Connecticut Electronic Tolling and Congestion Pricing Study

draft final report

Volume 3: Technical Appendices

prepared for
Connecticut Transportation Strategy Board
Connecticut Office of Policy and Management

prepared by
Cambridge Systematics, Inc.

with
Urbitran, a division of DMJM Harris/AECOM
IBI Group
Fitzgerald & Halliday, Inc.
Sam Schwartz, PLLC

February 2009

www.camsys.com

draft final report

Connecticut Electronic Tolls and Congestion Pricing Study

Volume 3 – Technical Appendices

prepared for

Connecticut Transportation Strategy Board
Connecticut Office of Policy and Management

prepared by

Cambridge Systematics, Inc.
100 CambridgePark Drive, Suite 400
Cambridge, Massachusetts 02140

with

Urbitran, a division of DMJM Harris/AECOM
IBI Group
Fitzgerald & Halliday, Inc.
Sam Schwartz, PLLC

February 2009

Table of Contents

Preface

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

- **Volume 1: Summary of Findings**, which presents key material on tolling and congestion pricing and summarizes the findings of the analysis of electronic tolling and congestion pricing options in Connecticut.
- **Volume 2: Background Report,** which provides details relating to implementation considerations of electronic tolling and road pricing in general on a variety of topics, as well as detailed technical analysis of options in Connecticut.
- **Volume 3: Technical Appendices,** which provides further detail on methodology and results.

