity, etc., as discussed earlier in this proposal, the potential for economic impacts – positive and negative – will primarily depend on the size and nature of the tolling or congestion pricing proposal. The present charge for entering and traveling within the London congestion zone on weekdays (7:00 a.m. to 6:30 p.m.) is close to $16.00 – clearly well above anything likely to be considered in any Connecticut travel market. More modest tolls would lessen the fear of negative economic impacts, but would also have fewer impacts on travel decisions and congestion levels.

The biggest concerns typically relate to so-called spatial competition differences created by a congestion toll, which in effect are so-called "horizontal equity" concerns that different geographic areas are being treated differently under a given policy. In large cities like New York City, businesses already face a congestion toll for large freight shipments, but it's levied by the shippers as a congestion surcharge on their customers rather than by a transportation agency. Congestion itself, and the significant costs it places on businesses, is really the ultimate congestion fee.

The question in this instance is will a congestion toll on key highways entering, say, Hartford, put employers in that City at a disadvantage, as it would be harder to attract workers to Hartford job sites, reducing their available workforce and increasing their costs. However, these commuter costs could be overshadowed by somewhat faster, more reliable work trips due to reduced congestion, improved freight movements, and similar benefits. Many of the concepts under consideration in this study did not have meaningful congestion relief as a principal goal, and would instead primarily focus on raising revenues.

■ 2.0 Economic Impact Factors Considered

The factors discussed below were used in assessing potential significant economic impact issues of possible roadway tolling and congestion pricing concepts.

Economic Costs of Congestion – This factor relates to the extent to which: 1) the highway travel market in question experiences significant congestion at this time; and 2) the concept under consideration holds the potential for a significant change in congestion levels, leading to travel benefits that could offset, in travelers' and shippers' minds, the cost of the toll. The fact that congestion is often relatively modest on most of the State's highway segments, and that the bulk of the concepts were not meaningfully focused on congestion relief, were important factors in these assessments.

Nature of Tolling Program – This factor considered the level of tolling overall and in peak periods and whether the concept's tolling strategy had a congestion-relief component. Many of the concepts tested included consideration of multiple tolling levels, with the lowest tolls likely to have a relatively minimal impact on travelers' decisions and related economic competitiveness. At the same time, very few were expected to make a meaningful change in congestion levels.

Spatial Competition Issues – Focused on if the concepts involve tolls across most of the State, or only on a select number of areas, creating concern over local market impacts, especially if area roadways are tolled with no offsetting congestion relief.

Highway's Market Role and Travel Alternative – Whether the tolled highway played a major role in local travel as well as regional and interstate movements, particularly when alterative route options are limited, along with the availability of transit options for a meaningful share of the travel markets in question, and whether toll-supported new or expanded transit service could make a difference.

Interstate Economic Issues – Investigated if by its structure, level of tolls, location, or present share of interstate travelers on the routes in question, would a concept raise important interstate economic impact issues. An adjoining state, for example, might see per-mile truck tolling as a tariff on shipments heading to and from their in-state locations.

3.0 Results of Economic Assessment

This set of straightforward economic impact criteria were created, with one or more measures of effectiveness to assess how well each criterion would be met under a given tolling or congestion pricing scheme. These assessments were qualitative in nature, the ordinal measures of the impacts in question (e.g., from "Minimal to No Impact" to "Potentially Significant Impacts"), based on a review of the available transportation and economic data, on the levels of toll under consideration, and on the projected level of traffic diversion by vehicle class.

The results of these assessments are presented in Volume 2 of this report. The assessment was based on a broad application of these concepts, using approximate ordinal rankings (i.e., from "Potential for Significant Impact and/or Public Concern" to "Minimal or No Impact or Public Concern"). As those results shown:

- As with equity issues, most of the economic issues would be driven by the obvious elements of the toll strategy itself – a low, flat toll on all vehicles across most highways on the state versus an aggressively high toll applied on only one area of the State or on one market (e.g., truck travel).

- Most of the corridors or locations in question have limited congestion levels (and therefore limited congestion relief benefits), and limited or no meaningful transit services or clear opportunities to successfully create or expand such services to capture diverted travelers.

- In location where the highways in question are used extensively by local travelers making relatively short trips and where alternate routes are limited, a high tolling concept could pose serious economic issues. The principal concept that has all of these limitations is Concept H – congested corridor tolling – which would also raise the spatial competition issue for local businesses along the tolled corridors.

