Final Report

Congestion Mitigation Systems Plan "Vision 2020"

February 2003

Prepared by:
Wilbur Smith Associates

Prepared for:
South Western Regional Planning Agency

SWRPA
South Western Regional Planning Agency

ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

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In Association With:

KKO Associates
Urbitran Associates
Fitzgerald & Halliday, Inc.
Buckhurst, Fish & Jacquemart
Geomatrix
Center For Research and Public Policy

With Support from:
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The South Western Regional Planning Agency also wishes to acknowledge the following persons and organizations whose participation helped shape the Vision: the Connecticut Department of Transportation, U.S. Department of Transportation Federal Highway Administration, the South Western Region Metropolitan Planning Organization, the Greater Bridgeport Regional Planning Agency, the Valley Council of Governments, the Housatonic Valley Council of Elected Officials, the South Central Regional Council of Governments, and the Council of Governments of the Central Naugatuck Valley, the Advisory Committee, and Herbert S. Levinson for reviewing the report prior to publication.

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1 Introduction

1.1 The Problem

In 1999, Michael Gallis and Associates presented the following statement: "Connecticut's access to the global marketplace is principally through the I-95 corridor. This corridor, with interstate and transit lines, provides access into the very dynamic New York metro region and access to the continental grid. As congestion increases in this corridor and the major global connections move west of the Hudson, this corridor will not offer the level of access to the economic activities and hubs necessary to support Connecticut's institutions, businesses and people. Congestion effectively blocks economic activity from extending farther than Stamford in the Coastal Corridor. Opening this corridor would allow economic activities to extend more into the statewide network."

In this state, transportation provides the framework necessary to keep pace with the evolving global marketplace. A transportation system that cannot handle the growing demands of people and goods movement will eventually form a rift in the economic sustainability of Connecticut. As this happens, businesses and people will relocate. Municipalities will suffer from diminishing tax bases. The quality of life that Connecticut citizens enjoy will deteriorate.

The solutions to these problems are difficult. They are often costly and controversial. Hard decisions will need to be made by policy makers, government agencies, business leaders and citizens. Decisive steps must be taken. The Congestion Mitigation System 2020 Study - also known as "Vision 2020" - has developed a vision for southwestern Connecticut. It is a vision that will help to reduce congestion, improve air quality and promote economic growth. It is a vision that will build upon existing transportation assets and strive to improve overall system efficiency. Most importantly, it is a vision that will offer transportation users, or customers, choices. The automobile has a monopoly on modal market share. Continued dominance by this mode will make it difficult for transit options to survive. If options do not exist, customers have no choices and the predictions offered by Mr. Gallis may become a reality.

1.2 The Transportation System

As far back as the 1950's and 1960's, research in the field of regional travel demand and transportation planning has documented the close connection between land use decisions and local traffic generation, choice of travel mode, overall traffic volume and congestion. The form and intensity of land use, traffic access and circulation correlate with a wide range of travel characteristics, such as:

- Trip purposes (home-work, home-school, home-shopping, recreational, etc.);
- Mix of vehicle types (the proportion of cars, buses and trucks in overall traffic volumes);
- Availability and use of non-vehicular travel modes (walking and bicycling); and
- Corridor/roadway-specific levels of traffic, transit and transportation demand.

Transportation and land use planning should have coordinated end goals – making the most efficient use of limited resources while creating an environment in which residents and businesses can enjoy a quality of life that is both desirable and sustainable. However, transportation implications of land use decisions have not always been considered thoroughly. For example, encouragement of mixed land use developments that blend residential, commercial, educational, and recreational uses may reduce or limit vehicular demand. Clustering of development may create an opportunity to implement transit service providing an alternative to the private automobile.

1.2.1 Existing Conditions

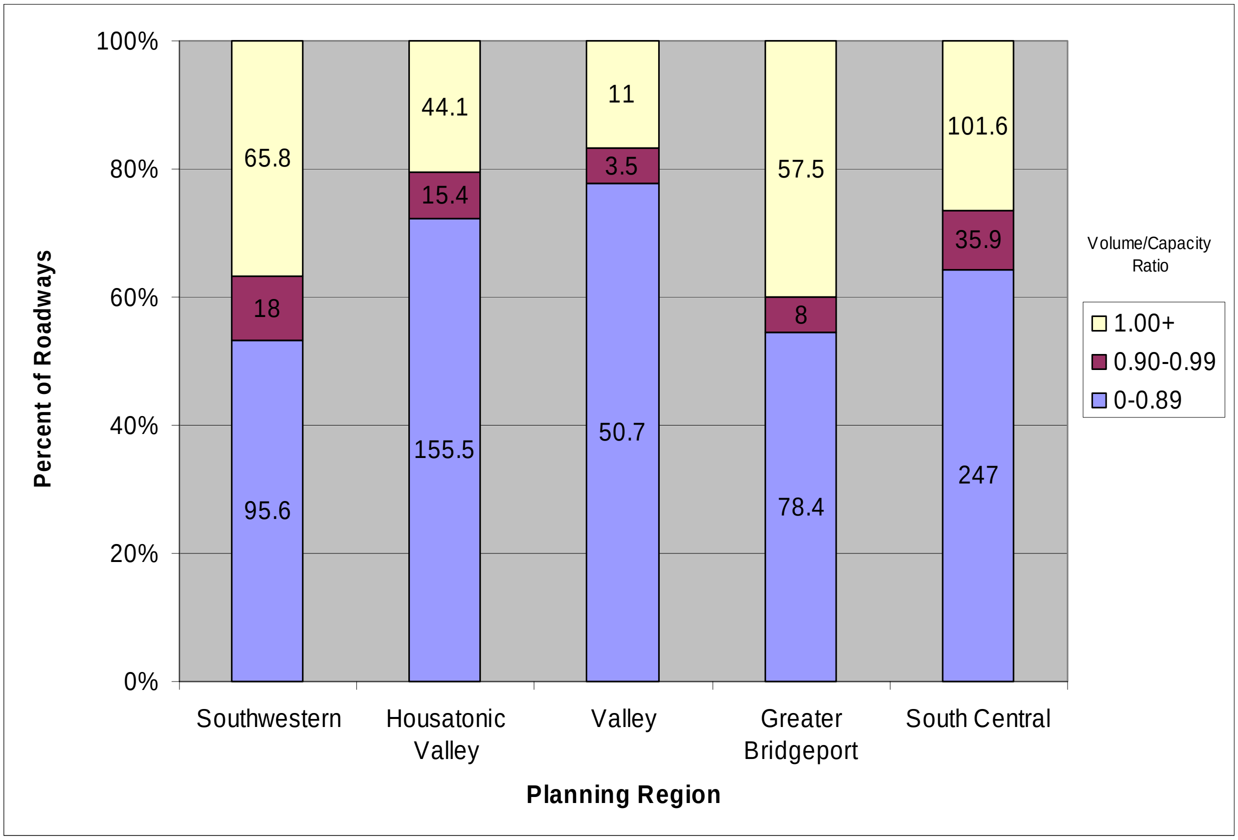
Within the Vision 2020 study area, three primary modes exist to move people from location to location. The most ubiquitous mode is the automobile and the extensive network of highways and arterials in southwestern Connecticut provides cars and trucks with virtually unlimited accessibility to businesses and residences. In addition, the networks of local bus services in the study area are an important resource for the transportation system. These services are mostly restricted to more densely developed urban areas and are essential for providing mobility options to transit dependents as well as discretionary riders who prefer not to drive. Finally, passenger rail services along the coastal corridor and along three inland branch lines help form the spine of the transportation network. Train service is capable of moving a large number of passengers safely and reliably. While most of the rail service is oriented to serve trip ends in New York City, a growing intrastate demand is indicating market potential for improved service. The following sections briefly frame the existing conditions of these primary transportation system assets.