This is Volume 3: Technical Appendices

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

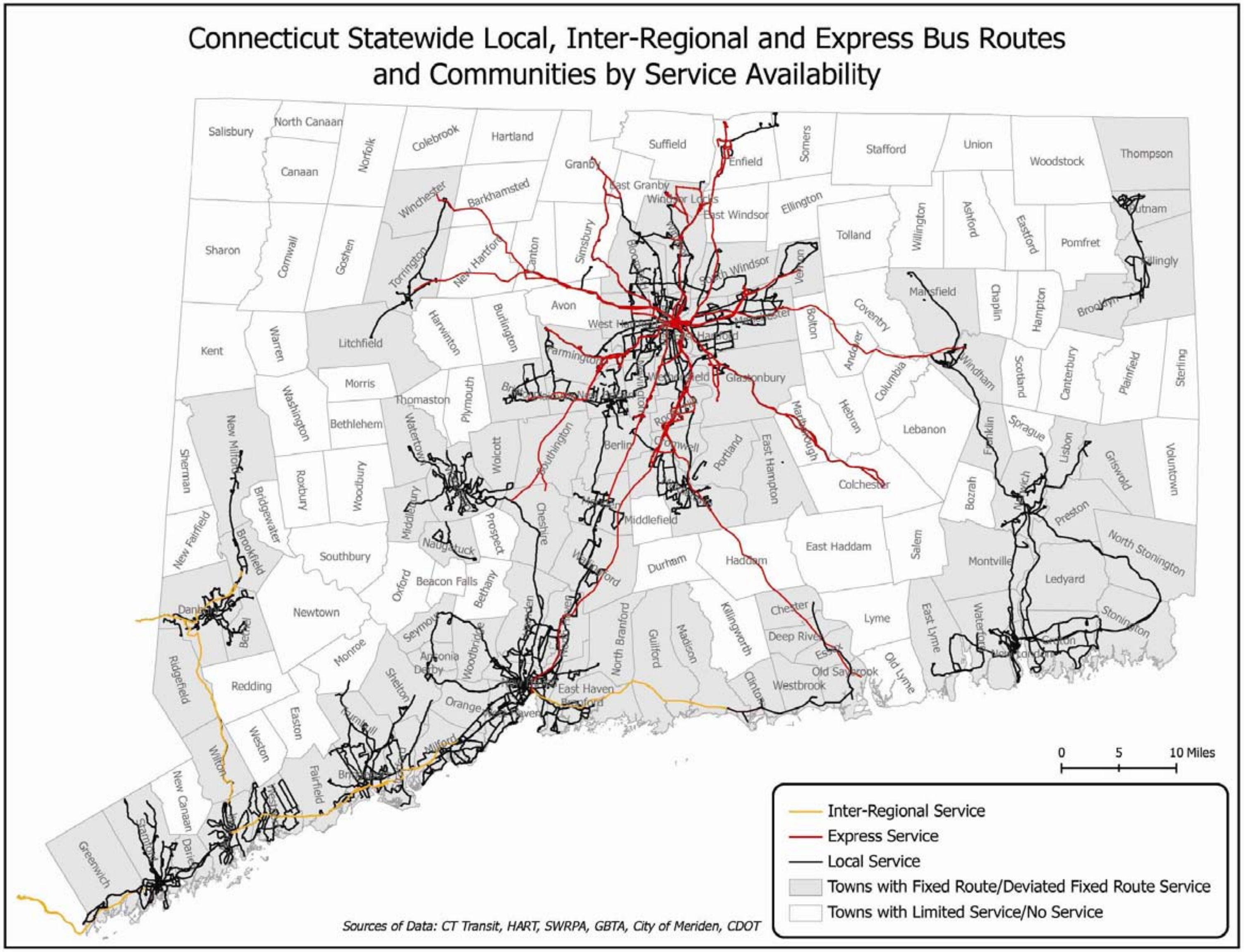


Figure 2. Existing Statewide Transit Resources – Northwest Detail

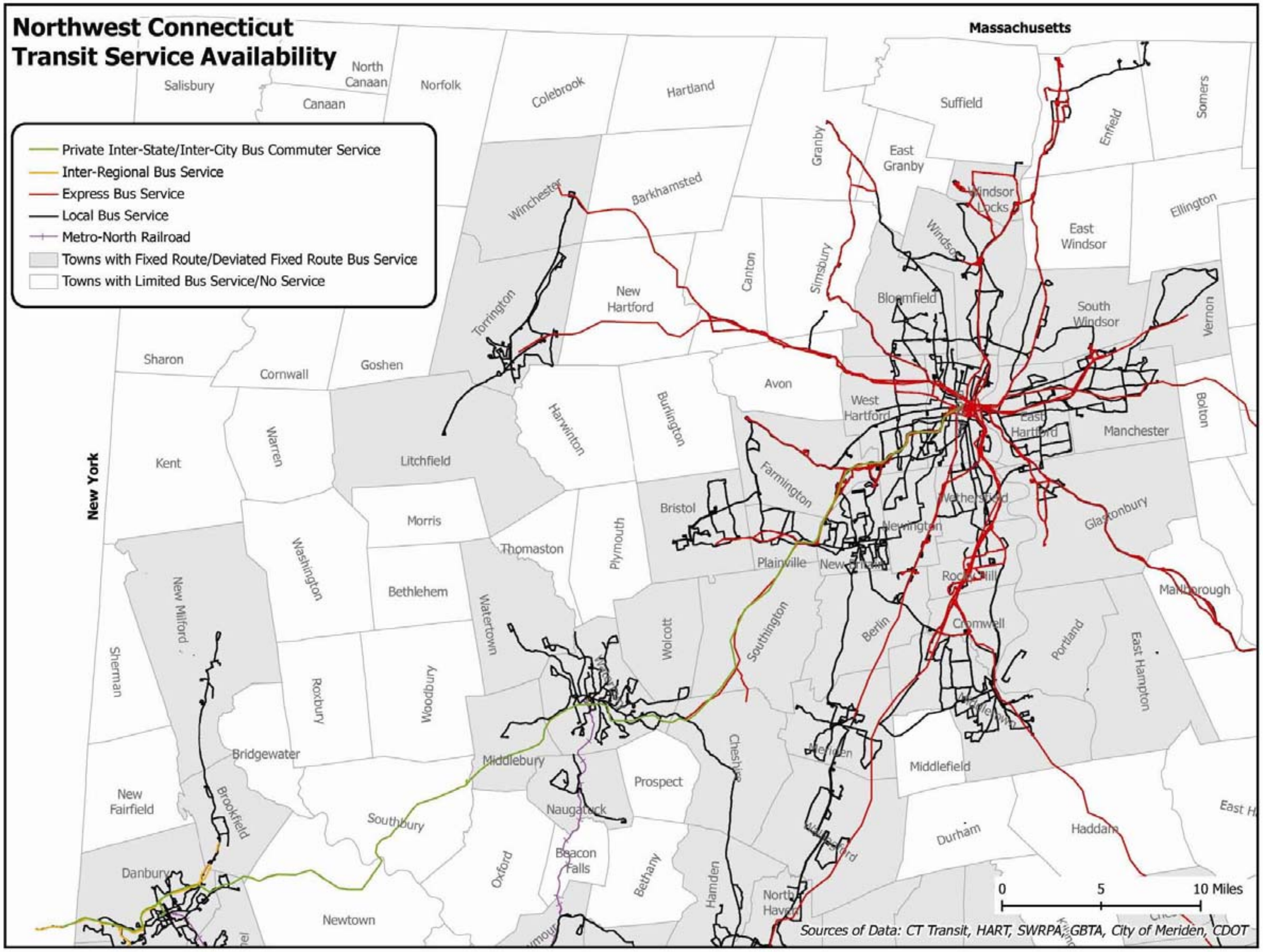


Figure 3. Existing Statewide Transit Resources – Northeast Detail

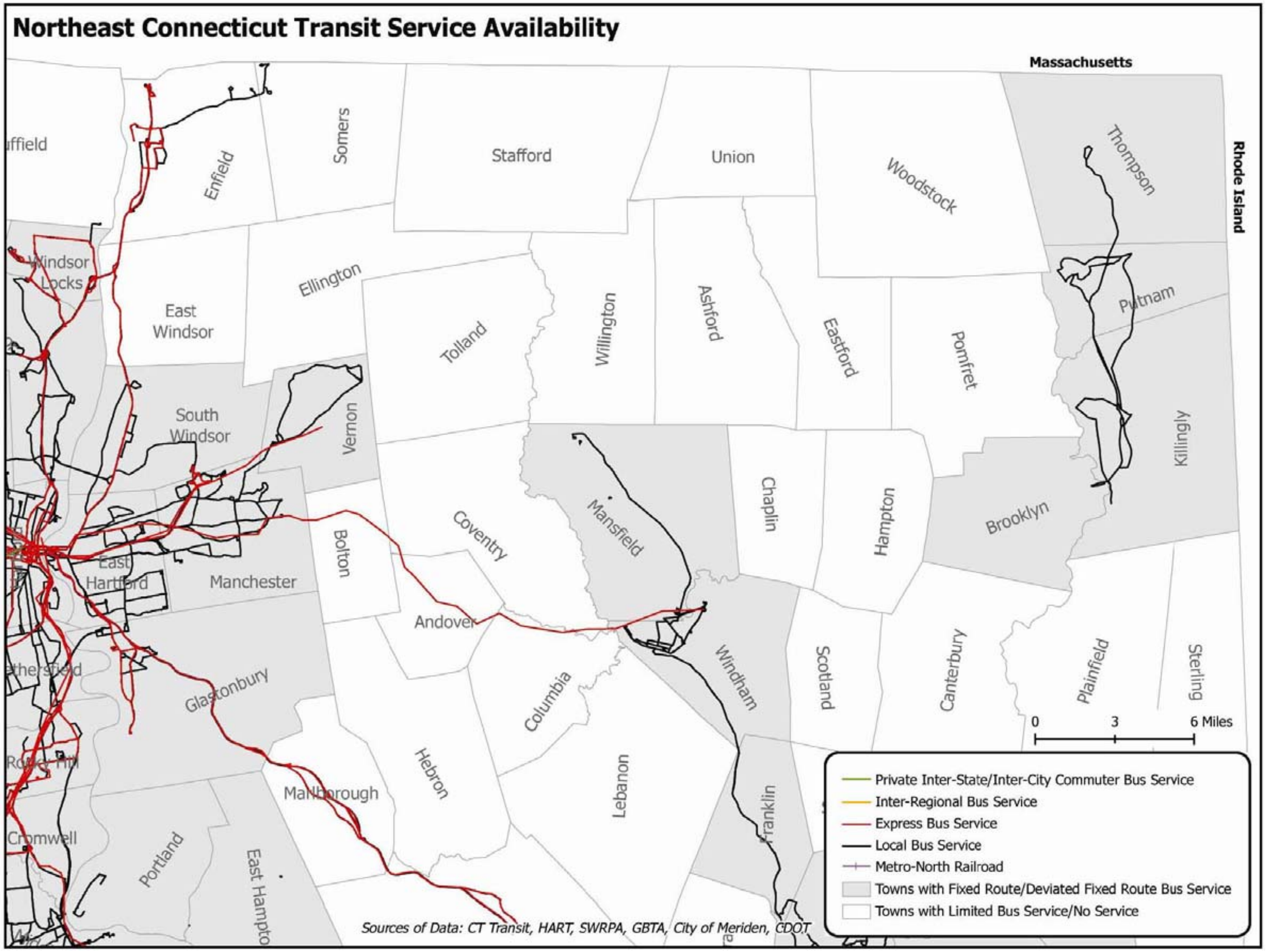


Figure 4. Existing Statewide Transit Resources – Southeast Detail

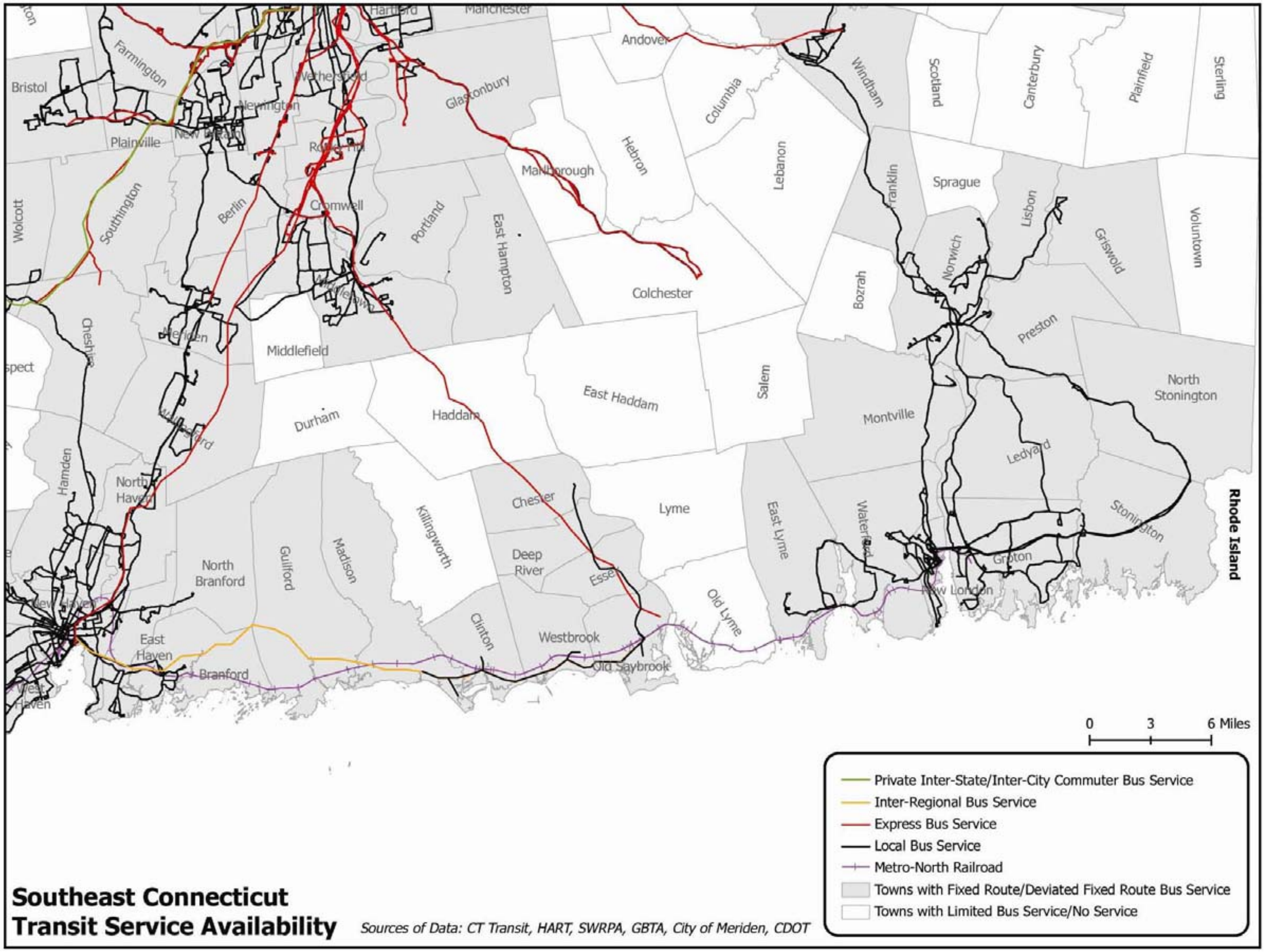
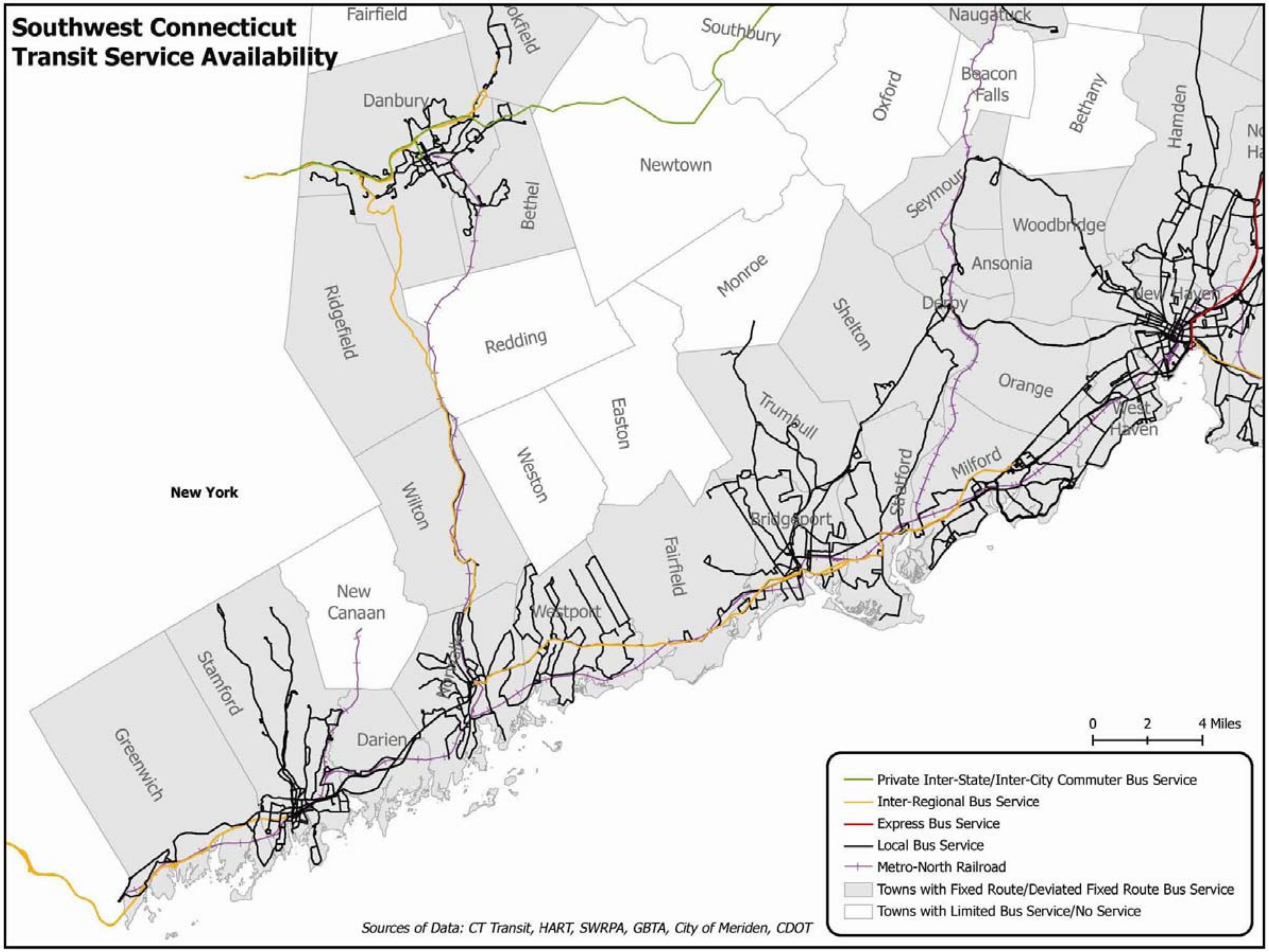


Figure 5. Existing Statewide Transit Resources – Southwest Detail



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.

---

[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 x 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 x number of tolling points.
Tag reader/antenna units	Reads the tag data of passing vehicles.	Number of units per tolling point x number of tolling points.
Image capture units	Records images of passing vehicles. Will include ALPR and OCR technology.	Number of units per tolling point x 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 x number of miles; or Number of units per tolling point x 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 x 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 x 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 x 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 x number of tolling points.

Component	Description	Number of Each Calculated By…
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 x number of tolling points.
Power connections	Provides power to the ITS components.	Number of units per tolling point x 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 x 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.