- The ability to effectively utilize the toll revenues along the same travel corridors to provide offsetting benefits – support effective transit options where viable, provide truck-related facilities and services (e.g., rest areas with services), create expanded capacity where critically needed – would go a long way in reducing the perception that the tolling programs effectively tax these travel markets without providing any services in return. At the same time, if other travel-related charges (especially gas taxes) were reduced or at least not increased as much, this could help support the public benefit side of these proposals and reduce the level of economic concern that they would raise.

Appendix E

Equity Impacts

Equity Impacts

1.0 Types of Equity

Two kinds of equity are involved in tolling and congestion pricing policies:

- **Horizontal Equity –** How groups or individuals with similar needs or resources are treated under a given proposal – most often what is meant when the phrase "fairness" is mentioned in connection with roadway pricing. It was understood in these studies that defining what is meant by "fair" let alone trying to measure or project how "fair" a specific proposal would be, and balancing these concerns against others' ideas of "fair" make this a very personal and often heated area of public discussion. These discussions also must consider the fairness of the State's existing highway-related revenue collection system, which is dominated by fuel taxes. Because larger cars, for example, with larger engines generate more pollutants per mile and low gas mileage, the present system has some "fairness" in terms of the public policies of reducing greenhouse gases and energy consumption. For example, assuming an annual average of 12,000 miles of travel and gas prices of $2.50 per gallon, an SUV getting 10 mpg would annually pay $1,800 more for gas – including approximately $450 more in Connecticut State gas tax – than a 25 mpg compact car.

- **Vertical Equity –** The treatment of individuals or groups that are unequal in some manner (usually income). Referring to HOT lane proposals as "Lexus Lanes" is a common example of this.

Plans to raise revenues through user charges such as roadway tolls involve the joint consideration of efficiency and equity. Efficiency involves the use of pricing or other controls to get the maximum public benefit out of a given public resource, such as a highway. Equity and efficiency can often work together in a "win-win" manner – low transit fares for the elderly are often available only in offpeak-periods, drawing more passengers into lower-demand periods while providing savings for the elderly. Sometimes equity considerations can interfere with potential efficiency gains – e.g., avoiding the use of peak-hour pricing on a river crossing to protect lower-income travelers can often protect few low-income individuals while forcing an agency to underprice the facility's use when its costs are the highest.

Equity considerations normally begin with horizontal equity – effectively the equivalent of "fairness" – i.e., are those that would pay the revenues being fairly levied, particularly when compared with others in the same or equivalent travel markets. Introducing tolls on a presently non-tolled roadway effectively raises the travel costs of those person and goods movements on that roadway. These newly tolled travelers are making trips among various origins and destinations for either single-purpose type trips (e.g., a commuter making a round trip between home and work; a long-haul trucker traveling between single out-of-state origin/destination points, etc.), or are making a group of linked trips. In some roadway segments under consideration travelers may have potentially reasonable alternative routes or modes, while in others the highway users are a captive market, especially for work trip travelers who have much less flexibility than shoppers for example.

After assessing the fairness of charging various travel groups for the use of a highway, the policy-maker must consider the socioeconomic characteristics of each group of travelers (e.g., work trip travelers into Hartford from various communities within the State or beyond). This represents the second half of the equity issue; i.e.:

- Even if it would otherwise be considered “fair” to charge someone for, say, the peak-hour use of a congested highway segment, would such a charge fall on a significant portion of low- and moderate-income travelers; and

- How should that factor be addressed when considering such a toll?

These types of vertical equity considerations are common topics raised when changes in any type of public user charge are under consideration – tolls, transit fares, water rates, etc. The types of factors to be considered in assessing the equity issues of roadway pricing concepts and their potential economic and travel patterns impacts on an interstate basis:

- The relative importance of a given highway sections in the overall commuter sheds in an area (e.g., I-84 from areas north and northeast into Hartford versus I-84 from the west/south, I-91 north/south, etc.; I-95 as a route into Stamford and Greenwich as well as into New York City, and other job centers to the south);

- The availability of competing transit modes within this corridor (e.g., the CT #3 and Buckland Flyer express routes operating on I-84 from the Buckland Park-and-Ride/ Buckland Hills Mall into downtown Hartford; Metro-North service along the same north-south corridor); logically, the more choices a traveler has in the tolled corridor or market (e.g., alternative routes, modes, travel times, etc.), the less likely he or she will have to pay a particular toll;[1]

- Congestion levels and truck percentages in tolled time periods (I-84: low relative to larger urban commuter corridors, with relatively low truck percentages; relatively high congestion levels on I-95, often in both directions, with higher truck percentages and most equivalent corridors);

- Commuter origin and destination (O/D) patterns (I-84: relatively small percentage of peak-hour traffic streams with origins or destinations outside of CT versus relatively high percentage in I-95 corridor); and

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[1] *Using Road Pricing Revenue: Economic Efficiency and Equity Considerations,* Victoria Transport Policy Institute (May 2005).