Highway Characteristics

Currently, the southwest corridor experiences routine congestion in the morning and afternoon peak periods. The two regions that together form the southernmost gateway into New England - South Western and Greater Bridgeport – both have approximately 50% of their major roadways approaching or at their maximum vehicle carrying capacity. Included in these statistics are interstate highways such as I-95, I-84 and I-91; expressways such as Route 15 and Route 8, major arterial roads such as U.S. 1 and, U.S. 7; and other state designated roads. Figure 1-1 illustrates the miles of congested roadway by planning region.

Volume-to-capacity (V/C) ratios are often used to indicate roadway segments that are congested. Traditional traffic engineering theory combined with practical experience has demonstrated that as traffic volume approaches roadway capacity, system breakdown often results. The inability of a road to achieve its maximum capacity is attributable to a wide variety of factors, such as driver unpredictability, frequency of curb-cuts, visual distractions, road conditions, and geometric conditions.

Figure 1-1 Miles of Congested Roadway by Planning Region



Source: ConnDOT Congestion Management System – 2000

The amount of residents suggesting traffic congestion is not a problem, decreased slightly to 11.8% in 2002, from 14.4% in 2001. Almost three quarters (71.7%) consider traffic congestion a very serious problem – up from 68.6% in 2001

Source: 2002 CRPP Telephone Survey – Survey results will be presented in green text boxes throughout the remainder of this document.

Rail Service Characteristics

There are three main rail lines serving Southern Connecticut between Branford and the New York state line: the New Haven Mainline, which runs between New Haven and New York City's Grand Central Terminal; the Shore Line, which runs between New Haven and the Rhode Island state line; and the Springfield Line, which runs from New Haven to the Massachusetts state line.

Passenger and limited freight railroad service is also provided on three branches of the New Haven Mainline: the New Canaan branch connects Stamford and New Canaan; the Waterbury branch connects Bridgeport and Waterbury; and the Danbury branch connects South Norwalk and Danbury.

All of these rail lines, with the exception of the Shore Line, are owned by the State of Connecticut, with rail passenger and freight services provided by different operators under contract to the Connecticut Department of Transportation. The Shore Line is owned by Amtrak. Table 1-1 lists the study area rail lines and the daily service characteristics.

Table 1-1 Rail Lines in Study Area

Line	Northern End	Southern End	Length	Daily passenger trains[1]	Daily Freight trains	Total Daily Ridership
New Haven Line	New Haven	New York City	72.3	307	4	91,628[2]
Shore Line East	New London	New Haven	50.9	55	2	1,096[3]
Springfield Line	Springfield	New Haven	36.6	14	2	1,000[4]
New Canaan Branch	New Canaan	Stamford	7.9	39	0	2,592[2]
Waterbury Branch	Waterbury	Bridgeport	26.9	6	2	226[2]
Danbury Branch	Danbury	Norwalk	23.6	20	2	1,155[2]
Maybrook Branch	Danbury	Derby	27.7	0	3	N/A
Total				**441**	**15**	**133,460**

Source: KKO Associates

Bus Service Characteristics

Six agencies provide public transit services in the study area:

- CT Transit New Haven Division
- Milford Transit District (MTD)
- Greater Bridgeport Transit Authority (GBTA)
- Norwalk Transit District (NTD)
- CT Transit, Stamford Division
- Housatonic Area Regional Transit (HART)

Service is provided by these operators to all towns along the I-95 corridor in the study area, as well as to the outlying areas and other major corridors in the study region. Table 1-2 lists the study area bus operators and the daily service characteristics for each.

Table 1-2 Bus Services in Study Area

Service	Daily buses	Total Daily Ridership
CT Transit, Stamford Division	33	10,600
Norwalk Transit District	34	5,800
Greater Bridgeport Transit Authority	43	16,000
Milford Transit District	6	500
CT Transit, New Haven Division	92	30,000
Housatonic Area Regional Transit (HART)	25	500
Coastal Link Service	9	3,400
Total	**242**	**66,800**

Source: Urbitran Associates

[1] Daily passenger trains on Lines includes Amtrak and Metro-North trains.
[2] Based on 1996 Metro-North counts.
[3] Shore Line East counts for February 1996.
[4] Approximate ridership, Amtrak data are not available at this time.

More than one quarter of employed respondents, 26.8%, indicated having an alternative mode of travel for work. These include:

Train	**20.6%**
Walk	**19.0%**
Bus	**17.9%**
Bike	**16.7%**
Car pool	**11.9%**
Car	**10.7%**
Other	**2.8%**
Car to train	**0.4%**

Further, a large majority of employed respondents, 85.8%, noted being very (55.6%) or somewhat (30.1%) aware of alternative modes of transportation available to them.

1.2.2 Future Growth

Roadways

I-95 and Route 15 together carry the majority of vehicles along the coastal corridor. In 1958, Interstate 95 carried less than 20,000 vehicles per day. By 1983, average daily traffic on Interstate 95 increased to approximately 70,000 vehicles per day at the Norwalk vehicle counting station and further increased to a staggering 130,000 vehicles per day in 2000. The highest daily vehicle counts in southwestern Connecticut – 150,000 vehicles per day – have been recorded in Stamford. The Merritt Parkway, which runs parallel to Interstate 95 through much of southwestern Connecticut, has seen similar percentage increases in average daily traffic.