Component	Description	Number of Each Calculated By…
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 x 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 for each direction of travel to ensure that even the shortest trips between adjacent exits are tolled. 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	Only one required per lane.
Roadside computers per tolling point	1	A single computer is required to control all ITS equipment at a tolling point.

Generic Factor	Value	Notes
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 one per segment per direction of traffic, so no vehicles can use toll facility for free. Calculated by number of segments x number of tolling points per segment.
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	Assumed 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.

Project-Specific Factor	Rationale
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 detection 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.
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
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		Con-gested	
	A1	A2	A3	B	C	D1	D2	D3	F1	F2	F3	G1	H
Tags (millions)	2.31	1.90	4.22	76.03	21.53	1.3	2.86	4.16	88.41	51.80	116.84	104.37	34.57
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
Dynamic messaging signs	124	68	192	0	0	32	24	56	0	34	0	0	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
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**	700	0	0	0	45	32	77	700	52
Communications – tolling point switchbox	62	34	96	0**	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*	0-1*	0-2*	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

*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.

** 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.

Cost Contributor	Description
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 + capital replacement cost through project lifespan.	(Yearly O&M cost) x (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.
	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) x (project lifespan).
	Service trucks	Assume leased trucks and hence no capital cost.	Service truck hourly operational cost x Number of hours operating per day x Number of days a year on which projects charge tolls x project lifespan.
	Roadside law enforcement officers	Assume no capital cost to hire staff.	Law enforcement hourly operational cost x Number of hours operating per day x Number of days a year on which projects charge tolls x project lifespan.
	Integration and testing	Assumed 100% of ITS capital costs.	Only applies at installation hence no carries no O&M costs.

	Cost Contributor	Capital Cost	O&M Cost
Back Office	Pre-implementation staff	Assume no capital cost to hire staff.	Staff salary x Number of years to implement project.
	Post-implementation staff	Assume no capital cost to hire staff.	Staff salary x project lifespan.
	Back office – account cost	Capital cost + 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 additional 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 x cost per account. • If between minimum and Economy of Scale number of accounts threshold, then cost equals number of accounts x cost per account. • If over Economy of Scale number of accounts, then cost equals: • (Economy of scale number of accounts x Charge per account) + • (Number of accounts over threshold x Discount Charge per account).
	Back office – video cost	Assumed included in the above "back office – account capital cost."	(Number of video transactions x cost to process a video transaction) + (Number of video notices sent x cost per video notice).
	Walk-in customer service centers	Capital cost + capital replacement cost through project lifespan.	(Yearly O&M cost) x (project lifespan).
	Retail channels	Capital cost + capital replacement cost through project lifespan.	(Yearly O&M cost) x (project lifespan).
	Account acquisition cost	n/a	Number of accounts x account acquisition fee per account.
	Payment card processing fee	Ongoing service, so assume no capital cost.	Credit card processing percentage fee x percent revenue that is collected via credit card.
	DMV lookup (in state)	Ongoing service, so assume no capital cost.	Number of video transactions x percentage of video transactions which are looked up at DMV x percentage of transactions which are from in-state vehicle x fee applied per DMV in-state lookup.

	Cost Contributor	Capital Cost	O&M Cost
	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 x percentage of transactions sent to collection agency x average toll value x 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*	9	10% of capital cost	8	
	Image capture units*	8	10% of cap	8	
	CCTV surveillance cameras*	9	10% of cap	8	
	Vehicle detection unit*	10	10% of cap	8	
	Dynamic messaging signs*	50	10% of cap	8	
	Static signs	10	0.5	15	
	Vehicle classification units*	20	10% of cap	8	
	Roadside computing*	60	10% of cap	8	
	Power connections	50	12	30	
	Comms – fiber	0.029 per ft[1]	<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	

[1] 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.

* Denotes ITS component.

	Cost Contributor	Factors			
		Unit Capital Cost ($K)	Unit Operating Cost ($K)	Lifespan	Rationale for Unit Costs
Back Office Components	Pre-implementation staff	0	150pa	n/a	ITS industry estimates
	Post-implementation staff	0	150pa	n/a	
	Back office	0	Project-specific (dependent on number of accounts/ transactions)	10	
	Walk-in customer service centers	125	500	10	
	Retail channels	3	1	5	

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 7a.m.-7p.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.

Generic Factor	Value	Notes
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). E.g., an 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 (the economy of scale number of accounts threshold – 500,000) 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 2 or 4 trips, depending on concept. A lower number – closer to or equal to 2 – 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 2 or 4 trips. (A lower number – closer to or equal to 2 – 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**	**Cong - sted**
	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	$9,879,282	$0	$9,879,282
	Gantry (1 lane)	$9,300,000	$5,580,000	$14,880,000
	Tag reader/antenna units*	$8,928,000	$6,696,000	$15,624,000
	Image capture units*	$7,936,000	$5,952,000	$13,888,000
	CCTV surveillance cameras*	$4,147,200	$3,110,400	$7,257,600
	Vehicle detection unit*	$9,216,000	$6,912,000	$16,128,000
	Dynamic messaging signs*	$24,800,000	$9,300,000	$34,100,000
	Static signs	$3,720,000	$2,790,000	$6,510,000
	Vehicle classification units*	$4,960,000	$3,720,000	$8,680,000
	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 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	$86,397,600	$0	$86,397,600
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	$3,607,611	$3,607,611
	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	$200,893,082	$194,606,963	**$395,500,045**

Concept A2

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$7,735,392	$0	$7,735,392
	Gantry (1 lane)	$5,100,000	$3,060,000	$8,160,000
	Tag reader/antenna units*	$4,896,000	$3,672,000	$8,568,000
	Image capture units*	$4,352,000	$3,264,000	$7,616,000
	CCTV surveillance cameras*	$2,296,800	$1,722,600	$4,019,400
	Vehicle detection unit*	$5,104,000	$3,828,000	$8,932,000
	Dynamic messaging signs*	$13,600,000	$5,100,000	$18,700,000
	Static signs	$2,040,000	$1,530,000	$3,570,000
	Vehicle classification units*	$2,720,000	$2,040,000	$4,760,000
	Roadside computing*	$8,160,000	$6,120,000	$14,280,000
	Power connections	$1,700,000	$12,240,000	$13,940,000
	Communications – fiber	$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	$48,708,640	$0	$48,708,640
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	$3,119,682	$3,119,682
	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	$116,566,072	$134,587,972	**$251,154,044**

Concept A All

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$17,614,620	$0	$17,614,620
	Gantry (1 lane)	$14,400,000	$8,640,000	$23,040,000
	Tag reader/antenna units*	$13,824,000	$10,368,000	$24,192,000
	Image capture units*	$12,288,000	$9,216,000	$21,504,000
	CCTV surveillance cameras*	$6,444,000	$4,833,000	$11,277,000
	Vehicle detection unit*	$14,320,000	$10,740,000	$25,060,000
	Dynamic messaging signs*	$38,400,000	$14,400,000	$52,800,000
	Static signs	$5,760,000	$4,320,000	$10,080,000
	Vehicle classification units*	$7,680,000	$5,760,000	$13,440,000
	Roadside computing*	$23,040,000	$17,280,000	$40,320,000
	Power connections	$4,800,000	$34,560,000	$39,360,000
	Communications – fiber	$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	$135,106,240	$0	$135,106,240
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	$6,727,293	$6,727,293
	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	$314,459,100	$284,658929	**$599,118,029**

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	$296,162,892	$0	$296,162,892
	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	$0	$0	$0
	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	$322,864,371	$322,864,371
	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	$348,018,892	$1,320,351,493	**$1,668,370,385**

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	$310,527,900	$0	$310,527,900
Back Office Components	Back office – account cost	$3,000,000	$606,861,362	$609,861,362
	Back office – video cost	$0	$314,900,114	$314,900,114
	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	$362,383,900	$1,575,886,293	**$1,938,270,193**

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	$249,157,224	$0	$249,157,224
Back Office Components	Back office – account cost	$3,000,000	$504,760,609	$507,760,609
	Back office – video cost	$0	$271,513,778	$271,513,778
	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	$301,013,224	$1,797,801,345	**$2,098,814,569**

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	$78,967,260	$0	$78,967,260
	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	$0	$0	$0
	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	$107,184,000	$0	$107,184,000
	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	$1,117,204,000	$0	$1,117,204,000
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	$81,902,443	$81,902,443
	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	$2,643,725,260	$1,892,482,153	**$4,536,207,413**

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	$78,509,970	$0	$78,509,970
Back Office Components	Back office – account cost	$3,000,000	$193,015,696	$196,015,696
	Back office – video cost	$0	$81,427,636	$81,427,636
	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	$2,643,267,970	$2,005,505,346	**$4,648,773,316**

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	$78,269,454	$0	$78,269,454

Back Office Components	Back office – account cost	$3,000,000	$192,428,265	$195,428,265
	Back office – video cost	$0	$81,179,626	$81,179,626
	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	$2,643,027,454	$2,132,306,861	**$4,775,334,315**

Concept D1

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$6,201,283	$0	$6,201,283
	Gantry (1 lane)	$2,400,000	$1,440,000	$3,840,000
	Tag reader/antenna units	$2,304,000	$1,728,000	$4,032,000
	Image capture units	$2,048,000	$1,536,000	$3,584,000
	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	$6,400,000	$2,400,000	$8,800,000
	Static signs	$960,000	$720,000	$1,680,000
	Vehicle classification units	$0	$0	$0
	Roadside computing	$3,840,000	$2,880,000	$6,720,000
	Power connections	$800,000	$5,760,000	$6,560,000
	Communications – fiber	$0	$0	$0
	Communications –tolling point switches	$520,000	$97,500	$617,500
	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	$18,464,000	$0	$18,464,000
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	$2,882,104	$2,882,104
	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	$482,522	$482,522
	Collection agency collection fees	$0	$41,436	$41,436
	Total Project Cost	$49,885,283	$88,268,782	**$138,154,065**

Concept D2

	Component Required	Total Capital Cost	Total O&M Cost	Total cost
Roadside Components	Tags	$13,748,480	$0	$13,748,480
	Gantry (1 lane)	$1,800,000	$1,080,000	$2,880,000
	Tag reader/antenna units	$1,728,000	$1,296,000	$3,024,000
	Image capture units	$1,536,000	$1,152,000	$2,688,000
	CCTV surveillance cameras	$576,000	$432,000	$1,008,000
	Vehicle detection unit	$1,280,000	$960,000	$2,240,000
	Dynamic messaging signs	$4,800,000	$1,800,000	$6,600,000
	Static signs	$720,000	$540,000	$1,260,000
	Vehicle classification units	$0	$0	$0
	Roadside computing	$2,880,000	$2,160,000	$5,040,000
	Power connections	$600,000	$4,320,000	$4,920,000
	Communications – fiber	$0	$0	$0
	Communications –tolling point switch	$440,000	$82,500	$522,500
	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	$13,840,000	$0	$13,840,000
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	$6,043,863	$6,043,863
	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	$813,367	$813,367
	Collection agency collection fees	$0	$84,658	$84,658
	Total Project Cost	$47,236,480	$88,770,346	**$136,006,826**