- Average income levels of those traveling in the corridor (preliminary data would indicate those levels are higher in the peak-period I-95 traffic stream).

The importance of any and all of these issues depends on the level and nature of the toll in question; i.e., relatively low flat charges for cars and trucks (e.g., $1.00 peak-hour auto and up to $3.50 truck surcharge along a busy interstate segment) would likely have minimal impact on commuter or other travel decisions (although use of the highway for local-area trips would be more impacted), and its impacts on various income groups, Interstate work force movements, etc. would similarly be minimal. However, higher peak-period charges would raise potential concerns on a variety of fronts, while a charge on, say, I-95 close to the Connecticut-New York border would raise more interstate market issues than one placed within the Stamford Area, as the more southern tolling location would raise more Interstate impact issues.

2.0 Equity Factors Considered

The following factors were used in assessing the potential for significant equity issues in the assessment of possible roadway tolling and pricing concepts:

- **Horizontal Equity**
  - **Geographic Distribution of Travelers –** The O/D patterns of the drivers in the tolled corridors or highway segments – would it encompass a broad range of intra- and Interstate travelers or would it focus on a more limited subregional or even local travelers.
  - **Distribution of Travel Markets –** Based on the time period and direction of the tolling scheme and the location of the tolled segment, what would be the likely distribution of travel markets among the potentially tolled travelers.
  - **Likely Truck Markets Involved –** Based on the truck percentage on a given segment, the distribution among truck types (e.g., vans and single-unit trucks versus longer-haul large tractor-trailers), the location with a large urban area versus, say, a more isolated rural area, what types of truck freight markets are likely involved among the potentially tolled vehicles.
  - **Time Savings in Tolled versus Untolled Lanes and Alternate Routes –** The extent to which travelers in the tolled lanes would have a distinct travel time and reliability benefit relative to those in the adjacent untolled lanes (where applicable) or on alternate routes.
- **Vertical Equity**
  - **Potential for Substantial and Unavoidable Tolls –** Would the concept under consideration potentially involve high tolls throughout the day or in certain time periods, particularly those that are intentionally set high enough to force a substantial amount of travelers to change their travel patterns (e.g., different roadways, alternate time periods, other modes of travel). Also, would the concept

toll all highway travelers or simply offer a premium travel lane at an optional fee without tolling other travelers.

- **Potential for Low-Moderate Income Concentration –** Based primarily on the location of the tolled corridor or segment, would the toll potentially fall on a relatively high concentration of low- and moderate-income travelers.
- **Availability of Convenient Alternate Travel Routes –** Are there relatively convenient alternate routes with available capacity in the same corridor as the tolled highway segment versus a situation where the tolled highway is the only reasonable roadway travel alternative.
- **Available Transit Services –** Are there reasonable public transit service alternatives for a meaningful number of travelers within the corridor or highway segment to be tolled.
- **Effectiveness of Possible Toll-Supported Transit Services –** Given the location of the tolled corridor or highway segment and the likely mix of travel markets and O/D pairs, what is the potential for toll-supported transit to provide (or expand) viable public transit services to absorb a portion of the travelers diverted from the highway by the toll.

3.0 Results of Equity Assessment

The results of these assessments are presented in Volume 2 of this report. The assessment was based on a broad application of these concepts, using approximate ordinal rankings (i.e., from "Potential for Significant Impact and/or Public Concern" to "Minimal or No Impact or Public Concern"). Those results show:

- Most of the equity issues would be driven by obvious elements of the toll strategy itself – i.e., a $1.00 flat toll on all vehicles would raise considerably less equity concern than, say, a congestion toll that could reach $6.00 to $8.00 for a typical trip in the congested peak-period;

- Most of the corridors in question have limited transit services that would not provide a viable option for diverted travelers – this is particularly true in the suburban and rural areas through which most of these highway segments travel through;

- The extent to which a concept focuses on specific areas of the State (e.g., southwestern areas along I-95 and Route 15 under Concept H would by definition raise concerns of reducing those areas' competitive advantage relative to other areas with or outside of the State; and

- The extent to which a tolling plan would produce off-setting travel benefits would be critical in travel market groups having a positive "benefit-cost" type perception about a given tolling or congestion pricing proposal. The use of toll revenues to support alternative transportation modes in the same corridors also would help balance these "benefit-cost" type considerations by the traveling public affected by the tolls in question.