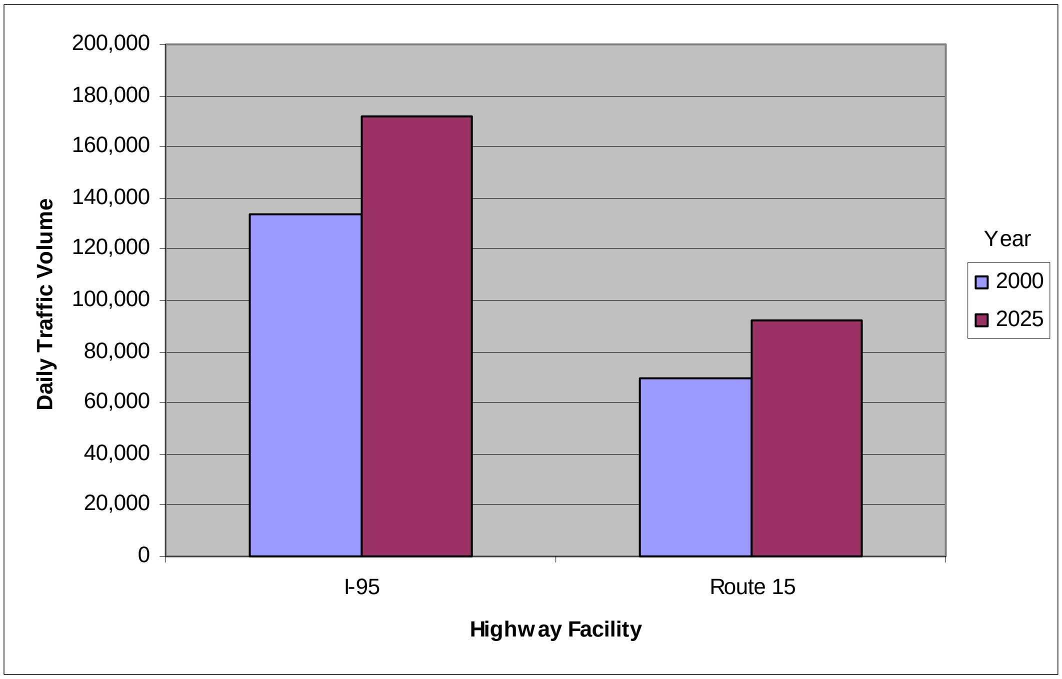
The highest recorded traffic volumes are between the hours of 3:00 p.m. and 8:00 p.m., during which close to 9,000 vehicles pass through the vehicle-counting station in Norwalk. Approximately 8,000 vehicles per hour pass the Norwalk counting station between the hours of 6:00 a.m. and 9:00 a.m. (Interstate 95 was designed to accommodate 5,750 vehicles per hour on this segment.)

The effects of climbing traffic volumes on Interstate 95 and the Merritt Parkway translate into increased travel times and decreased safety. In fact, a mapping of crash data shows that traffic accidents most frequently occur during those times of day when the highway is most congested. The highest accident rates are found in the South Western Region.

As future population and employment projections indicate, traffic demand these two major east-west highways will increase by approximately 30% over the next 25 years. Figure 1-2 illustrates the projected growth in travel along these two arteries.

Almost three quarters (71.7%) of survey participants consider traffic congestion a very serious problem – up from 68.6% surveyed in 2001.

Figure 1-2 Forecasted Daily Travel Demand



Source: ConnDOT Congestion Management System - 2000

Transit

ConnDOT reports that 90% of Metro-North's approximately 70,000 peak passenger trips on the New Haven Line services start or end at Grand Central Terminal. Only 10% of peak travel is oriented toward "intermediate" length trips between stations along the line. Off peak and reverse peak use of the New Haven line service is a growth-market for Metro North. Over the next decade, ConnDOT expects ridership for services to Manhattan to grow annually by 1.9% in the peak and 5.1% in the off peak. By contrast, intermediate ridership, with destinations outside Manhattan, is projected to increase annually by 7.6% in the peak and 3.3% in the off peak.

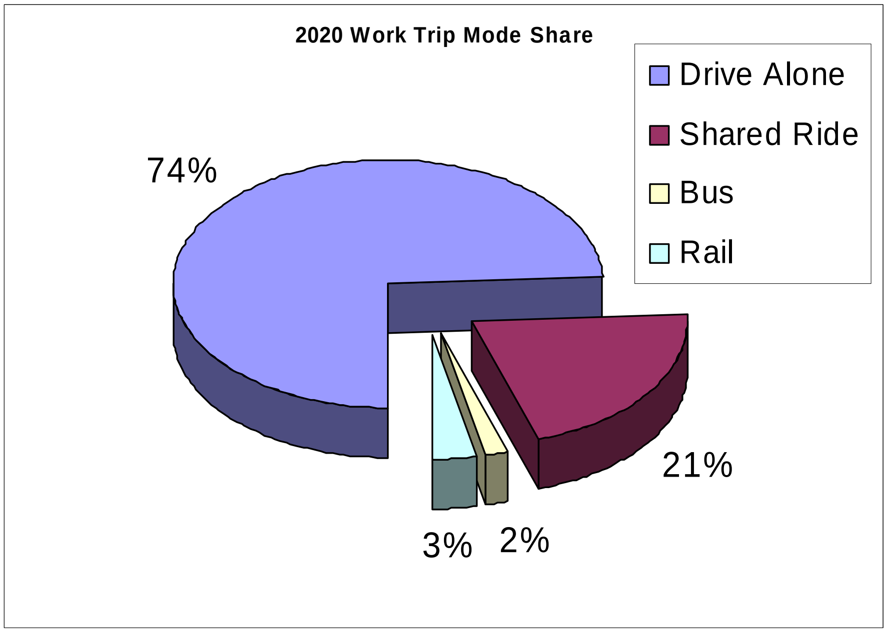
Mode Share

Accounting for a projected future growth in person trips within the study corridor of about 16% over 25 years, the mode share was estimated for study area trips. As illustrated in Figure 1-3, the automobile clearly has a monopoly on modal share. In the Vision 2020 study area approximately 74% of work-related trips are made by solo drivers and 21% of trips are shared rides. The remaining 5% of trips are accommodated by either bus or rail transit.

In 2002, the primary reasons cited by commuters for using their cars for work included: No other option (32.4%), convenience (29.9%), it's easier to use (9.1%), need vehicle for work (6.4%), proximity to work/short distance (4.6%), and like/enjoy driving (3.4%).

Overall, the heavy reliance on auto-based mobility indicates that some major form of capacity expansion is necessary in the corridor. Capacity expansion refers to the increase of supply in either transit or highway systems to accommodate growth in demand. The Vision 2020 Study will examine capacity expansion as a means to satisfy transportation demand and alter trip maker behavior.

Figure 1-3 Year 2020 Person Trips by Mode



Source: ConnDOT Travel Demand Model

1.2.3 Study Process

Over the past two decades, many efforts have been made to address the complex issues involving transportation in southwestern Connecticut. This study will take a different approach to plan development than prior efforts. This plan will provide for a bold "**vision"** for transportation in the corridor that has as its basis "the commuter and shipper as customer". The vision will be largely formulated through an intensive public outreach process that fosters input from a wide cross section of customers including: chief elected officials, business owners, commuters, logistics managers, transit passengers and operators, and numerous public and private agencies. The result of this process was the development of a vision that is deeply rooted in the people, communities and businesses of southwestern Connecticut. The vision is a consensus-based long range plan for southwestern Connecticut that will serve as a platform for the development of transportation investment over the next twenty years.