Concept D All

	Component Required	Total Capital Cost	Total O&M Cost	Total Cost
Roadside Components	Tags	$19,949,671	$0	$19,949,671
	Gantry (1 lane)	$4,200,000	$2,520,000	$6,720,000
	Tag reader/antenna units	$4,032,000	$3,024,000	$7,056,000
	Image capture units	$3,584,000	$2,688,000	$6,272,000
	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	$11,200,000	$4,200,000	$15,400,000
	Static signs	$1,680,000	$1,260,000	$2,940,000
	Vehicle classification units	$0	$0	$0
	Roadside computing	$6,720,000	$5,040,000	$11,760,000
	Power connections	$1,400,000	$10,080,000	$11,480,000
	Communications – fiber	$0	$0	$0
	Communications –tolling point switchbox	$960,000	$180,000	$1,140,000
	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	$32,304,000	$0	$32,304,000
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	$8,925,967	$8,925,967
	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	$1,295,889	$1,295,889
	Collection agency collection fees	$0	$126,410	$126,410
	Total Project Cost	$94,121,671	$122,801,193	**$216,922,864**

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	$325,225,386	$0	
	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	$0	$0	$0
	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	$282,697,065	$282,697,065
	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	**$549,902,786**	**$1,340,631,311**	**$1,890,534,097**

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	$295,226,910	$0	$295,226,910
Back Office Components	Back office – account cost	$3,000,000	$591,514,922	$594,514,922
	Back office – video cost	$0	$256,622,459	$256,622,459
	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	$519,904,310	$1,376,421,039	**$1,896,325,349**

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	$259,874,154	$0	$259,874,154
Back Office Components	Back office – account cost	$3,000,000	$527,148,072	$530,148,072
	Back office – video cost	$0	$225,892,325	$225,892,325
	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	$484,551,554	$1,360,506,733	**$1,845,058,287**

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	$190,365,462	$0	$190,365,462
	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	$0	$0	$0
	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	$166,059,423	$166,059,423
	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	**$317,824,542**	**$825,852,213**	**$1,143,676,755**

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	$173,638,116	$0	$173,638,116
Back Office Components	Back office – account cost	$3,000,000	$370,330,686	$373,330,686
	Back office – video cost	$0	$151,468,339	$151,468,339
	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	$301,097,196	$850,101,290	**$1,151,198,486**

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 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	$153,103,338	$0	$153,103,338
Back Office Components	Back office – account cost	$3,000,000	$332,920,429	$335,920,429
	Back office – video cost	$0	$133,555,616	$133,555,616
	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	$280,562,418	$841,880,268	**$1,122,442,686**

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	$429,659,010	$0	$429,659,010
	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	$0	$0	$0
	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	$448,756,488	$448,756,488
	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	**$778,795,490**	**$1,921,671,797**	**$2,700,467,287**

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	$390,720,834	$0	$390,720,834
Back Office Components	Back office – account cost	$3,000,000	$765,538,007	$768,538,007
	Back office – video cost	$0	$408,090,798	$408,090,798
	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	$739,857,314	$1,996,392,990	**$2,736,250,304**

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	$429,659,010	$0	$429,659,010
Back Office Components	Back office – account cost	$3,000,000	$836,445,719	$839,445,719
	Back office – video cost	$0	$448,756,488	$448,756,488
	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	$778,795,490	$1,921,671,797	**$2,700,467,287**

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	$382,790,520	$0	$382,790,520
	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	$0	$0	$0
	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	$107,184,000	$0	$107,184,000
	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	$1,117,204,000	$0	$1,117,204,000
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	$520,584,841	$520,584,841
	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	**$2,955,391,360**	**$3,380,892,190**	**$6,336,283,550**

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	$381,851,262	$0	$381,851,262
Back Office Components	Back office – account cost	$3,000,000	$750,624,548	$753,624,548
	Back office – video cost	$0	$519,305,011	$519,305,011
	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	$2,954,452,102	$3,653,341,451	**$6,607,793,553**

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	$379,775,430	$0	$379,775,430
Back Office Components	Back office – account cost	$3,000,000	$746,837,656	$749,837,656
	Back office – video cost	$0	$516,482,052	$516,482,052
	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	$2,952,376,270	$3,933,874,751	**$6,886,251,021**

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	$126,258,156	$0	$126,258,156
	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	$12,000,000	$12,000,000
	Post-implementation staff	$0	$13,200,000	$13,200,000
	Back office – account cost	$3,000,000	$285,570,714	$288,570,714
	Back office – video cost	$0	$152,779,141	$152,779,141
	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	$8,373,145	$8,373,145
	Payment card processing fee	$0	$1,433,405,665	$1,433,405,665
	DMV lookups (in state)	$0	$0	$0
	DMV lookups (out of state)	$0	$25,407,322	$25,407,322
	Collection agency collection fees	$0	$117,788,774	$117,788,774
	Total Project Cost	$605,165,436	$2,326,089,394	**$2,931,254,830**

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;

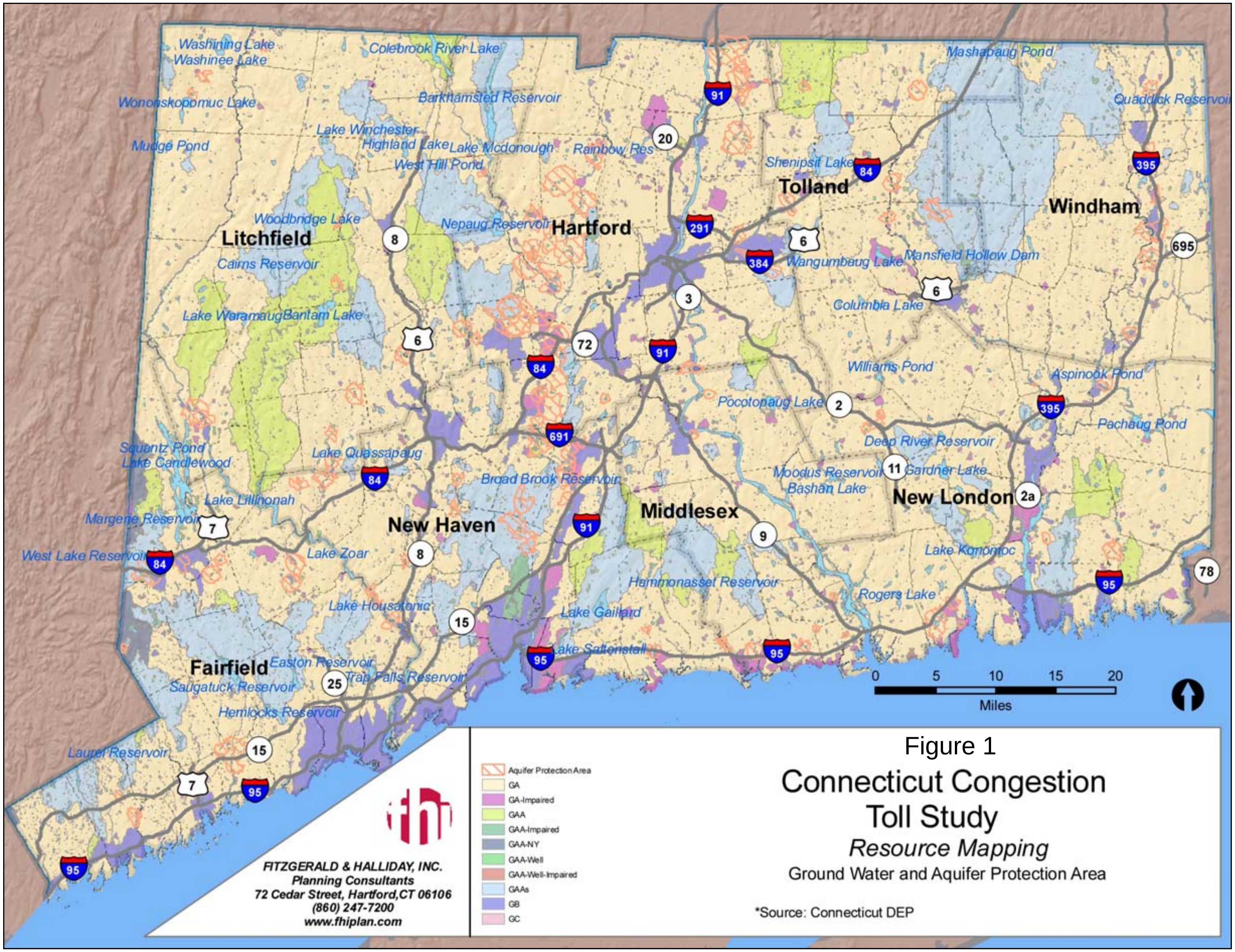


Figure 1
Connecticut Congestion Toll Study
Resource Mapping
Ground Water and Aquifer Protection Area
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
Aquifer Protection Area
GA
GA-Impaired
GAA
GAA-Impaired
GAA-NY
GAA-Well
GAA-Well-Impaired
GAAs
GB
GC
0 5 10 15 20
Miles
Litchfield
Hartford
Tolland
Windham
New Haven
Middlesex
New London
Fairfield

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 footprint 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 reservoirs, 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 drainage 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, particularly heavy truck traffic, could increase the probability of vehicular accidents. This could increase the potential for localized water quality degradation from spills of hazardous 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 avoidance behavior that leads to increased traffic along diversion routes. The assessment of indirect 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 effectively 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**