Appendix F

Traffic and Traffic Safety Impacts

Traffic and Traffic Safety Impacts

1.0 Traffic and Safety Issues

The traffic diversion and toll revenue studies assessed the potential change in vehicle miles of travel (VMT), vehicle hours of travel (VHT), average travel speed (VMT/VHT), and in some instances volume/capacity (V/C) ratios and/or Level of Service (LOS). Those issues are discussed in the reviews of each of the tolling concepts in Volume 2 of this report. Beyond those traffic-related issues, the Study Team also considered the following traffic operations and traffic safety issues:

- **On-Highway Impacts –** Potential impact on traffic and safety conditions on the highway segments to be tolled. This primarily focused on:
  - The potential for sufficient traffic to divert from the highway and improve traffic flow.
  - The design adequacy of those elements of the highway that were changed as part of the tolling concept. Many of the concepts would involve the construction of overhead and roadside tolling equipment associated with open road tolling (ORT) systems, which typically do not change the design or operation of the highway itself. These would include Concepts B, C, F, G-1, and H. Those concepts that would involve changes in roadway design – adding new lanes or converting existing lanes included Concepts A, D and F. Overall, except for Concept E (HOT lanes on existing shoulders) which was dropped due to existing space and design limitation that would make an adequate design difficult and expensive, it was assumed that any of the concepts would be designed in a safe manner consistent with all applicable state and Federal standards.
  - The impacts of traffic diversion in highway interchange areas as vehicles exit upstream of the tolls and (where applicable) re-enter past the tolled segment.
- **Local Roadway Impacts –** The extent to which the volume and mix of vehicles diverted onto local roadways and arterials would be sufficient to adversely impact the operation of those roadways and vehicular and pedestrian safety in the communities through which these roadways pass.

■ 2.0 Analysis Inputs

The following information was used to assess the potential local traffic factors:

- Diversion levels from highways – generated by direction on either a 24-hour basis or a four travel period basis (a.m., Midday, p.m. and Nighttime) by vehicle classification (cars, vans, Single Unit Trucks (SUTs), and Tractor Trailers (TT).

- The projected diversion routes estimated for each concept and highway corridor or border crossing (for Concept B). These diversions, which are discussed in the concept analysis sections of this report, and these routes were based on trip routing web sites (MapQuest and GoogleMap) and on the team's knowledge of the travel corridors and communities in question.

- Traffic volumes and congestion levels for the diversion routes – some data were available for almost all routes from ConnDOT (especially from 2007 Traffic Volumes State Maintained Highway Network (Traffic Log) ConnDOT Division of Systems Information, Bureau of Policy and Planning, 2008). Most of these data were 24-hour two-way volumes for specific milepost segments along the full length of these roadways, but with no information about overall congestion levels or conditions in the peak-travel-periods. Detailed hourly volumes were available for certain locations (e.g., U.S. Route 1, the segments of I-84 and I-91 with existing HOV lanes). Where data were lacking, planning-level assumptions were made about likely roadway capacities and the percent of daily traffic in the peak-periods to obtain a rough sense of the ability of these roadways to safely absorb various levels of diverted traffic.

- Study Team's local knowledge of typical conditions along the highway corridors and the major projected diversion routes, particularly in areas where this added traffic would travel through populated and developed areas. This was particularly important for diverted large trucks (especially TTs), where the roadway's geometry, especially at local community intersections, could pose both operational and safety concerns.

- Aerial photos from GoogleMaps, MS LiveLocal and other sources were used to confirm likely number of travel lanes, roadway widths, etc., which was helpful in determining the ability of a roadway to safely handle large trucks. These images also could confirm team members' understanding of various roadway segments.

■ 3.0 Results of Local Traffic and Safety Assessment

The results of these assessments are presented in Volume 2 of this report.