Low positive ratings continued to be recorded for all State of Connecticut transportation service characteristic measured. These include:

➢ **Keeping commuters informed of planning activities**	**28.1%**
➢ **Efforts to make mass transit available and accessible**	**24.7%**
➢ **Condition of state roads and highways**	**24.1%**
➢ **Planning efforts for the area's roads and highways**	**19.0%**
➢ **Innovative efforts to remedy traffic congestion**	**15.0%**
➢ **Efforts to reduce traffic congestion on roads and highways**	**14.9%**
➢ **Having sufficient pathways for travel on foot or bike**	**9.9%**

Planning Regions

This study was administered by the South Western Regional Planning Agency (SWRPA). SWRPA is the state designated regional planning agency dedicated to preserving and improving the quality of life and economic vitality in Southwestern Connecticut. SWRPA brings together its eight member municipalities to coordinate planning for the Region's future.

In addition, coordination from four other regional planning agencies was essential to making this study successful. These are: the Housatonic Valley Council of Elected Officials (HVCEO), Greater Bridgeport Regional Planning Agency (GBRPA), Valley Regional Planning Agency (VRPA), and South Central Regional Council of Governments (SCRCOG).

Study Team

- Wilbur Smith Associates (WSA) is the prime consultant on the study and responsible for overall coordination of efforts, strategic planning and evaluation. Other members of the study team included:
  - ✓ KKO Associates
  - ✓ Fitzgerald & Halliday, Inc. (FHI)
  - ✓ Urbitran Associates
  - ✓ Geomatrix Productions
  - ✓ Center for Research and Public Policy (CRPP)
  - ✓ Buckhurst, Fish and Jacquemart (BFJ)

Public Involvement

Opportunities for public participation were incorporated throughout the study process. An advisory committee including representatives of local, state and federal agencies, transportation providers, environmental organizations and the business community was the primary link between the study team and those constituencies that will likely emerge as providers or users of the transportation services comprising the vision. The advisory committee provided input on the direction of the study at regular intervals during the process. Advisory committee members also were encouraged to review and comment on the draft technical memoranda which form the basis on the vision.

Other members of the general public also were provided with an opportunity to share their support for various congestion mitigation strategies. Three general public meetings were held during the initial phase of the study, one each in the South Western, Greater Bridgeport and South Central regions. An additional public meeting was held in the South Western Region upon release of preliminary evaluation results. Study updates and progress reports were also provided to a variety of organizations upon request.

Market Research

Public opinion surveys and focus groups were conducted to test a variety of factors including public perception of traffic congestion, awareness of current transportation planning efforts, preference for various congestion mitigation strategies and willingness to pay for transportation improvements. An initial survey of 1,000 randomly selected telephone respondents was fielded in fall 2001; a second survey of 1,000 randomly selected telephone respondents was fielded in fall 2002. Eight focus groups were conducted in early 2002. Focus group participants included persons commuting by both automobile and transit, business managers and human resources personnel, and shippers and receivers.

Goals and Objectives

The primary goals of the Vision 2020 Study are as follows:

- Reduce Congestion;
- Improve Mobility;

- Improve Accessibility;
- Promote Options; and
- Support Economic Growth.

Further explanation of these goals is as follows:

1. Congestion generally involves vehicle movement on roadways. It is measured using vehicle-miles and vehicle-trips, roadway Level-of-Service (LOS), average traffic speeds, vehicle delay, and vehicle operating costs. It assumes that transportation improvements affect vehicle travel. It is the easiest way to measure transportation and is commonly used in transport planning.

2. Mobility refers to the movement of people and goods. It is measured using person-miles, person-trips, average trip speeds, and cost per person-mile. It recognizes automobile, transit, ridesharing, and to a lesser degree non-motorized improvements to transportation problems. Mobility is moderately difficult to measure.

3. Accessibility refers to the ability to reach desired goods, services and activities. It is the ultimate goal of transportation and is measured using generalized cost (money, time and discomfort) per trip. Accessibility is relatively difficult to measure and so is not often used in transport planning.

4. Promoting options refers to providing transportation alternatives that allow customers to make decisions that are based on cost and convenience. Transportation options that are competitive and have flexibility for future expansion are desirable. Change in mode choice can be used to measuring the effectiveness of improved travel options.

5. Economic growth is an important goal but one that is very difficult to justify through transportation improvements. In general, travel time and vehicle cost savings can be related to increased productivity and development. Economic development is difficult to measure because a decline in one location typically leads to an increase somewhere else, and revenue transfers are the result. In southwestern Connecticut, the overarching goal is to remain a competitive force in the global marketplace.

Performance Metrics

Performance metrics are used in this study to compare the impacts resulting from a set of transportation improvements to the Base scenario. The five basic metrics used in this evaluation are as follows:

1. <u>Travel Time</u> - Travel time savings are the result of transportation improvements that improve the flow of traffic, improve the speed of transit service, or reduce wait times for parking or transit transfers. In the case of automobiles, travel time savings typically are the result of congestion reduction measures such as adding capacity, removing localized choke point, improving signal systems or using ITS to manage delay. In the case of transit, travel time savings typically are the result of improving service speeds by upgrading equipment and infrastructure, increasing service frequency so less time is spent waiting and providing convenient access to stations and park and ride lots.

   Travel time savings in the Vision are related to improved speeds and therefore contribute to air quality benefits.

2. <u>Vehicle Miles Traveled (VMT)</u> – VMT reductions are the result of fewer or shorter distance automobile trips on the roads. Reductions in VMT contribute to air quality, safety and energy consumption benefits.

3. Mode Shift – Mode shift is the result of providing competitive transport options so that reductions in single occupant vehicle use is encouraged. Mode shift typically is the result of providing transit services that are fast, convenient and affordable and compete favorably with the automobile. Mode shift can also include shifts from single occupant vehicles to multi-occupant vehicles such as car or vanpools by providing incentives to do so.

4. Accessibility – Accessibility involves reducing the travel time impedance or spatial separation between people and their intended destinations. Accessibility can be increased by focusing development near residential concentrations or by improving the transportation network so that it takes less time to travel between origins and destinations. In either case, efficiencies are gained by concentration and proximity of land uses.

5. Safety – Safety is the result of improving roadways or reducing traffic so that the number and severity of traffic accidents is mitigated in the study area.

Parameters and Constraints

Identification of strategies to mitigate traffic congestion in the study area was subject to several constraints. These constraints were identified jointly by SWRPA and the study team prior to commencing work and are as follows:

- Analysis is focused on trips starting and ending within the study area.
- Analysis is focused on peak period work trips.
- Expansion or alteration of the Merritt Parkway was not considered due to its status as a federally designated historic landmark.
- Analysis of land use strategies assumes maintenance of local jurisdiction of land use regulation.