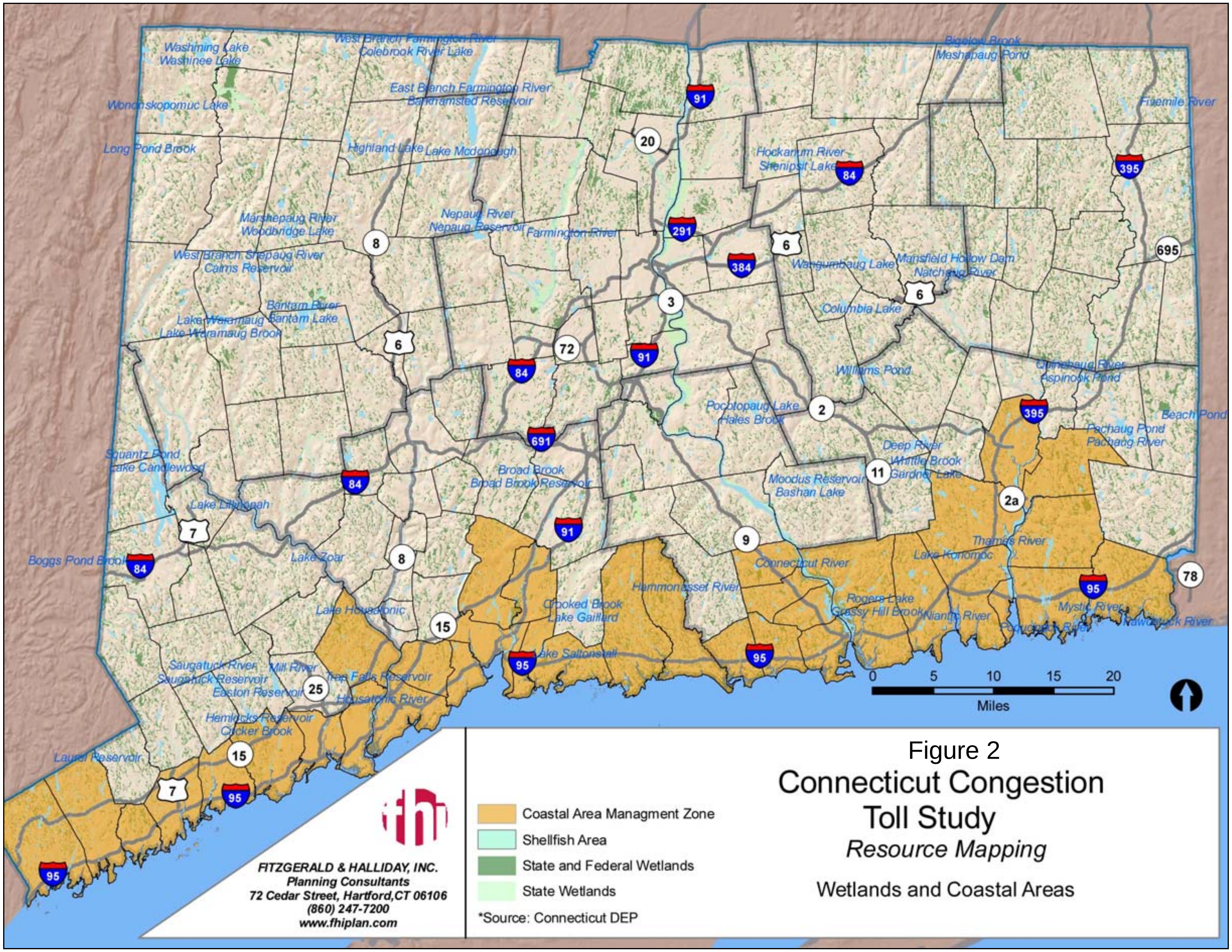


Figure 2
Connecticut Congestion Toll Study
Resource Mapping
Wetlands and Coastal Areas
Coastal Area Managment Zone
Shellfish Area
State and Federal Wetlands
State Wetlands
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
0
5
10
15
20
Miles
Washining Lake
Washinee Lake
Colebrook River Lake
East Branch Farmington River
Barkhamsted Reservoir
Wononskopomuc Lake
Long Pond Brook
Highland Lake
Lake Mcdonough
Marshepaug River
Woodbridge Lake
West Branch Shepaug River
Cairns Reservoir
Nepaug River
Nepaug Reservoir
Farmington River
Bantam River
Bantam Lake
Lake Waramaug
Lake Waramaug Brook
Hockanum River
Shenipsit Lake
Bigelow Brook
Mashapaug Pond
Fivemile River
Wangumbaug Lake
Mansfield Hollow Dam
Natchaug River
Columbia Lake
Williams Pond
Quinebaug River
Aspinook Pond
Pocotopaug Lake
Hales Brook
Beach Pond
Pachaug Pond
Pachaug River
Deep River
Whittle Brook
Gardner Lake
Moodus Reservoir
Bashan Lake
Broad Brook
Broad Brook Reservoir
Squantz Pond
Lake Candlewood
Lake Lillinonah
Boggs Pond Brook
Lake Zoar
Lake Housatonic
Connecticut River
Hammonasset River
Crooked Brook
Lake Gaillard
Lake Saltonstall
Thames River
Lake Konomoc
Rogers Lake
Grassy Hill Brook
Niantic River
Mystic River
Pawcatuck River
Saugatuck River
Saugatuck Reservoir
Mill River
Easton Reservoir
Trap Falls Reservoir
Housatonic River
Hemlocks Reservoir
Aspetuck Brook
Laurel Reservoir
91
20
84
395
291
384
6
695
8
3
72
2
691
11
2a
7
9
78
95
15
25

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.

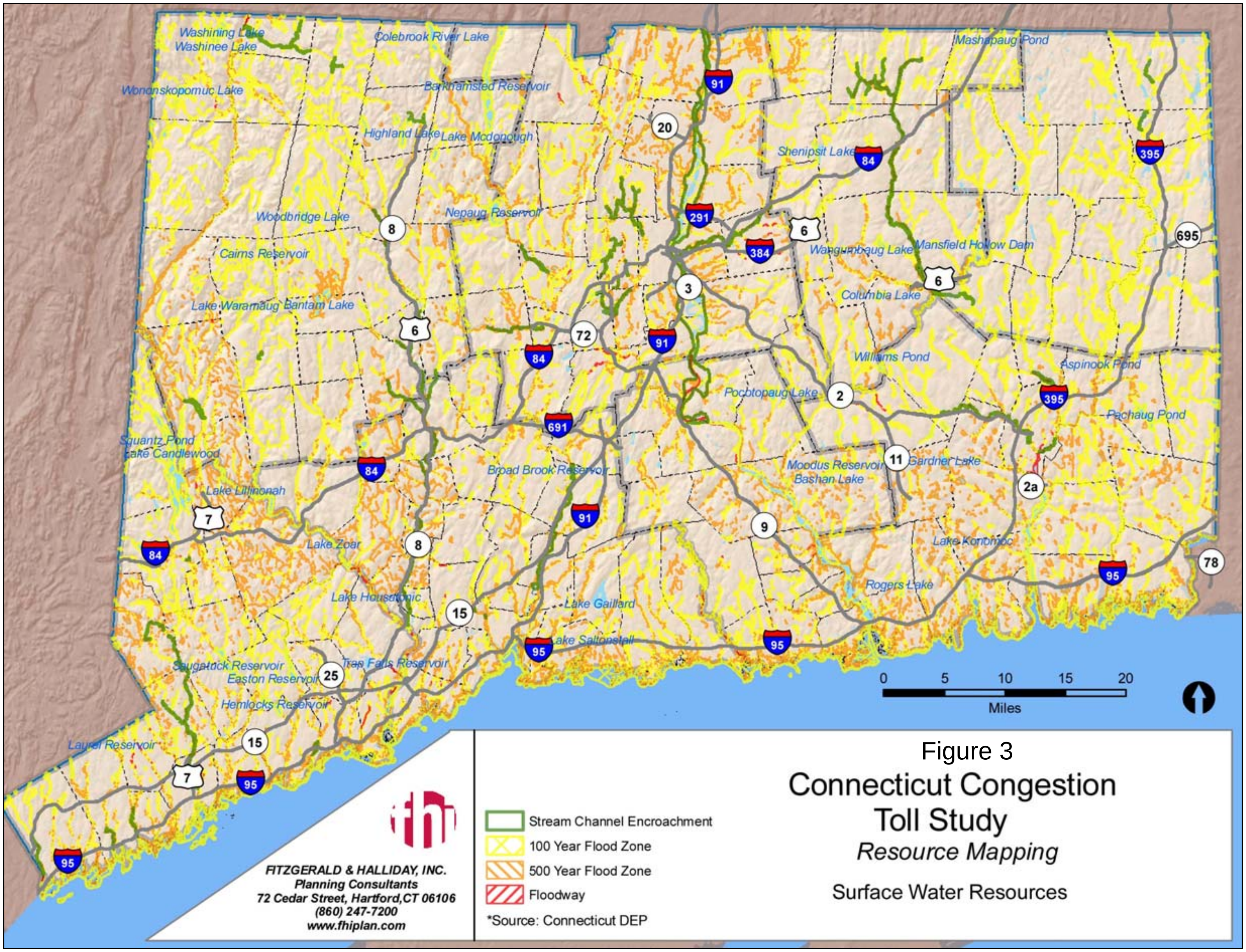


Figure 3
Connecticut Congestion Toll Study
Resource Mapping
Surface Water Resources
Stream Channel Encroachment
100 Year Flood Zone
500 Year Flood Zone
Floodway
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
0 5 10 15 20
Miles

■ 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

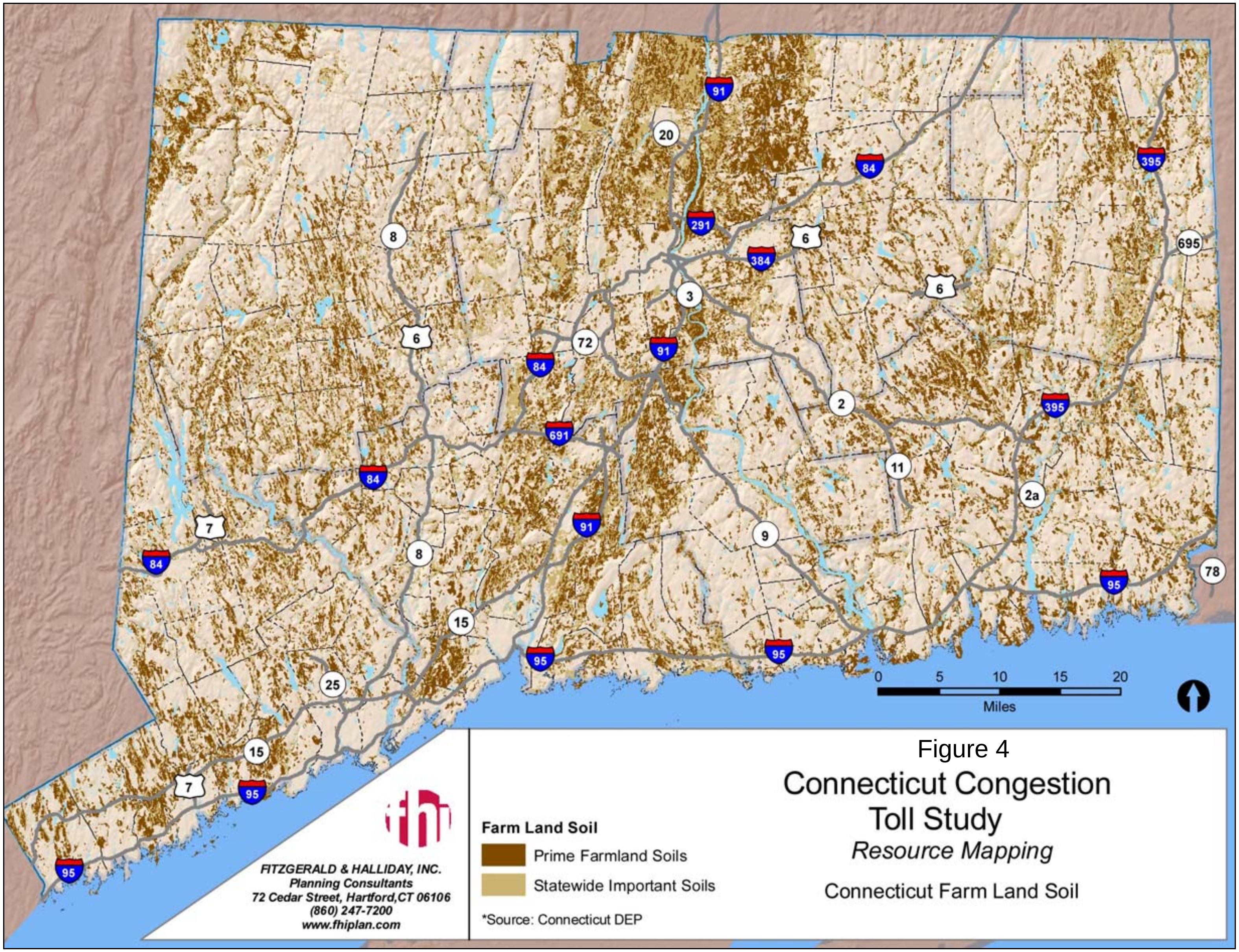
Roadway Corridor	Geographic Subarea	General Locales of Farmland Soils
I-84 Corridor	Within 1,000 Feet of the Road along the Corridor	Scattered pockets of farmland soils north of Danbury, though this area is mostly suburban in development; more concentrated areas of farmland soils north of Hartford and 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