2 The Vision

2.1 Vision Statement

The study focus was to provide transportation system capacity in a way that both achieves study goals and allows transportation users to make choices rather than be required to change their way of life. The resulting vision is a hybrid of bus, rail and roadway strategies that offers customers improved flexibility in their travel options and could be incrementally expanded to meet future growth in demand.

Over the course of the study process, the following vision statement was developed.

Vision 2020 will identify strategies that support safe, reliable, convenient and affordable travel options for the movement of persons and goods in and through southwestern Connecticut, with a focus on those travel options which have the greatest potential for reducing traffic congestion, improving environmental quality, promoting sustainable growth and offering long-term, flexible opportunities for increasing transportation system capacity.

2.2 The Transportation Strategies

A wide array of transportation and land use strategies were evaluated as part of the Vision 2020 Study. Of these strategies, the most applicable to southwestern Connecticut were selected for evaluation.

There exists strong support for a number of conceptual strategies to reduce road and highway traffic. These strategies include:

➢ **Enhance a rapid response program for highway accidents**	**92.1%**
➢ **Create a reduced fee commuter bus/rail pass**	**91.0%**
➢ **Adding additional parking at rail stations**	**90.6%**
➢ **Creating incentives for parking at rail stations or park and ride lots**	**89.6%**
➢ **Increase park and ride opportunities**	**89.4%**
➢ **Enhance flextime and short week programs**	**87.4%**
➢ **Reduced parking costs at rail stations**	**86.1%**
➢ **Enhancing rideshare programs (car/van pooling)**	**85.2%**
➢ **Create an "express bus" system**	**81.4%**

The Vision contains a group of strategies that work together to provide customers with a wide range of choices to satisfy demand for mobility, travel options, and goods and services. Strategies included in the Vision have been grouped into the following three categories:

- Transportation Systems Management (TSM);
- Transportation Demand Management (TDM); and
- System Expansion.

These strategies are presented along a continuum illustrated in Figure 2-1. The continuum reflects the grouping of Vision strategies, but also indicates an increasing level of complexity and uncertainty in their application. Uncertainty is tied to the fact that land use support becomes more necessary as progression along the continuum increases. Transit strategies are almost entirely dependent on supportive land use policy.

Transportation Systems Management strategies included in the Vision serve to maximize the performance of the existing transportation system by making more efficient use of supply. TSM strategies generally provide improvements such as safety enhancements and improved operations rather than major expansion to road and transit capacity. They also form the foundation of the Vision. These strategies provide the essential components for the successful integration of major highway and transit strategies.

Transportation Demand Management strategies included in the Vision attempt to reduce trips during the peak travel periods of the day by promoting programs that influence system demand. These strategies can also offer incentives to help influence traveler behavior.

System Expansion strategies included in the Vision attempt to increase transportation supply to meet the needs of growing demand. This expansion includes:

Increasing transit services and infrastructure in the study area will provide more frequent, convenient and faster service for both trains and buses. New bus services would be designed as Bus Rapid Transit services so that travel time savings and added conveniences similar to those found on trains can be combined with the flexibility of buses. In addition, trains would run more frequently and provide better intrastate service for this growing market. Transit strategies are essential for providing transportation choices to customers who are now reliant on the automobile to serve their travel needs.

A fast and convenient transit system can be a catalyst for change in both land use policy and travel behavior, and with such policy in place the performance of these systems can increase significantly.

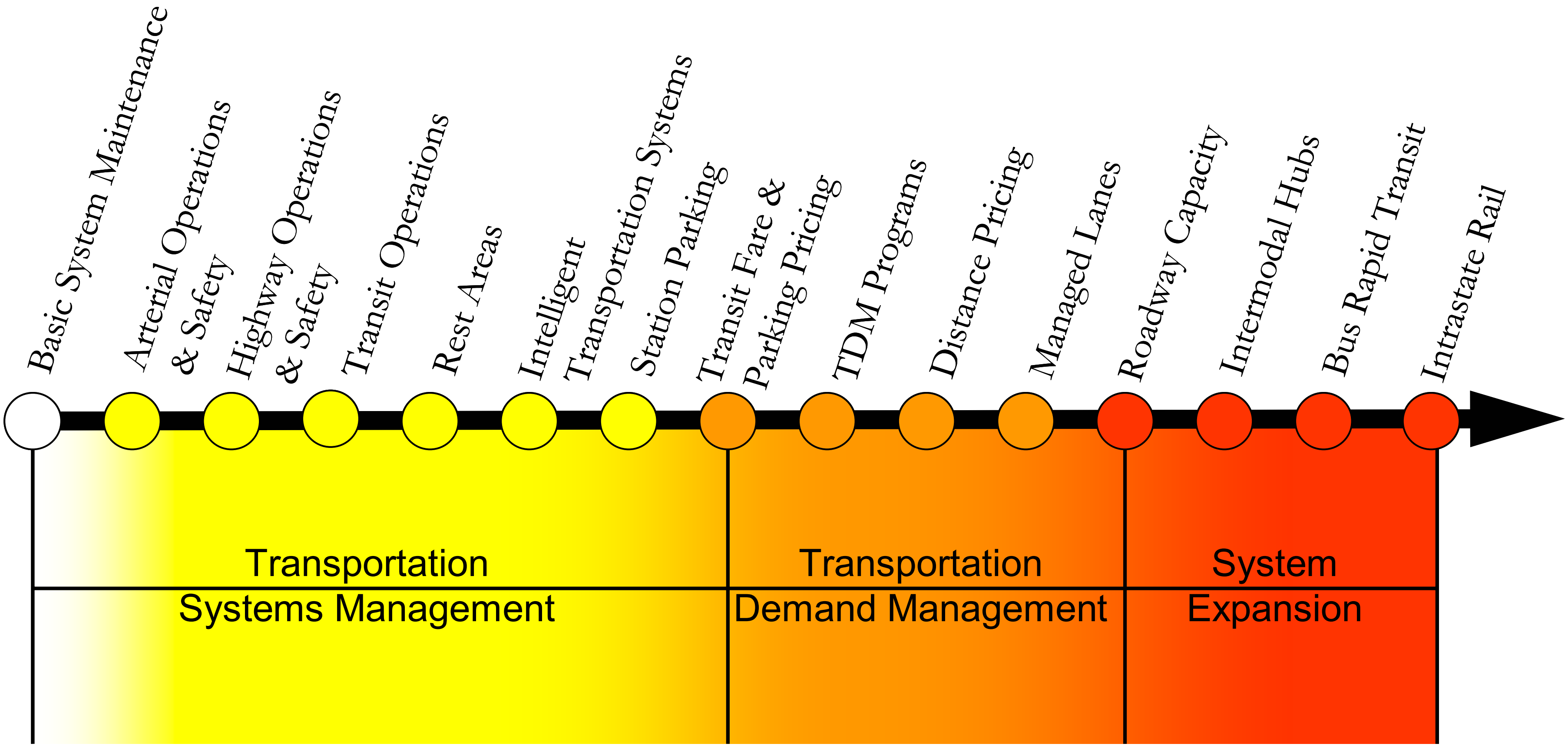
It should be noted that the model used to evaluate the performance of these services assumes that current trends in demographics are projected into the future. Ultimately, any transportation investment made in the study area will fail without the support of land use policy that will change how we live and work.

Increasing roadway capacity in the study area to serve the dominant auto-based travel mode as well as truck-based freight distribution. Added highway capacity can be coupled with TDM strategies to influence driver behavior by providing incentive to carpool or use transit.

To reduce congestion, provide choices to the customer, and influence traveler behavior, demand for I-95 should be managed with value pricing strategies.

A large majority of respondents (88.4%) believe that highway expansion alone will not solve congestion and that a number of strategies will be required. Only 5.4% of respondents believe that highway expansion alone will work.

Figure 2-1 Transportation Strategy Continuum



2.2.1 Basic System Maintenance

Basic system maintenance is defined as the preservation of the existing transportation system. It would consider the implementation of improvements currently programmed but would involve no further increases to transport system capacity. This scenario assumes that existing facilities will be maintained effectively and safety improvements made where necessary. Maintenance and preservation of the existing infrastructure will require considerable investment.

2.2.2 Arterial Operations and Safety

Traffic systems management strategies focus on improving the flow of traffic by optimizing the operation of the existing roadway system. These strategies do not generally include increases in roadway capacity, but instead maximize the efficiency of existing capacity with location specific improvements. These strategies can be applied to arterial roads as well as to limited access highways. Some of the techniques that could be used include:

It is important to note that these strategies alone will not solve the problems of congestion, economic stagnation, and negative environmental impact. They will however, help to mitigate the negative impacts created by congestion by making the overall transportation system more efficient.

- Signal timing and coordination;
- Access management; and
- Operational improvements – i.e. turn lanes, shoulders, geometric modifications.

The following evaluation found that significant benefits can be obtained with relatively low capital and operating investments. To evaluate the benefits of signal coordination, the SCRITS model developed by Science Applications International Corporation (SAIC) was used. SCRITS (SCReening for ITS) is a spreadsheet analysis tool for estimating the user benefits of Intelligent Transportation Systems (ITS). It is intended as a sketch-level or screening-level analysis tool to obtain an initial indication of the possible benefits of various ITS applications. It is not intended for detailed analysis.

For this analysis, approximately 50 miles of Route 1 from New Haven to Greenwich was tested for signal coordination. Approximately 270 signals exist along this corridor, of which 88 remain uncoordinated. Coordinating these remaining signals will provide more efficient progression of traffic along Route 1.

Table 2-1 Traffic Signal Coordination on Route 1

Description of improvement: Signal Coordination Analysis (88 signals on Route 1)	Assumed Value	Calculated Value
TRAFFIC AND TRAVEL		
Current total weekday VMT on Route 1 in study area		1,285,362
Current total weekday VHT on Route 1 in study area		41,015
Average speed on Route 1 in study area		31.3
Percent improvement in average speed expected	20%	
Average speed expected after improvement		37.6
Total weekday VHT after improvement		34,179
Time (hrs.) saved per weekday		6,836
Time (hrs.) saved per year, weekdays only		1,708,958
Current no. stops per VMT	0.5	
Current no. stops in study area, average weekday		642,681
Percent reduction in stops expected	10%	
No. stops eliminated, average weekday		64,268
ENERGY AND EMISSIONS		
Annual gallons of fuel saved, weekdays only		321,341
Annual change in weekday CO (tons/year)		-7,992
Annual change in weekday Nox (tons/year)		139
Annual change in weekday HC (tons/year)		-906
ACCIDENTS		
Current no. annual accidents on Route 1, weekdays only		3,313
Percent accident reduction		10%
No. accidents eliminated per year, weekdays only		331
COSTS		
Installation cost	$880,000	
Service life (years)	20	
Annual operating/maintenance cost	$88,000	

Source: Wilbur Smith Associates with SCRITS Model developed by SAIC

2.2.3 Highway Operations and Safety

Generally, traffic congestion on a freeway is caused by factors such as traffic volume, weaving movements, interchange spacing, and horizontal and vertical curvature. To identify operational deficiencies along I-95, interchange spacing and ramp operations for the entire corridor from Greenwich to Branford was analyzed.

More than half of all commuters surveyed, 60.6% indicate that highway safety has decreased (47.7%) or remained unsafe (12.9%) – a number that is higher than 2001 results at 46.3%.

For the purpose of this evaluation, the entire I-95 corridor from Greenwich to Branford was divided into four segments. They are as follows:

- Segment 1: Greenwich to Norwalk
- Segment 2: Norwalk to Bridgeport
- Segment 3: Bridgeport to New Haven
- Segment 4: New Haven to Branford

The analysis of I-95 in the study area identified some of the operational deficiencies that currently exist. Deficiencies were defined as being poor Levels of Service (LOS) at interchanges or sub-standard ramp spacing. Poor LOS was defined to be in the E to F range, as qualified in the 2000 Highway Capacity Manual[1]. In addition, interchange ramps that violate spacing standards defined by the American Association of State Highway Transportations Officials (AASHTO) were identified. Figure 2-2 illustrates the location and type of deficiency by highway segment. The following text describes the location and type of the deficiency along each segment.

Deficiencies along Segment 1

The following is a list of deficiencies identified in Segment 1 related to interchange spacing and freeway-ramp operations:

- Interchanges 3, 4, and 5 in Greenwich operates at a LOS E in the southbound direction during the A.M. peak period;
- Interchanges 6, 7, and 8 in Stamford have substandard spacing and operate at LOS F in A.M. and P.M. peak periods;
- Interchange 9 operates at a LOS E during the A.M. and P.M. peak periods;
- Interchanges 10, 11, and 12 in Darien have substandard spacing and operate at a LOS E during the P.M. peak period;
- Interchanges 13 and 14 in Norwalk operate at LOS F during the P.M. peak period; and
- Interchange 15 operates at LOS F during the A.M. and P.M. peak periods. In addition, Interchanges 14 and 15 have substandard spacing in the northbound direction while Interchanges 15 and 16 have substandard spacing in the southbound direction.

As part of the ConnDOT Long Range Plan, roadway improvements are in process at Interchanges 14 and 15 in Norwalk. An operational lane is proposed in the southbound direction on I-95 between Interchanges 14 and 15. This improvement would provide additional merge distance for vehicles entering I-95 from Interchange 15 and additional diverge distance for vehicles exiting at Interchange 14.

[1] Highway Capacity Manual, Transportation Research Board, Washington D.C., 2000.