91
20
84
395
291
384
6
695
8
6
3
72
6
91
84
2
395
691
84
11
2a
7
91
9
84
8
95
78
15
95
95
25
0 5 10 15 20
Miles
15
7
95
95
Farm Land Soil
Prime Farmland Soils
Statewide Important Soils
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
Figure 4
Connecticut Congestion
Toll Study
Resource Mapping
Connecticut Farm Land Soil

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.

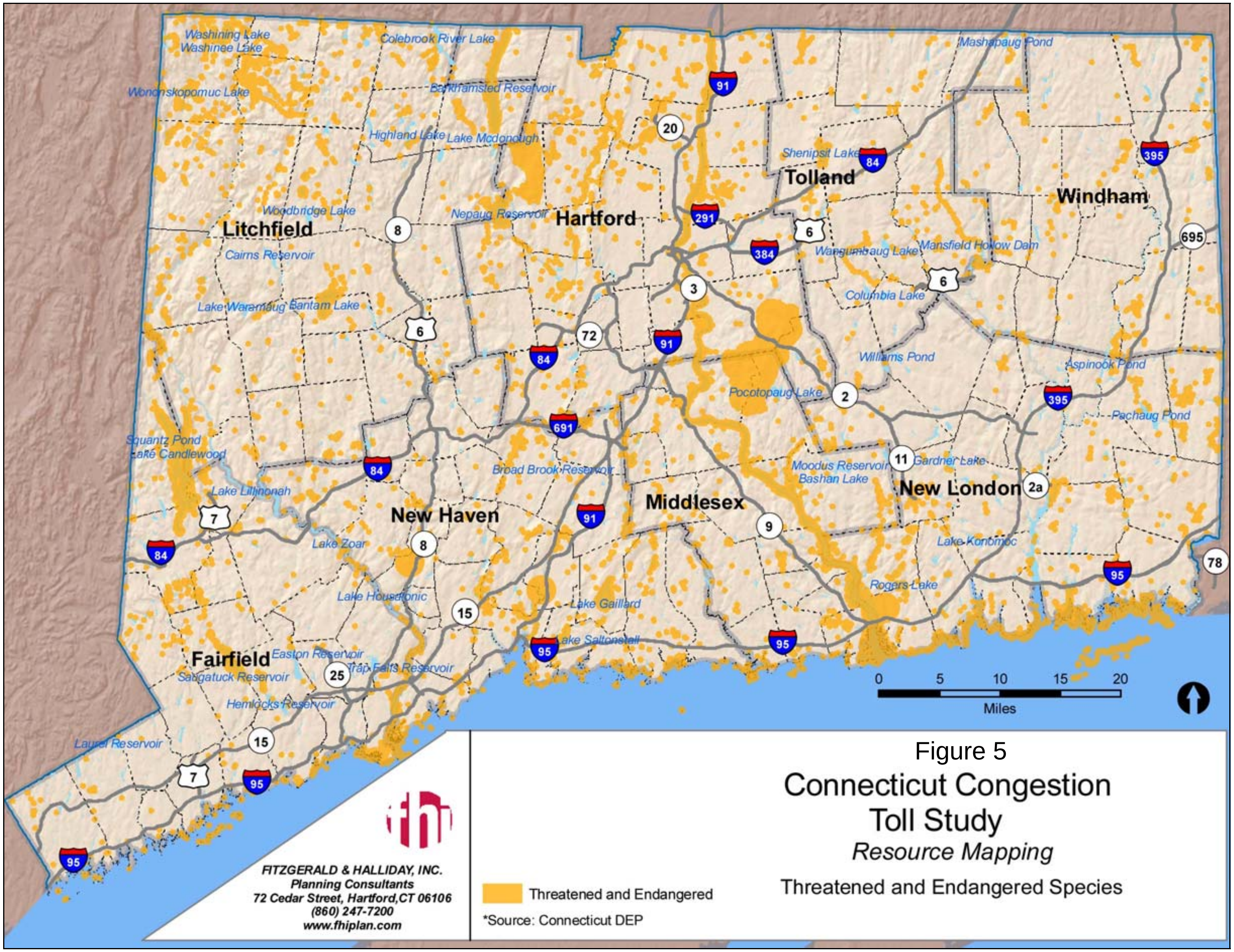


Figure 5
Connecticut Congestion
Toll Study
Resource Mapping
Threatened and Endangered Species
Threatened and Endangered
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
0
5
10
15
20
Miles
Litchfield
Hartford
Tolland
Windham
New Haven
Middlesex
New London
Fairfield
Washining Lake
Washinee Lake
Colebrook River Lake
Mashapaug Pond
Barkhamsted Reservoir
Highland Lake
Lake Mcdonough
Shenipsit Lake
Woodbridge Lake
Nepaug Reservoir
Cairns Reservoir
Lake Waramaug
Bantam Lake
Columbia Lake
Mansfield Hollow Dam
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
Easton Reservoir
Saugatuck Reservoir
Trap Falls Reservoir
Hemlocks Reservoir
Laurel Reservoir
91
20
84
395
291
8
6
384
695
3
72
84
91
2
691
395
84
11
2a
7
84
91
9
8
78
95
15
95
95
25
15
7
95
95

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.

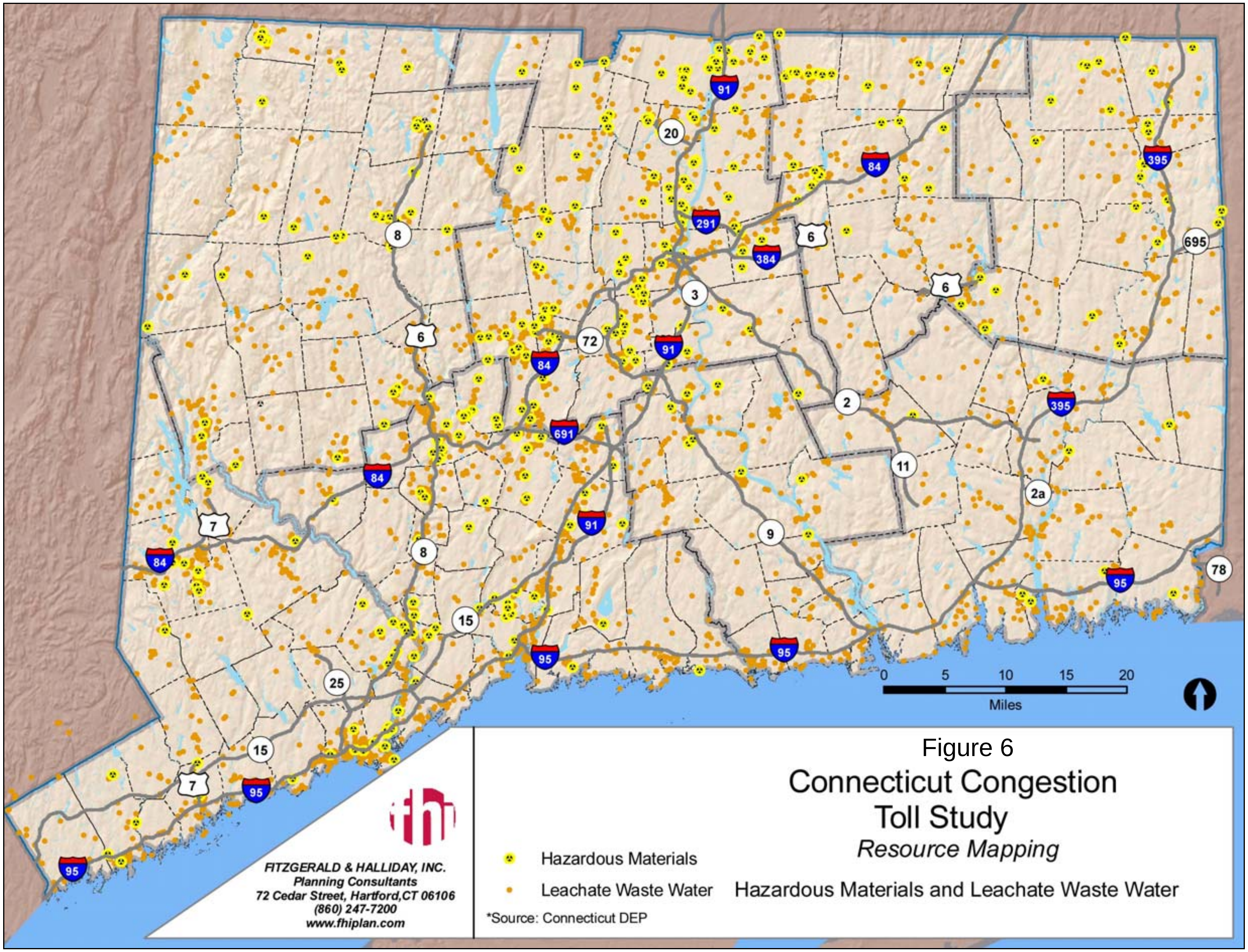


Figure 6
Connecticut Congestion
Toll Study
Resource Mapping
Hazardous Materials and Leachate Waste Water
Hazardous Materials
Leachate Waste Water
*Source: Connecticut DEP
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
0 5 10 15 20
Miles