Deficiencies along Segment 2

The following is a list of deficiencies identified for Segment 2 related to interchange spacing and freeway-ramp operations:

- Interchanges 16, 17, and 18 in Norwalk and Westport operate at a LOS E during the P.M. peak period;
- Interchanges 21 through 27 have substandard spacing;
- The exit ramps at Interchanges 21 and 22 operate at a LOS E in the southbound direction during the A.M. peak period;
- The freeway-ramp junction at Interchange 26 operates at a LOS E in the northbound direction during the P.M. peak period;
- The Route 8 exit ramp at Interchange 27A in the northbound direction operates at LOS F during the P.M. peak period; and,
- The exit ramp to downtown Bridgeport operates at a LOS E in the southbound direction during the A.M. peak period.

As part of the ConnDOT Long Range Plan, roadway improvements are in process from Interchanges 25 to 29 in Bridgeport. The entire project is a mix of five major construction projects. The project provides new full shoulders and operational lanes in some sections and also involves reconstruction of several bridges from Interchange 25 to Interchange 29. Improvements to the I-95 southbound ramps from Route 8/Myrtle Avenue are also included in this project. Many of the deficiencies found in this segment are expected to be addressed within these projects.

Deficiencies along Segment 3

The following is a list of deficiencies identified in Segment 3 related to interchange spacing and freeway-ramp operations:

- Interchange 28 operates at LOS F during the P.M. peak hour period;
- Interchanges 31 and 32 have substandard spacing deficiencies;
- Interchanges 34 and 35 have substandard spacing deficiencies;
- Interchanges 37 and 38 have substandard spacing and Interchange 38 operates at LOS F during the P.M. peak period;
- Interchanges 44 and 45 have substandard spacing and Interchange 44 operates at a LOS E during the A.M. peak period; and,
- Interchanges 46, 47, and 48 have substandard spacing and the freeway-ramp junctions operate at a LOS E.

The I-95 New Haven Harbor Crossing Corridor Improvement Program will provide operational and safety improvements to approximately 7 miles of I-95 between New Haven and Branford. This project will also improve the I-95/I-91/Route 34 interchange and provide improved transit opportunities in the area. A five-lane section on I-95 is proposed in each direction from Interchange 46 to Interchange 50 (Woodward Avenue). I-95 east of that point will consist of three to four lanes in each direction. This project is ongoing and will be completed in 12 years.

Deficiencies along Segment 4

- Interchanges 47 and 48 have substandard spacing in the southbound direction. Interchange 47 serves Route 34 and downtown New Haven while Interchange 48 serves I-91 and points north.
- Southbound merge from I-91 onto I-95 and Route 34 backs up over a mile during peak periods.

The current ConnDOT study to evaluate additional lanes on I-95 from New Haven to the Rhode Island State Line will address operational deficiencies in this segment.

Summary

Of the four segments detailed in the analysis, Segment 1 contains the greatest number of substandard interchanges. This segment also has the most significant congestion in the corridor. Measurements recorded with a Global Positioning Systems (GPS) device along this segment indicated that on average the travel time is almost twice the duration that could be expected under un-congested conditions. When incidents occur, which is relatively frequent along this segment, the delay can be as much as an hour.

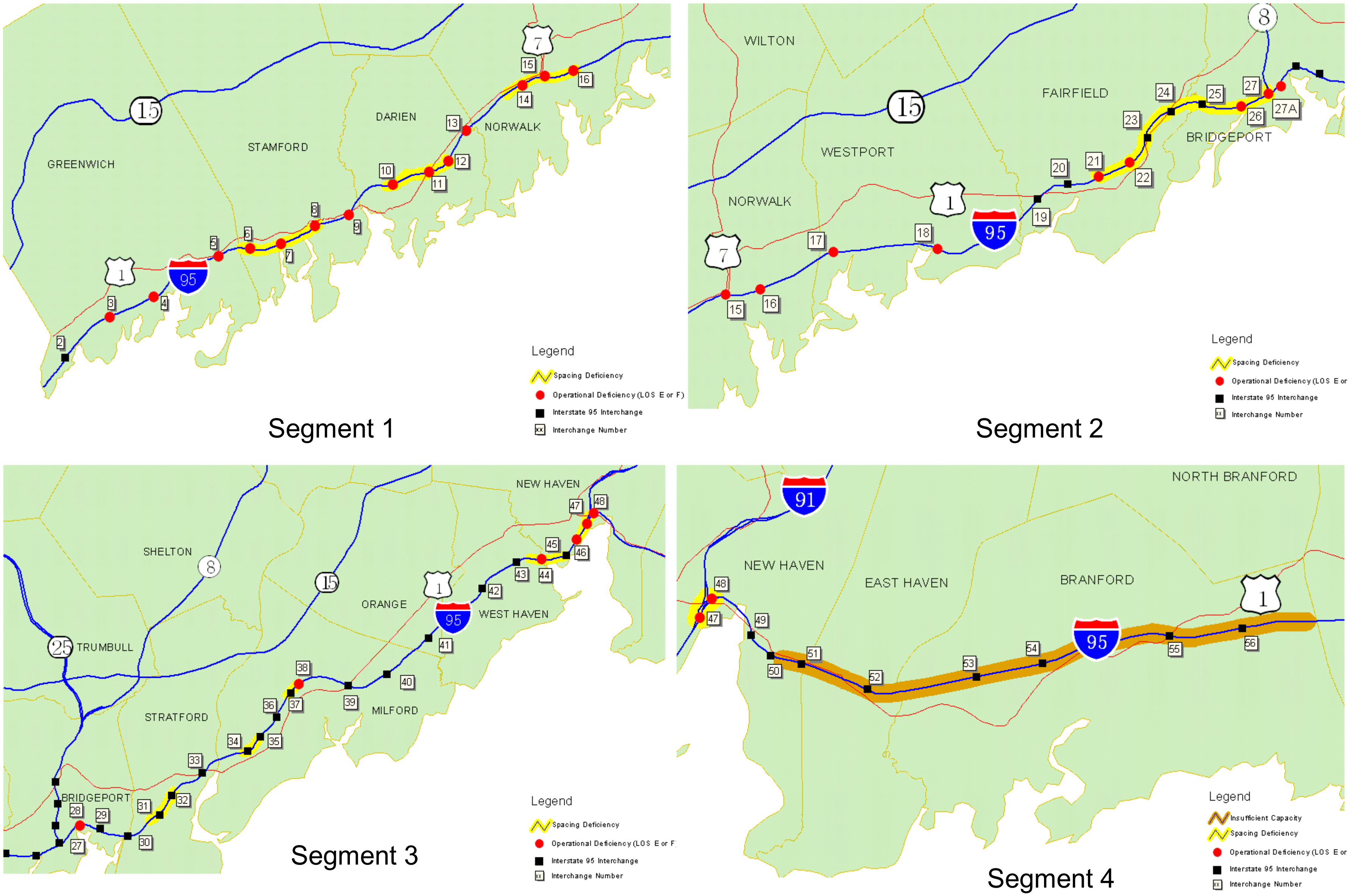
With the ongoing improvements being made to Bridgeport in Segment 2, New Haven in Segment 3, and the study of widening I-95 in Segment 4, Segment 1 is the remaining segment to be addressed. While spot improvements are currently underway, a major feasibility study would be necessary to fully evaluate the deficiencies and opportunities for improvement of this critical section of I-95. Additional evaluation of these interchange locations should consider the following improvements:

The section of I-95 between Norwalk and Stamford exhibits some of the most extreme traffic conditions in the entire corridor.