8.0 Noise

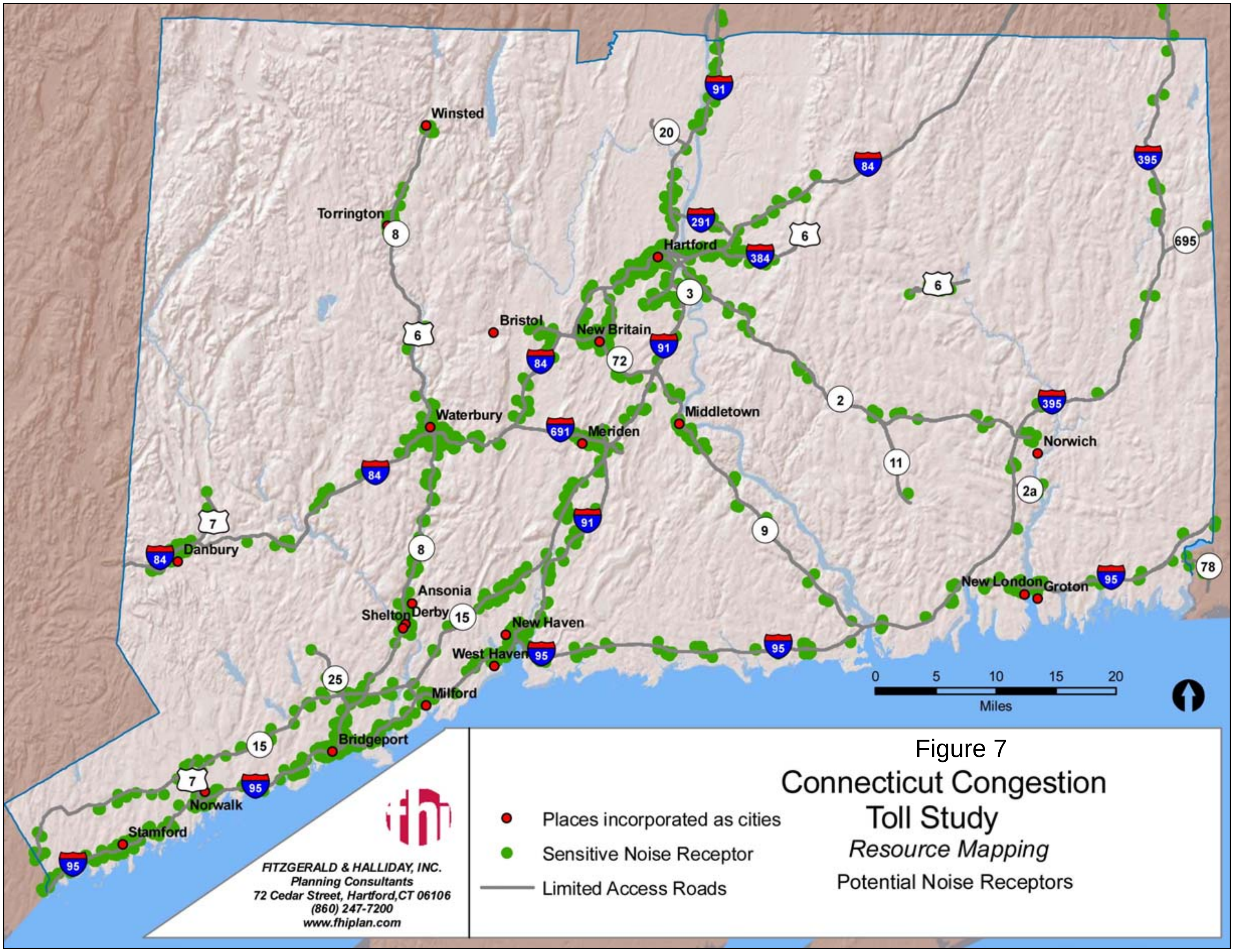
Noise-sensitive land uses include: a) residences, hotels, and other buildings where people sleep; 2) institutional resources, such as churches, schools, hospitals, and libraries; and 3) various tracts of land where quiet is an essential element of the land's intended purpose, such as a National Historic 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.


Winsted
Torrington
Bristol
New Britain
Hartford
Waterbury
Meriden
Middletown
Norwich
Danbury
Ansonia
Shelton
Derby
New Haven
West Haven
Milford
Bridgeport
Norwalk
Stamford
New London
Groton
0 5 10 15 20
Miles
Places incorporated as cities
Sensitive Noise Receptor
Limited Access Roads
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
Figure 7
Connecticut Congestion Toll Study
Resource Mapping
Potential Noise Receptors

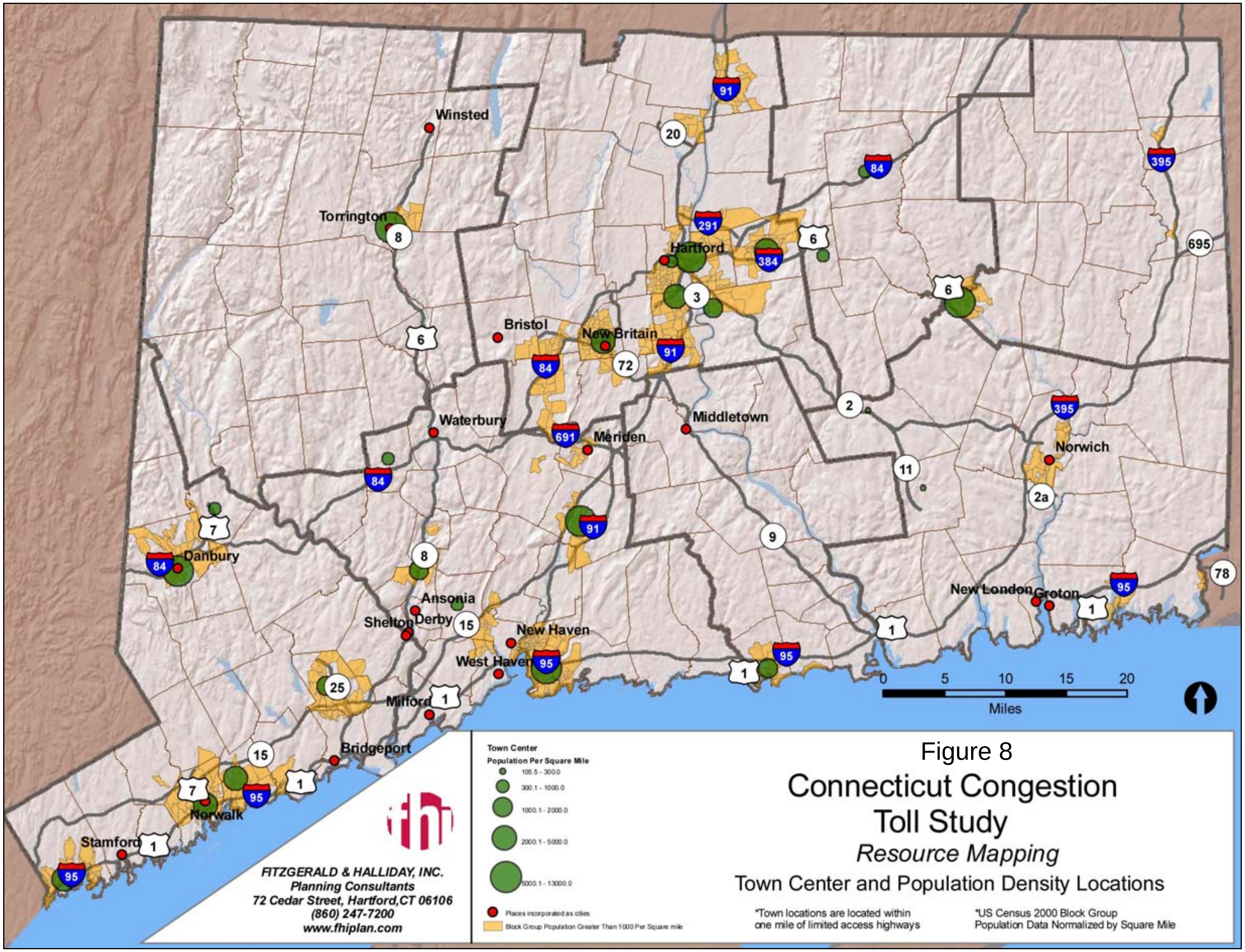


Figure 8
Connecticut Congestion Toll Study
Resource Mapping
Town Center and Population Density Locations

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								Statewide Average
	Fairfield	Hartford	Litchfield	Middlesex	New Haven	New London	Tolland	Windham	
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.

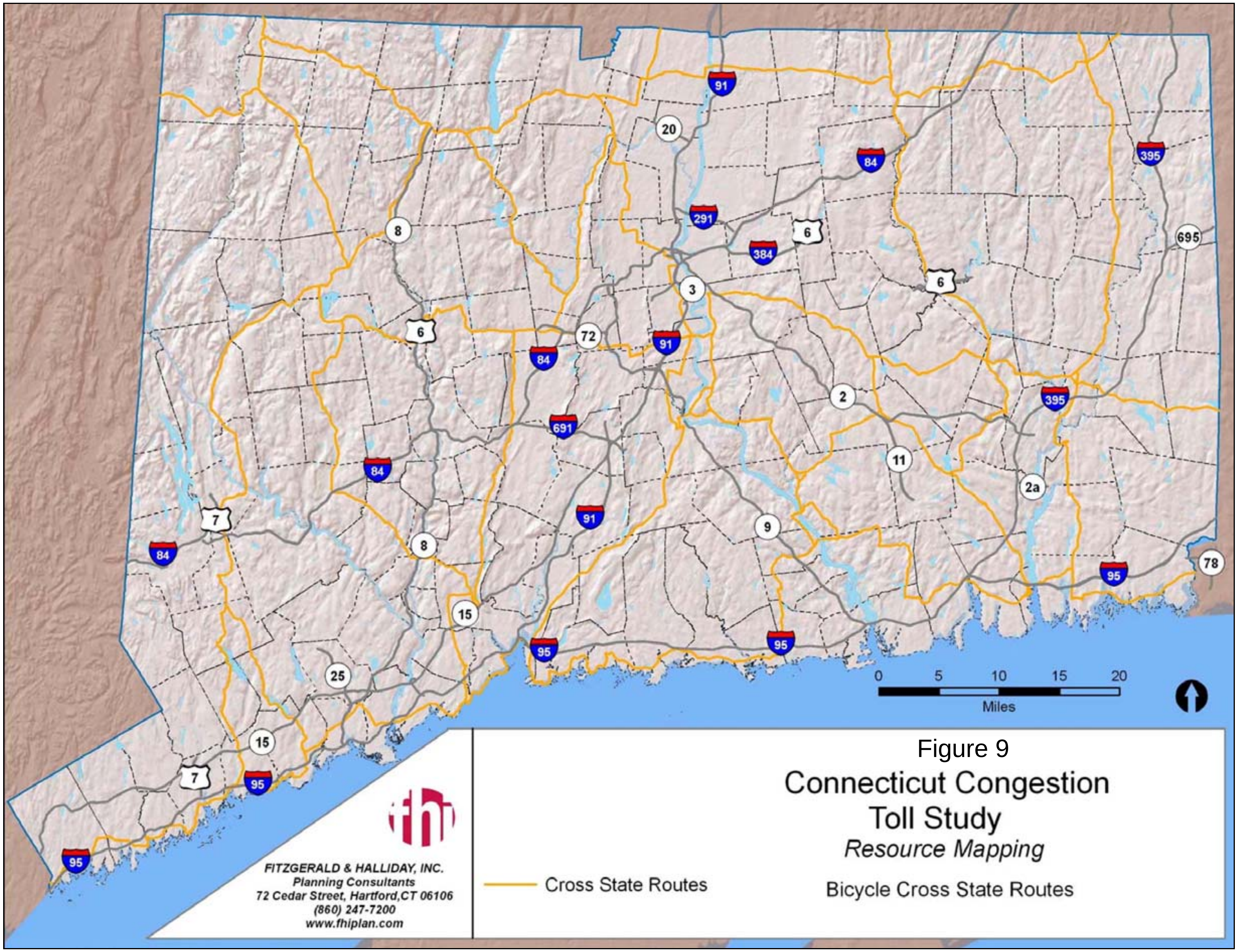


Figure 9
Connecticut Congestion Toll Study
Resource Mapping
Bicycle Cross State Routes

- *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.

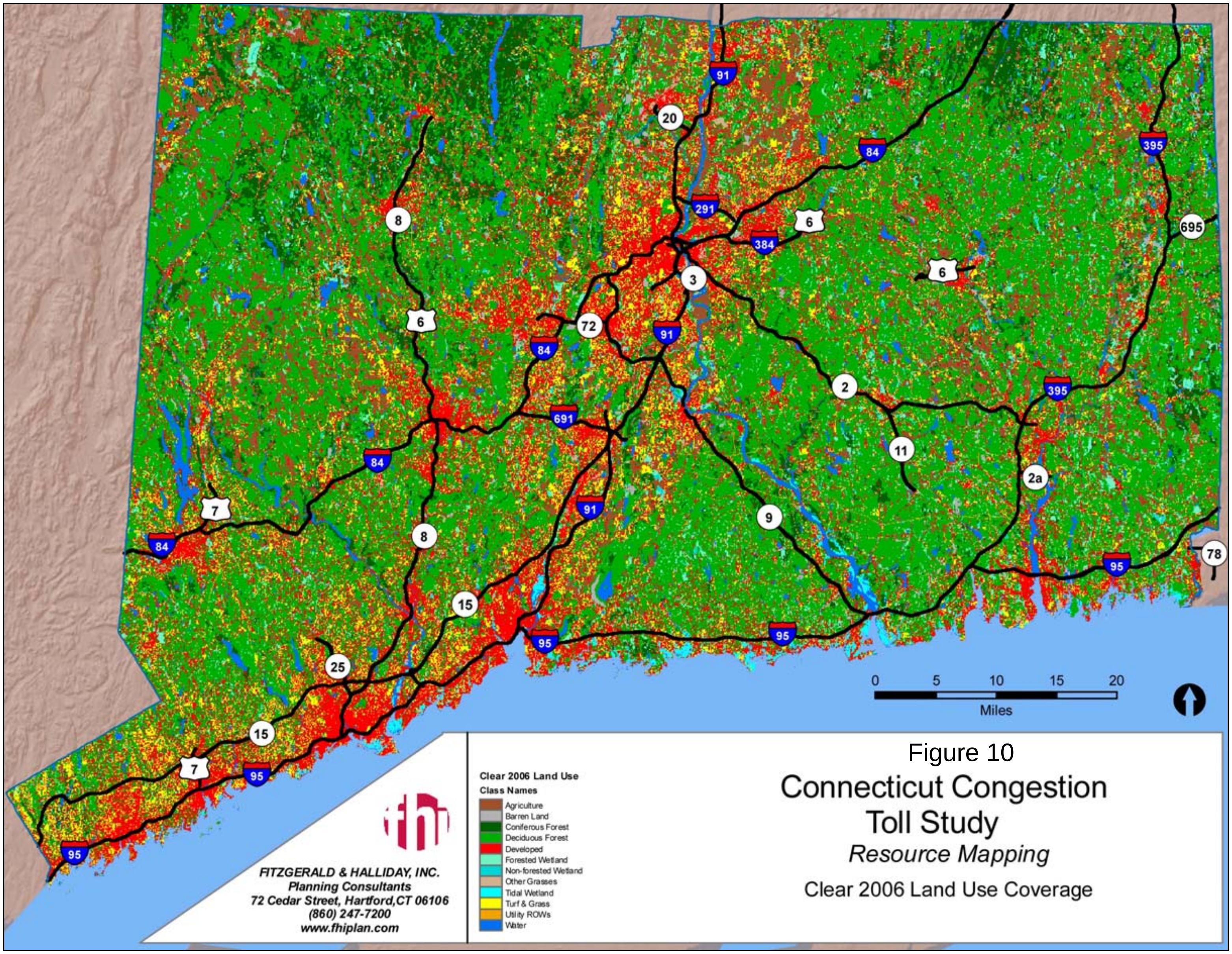
A statewide land cover map has also been developed by the University of Connecticut Center for Land Use Education and Research (CLEAR). This map focuses on broad categories of land cover associated with different types of land use from developed land to agricultural lands to forested areas to wetlands 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.


91
20
84
395
8
291
6
384
695
3
6
72
6
91
84
2
395
691
11
84
2a
91
7
9
8
84
78
95
15
95
95
25
0
5
10
15
20
Miles
15
7
95
95
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
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
Figure 10
Connecticut Congestion
Toll Study
Resource Mapping
Clear 2006 Land Use Coverage

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.*

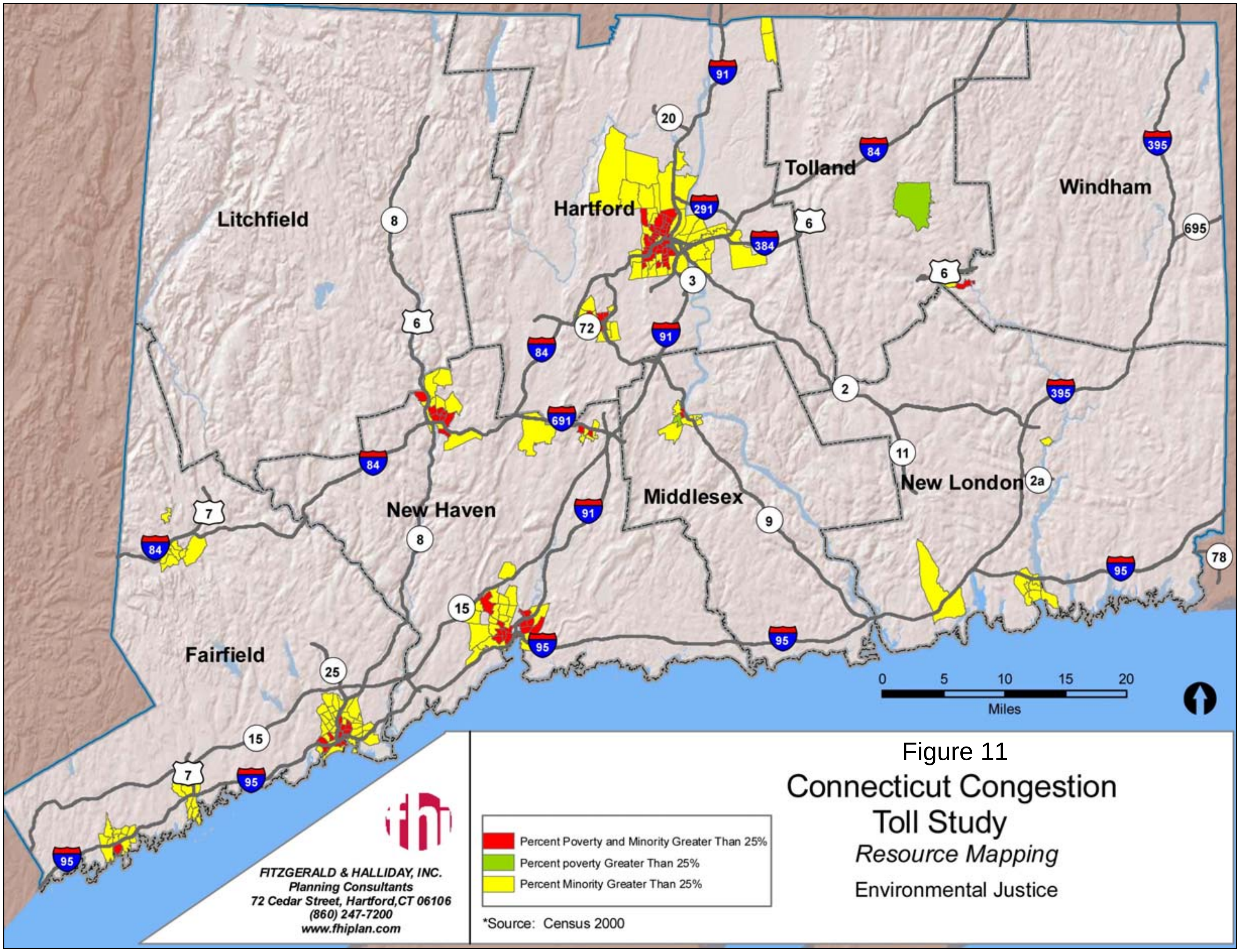
In order to evaluate the tolling alternatives for the purposes of environmental justice, U.S. Census Bureau (Census) data (2000) were used to determine the presence or concentration of minority and low-income populations within the major interstate and state route corridors. The data collection effort 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.


Litchfield
Hartford
Tolland
Windham
New Haven
Middlesex
New London
Fairfield
0 5 10 15 20
Miles
FITZGERALD & HALLIDAY, INC.
Planning Consultants
72 Cedar Street, Hartford,CT 06106
(860) 247-7200
www.fhiplan.com
Percent Poverty and Minority Greater Than 25%
Percent poverty Greater Than 25%
Percent Minority Greater Than 25%
*Source: Census 2000
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

---

[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.