- Safety and operational improvements at specific interchanges;
- Provide additional operational lanes at specific locations in the corridor;
- Consolidation of closely spaced interchanges;
- Horizontal and vertical alignment modifications;
- Expansion of highway underpasses and approaches to interchanges;
- Ramp metering or peak period ramp closures;
- Increase ramp spacing at closely spaced interchange locations; and
- Deployment of additional ITS technology in the corridor.

To properly evaluate the costs and benefits of such improvements, the physical improvements need to be conceptually drafted. The practical considerations of construction, maintenance of traffic, right of way and environmental impact would need to be addressed in greater detail. Costs for these types of improvements can range from a few million to a few hundred million dollars, depending on the extent of the improvement and the presence of significant structures that would need to be modified.

Figure 2-2 I-95 Operational Improvements

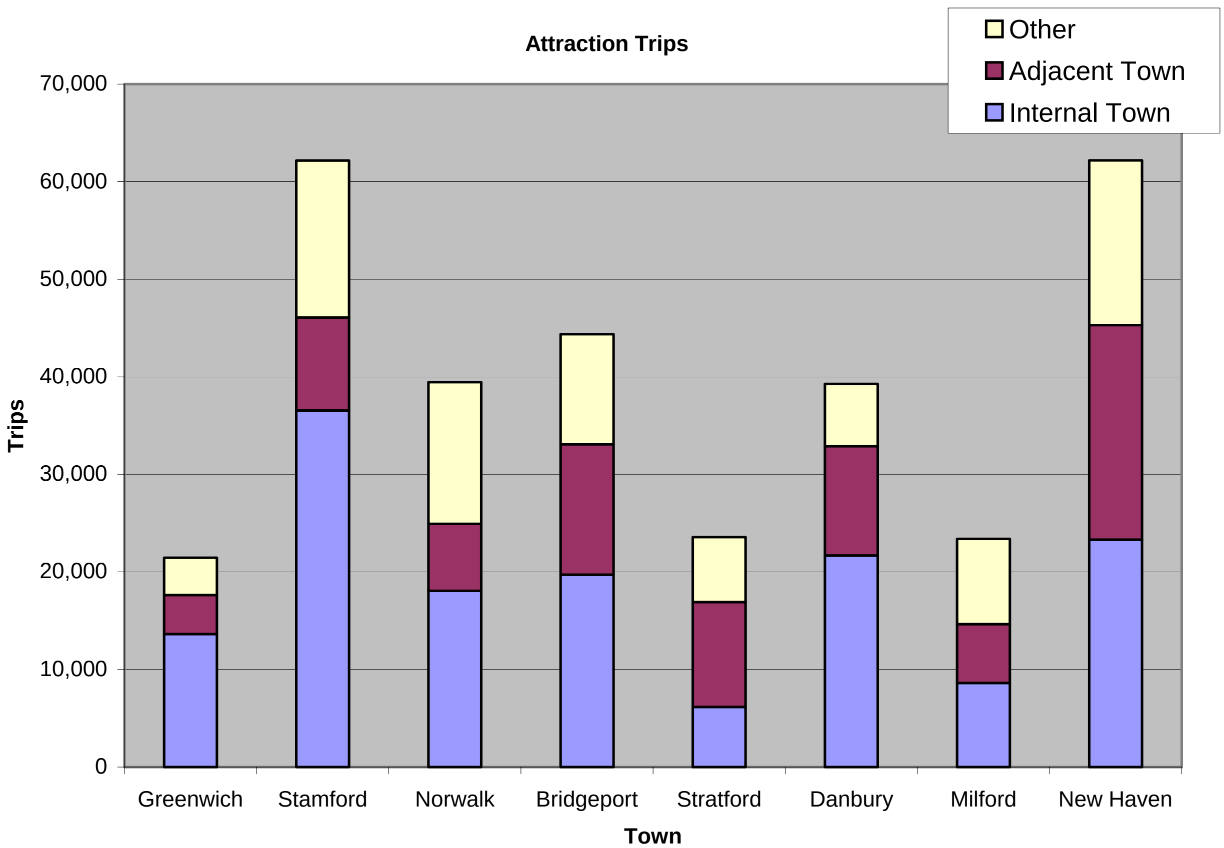


Source: Wilbur Smith Associates

2.2.4 Transit Operations

Based on demographic information derived from the Vision 2020 model, a high proportion of trips destined for major towns and cities in the study area were determined to be intra-town trips within the key cities in the study area. Major cities included New Haven, Bridgeport, Danbury, Norwalk, and Stamford. The next highest level of trip distribution was between these core towns and cities and their adjacent communities. In most cases local transit operators currently serve these trips. The high percentage of short trips indicates the need for enhanced local services throughout the study area. Figure 2-3 presents an overview of the importance of intra-town trips. The bars in the figure illustrate the total number of work trips attracted to the eight major destinations in the study area. The inter-town work trips are shown on the lowest stack. The middle stack refers to the additional number of work trips from an adjacent community to that destination. The top stack indicates the longer distance trips that come from further than one town away.

Figure 2-3 Work Trips to Major Destinations



Source: ConnDOT Travel Demand Model

Upgrades to local transit services should be considered in the study area. Improvements could encourage greater transit usage and offer alternatives to driving throughout the study corridor. The following modifications should be considered.

1. *Enhance Local Bus Services* – There are numerous transit districts that operate bus service in the study area. Services should be continuously modified to improve efficiency and effectiveness to ensure that local trip needs are not ignored. Travel patterns indicate that intra-town trips will remain a major component of overall travel, and resources should

provide increased frequencies and service hours for local travel needs and integrated connections to regional service.

2. *Upgrade Transit Links to Rail Stations* – Transit linkages to the rail stations should be improved to provide opportunity for remote parking, home-based availability and the potential to transfer between bus and rail in a more seamless manner. Services to rail stations will vary based on each community, but outlying suburban and rural towns should include demand responsive services to bring transit users from park and ride lots to stations.

2.2.5 Truck Rest Area Development

Adequate truck parking on major interstate facilities is necessary for the safety of both truckers and automobile drivers alike. The Federal Highway Administration (FHWA) has indicated that Connecticut currently lacks a sufficient number of truck parking spaces to accommodate truck parking demand based on the volume of trucks on the highways.

In 1999, a reconfiguration of existing rest areas increased the total number of spaces from 100 to 180 in the northbound and southbound rest areas in Darien, Fairfield, Milford, Branford and Madison. ConnDOT anticipates reviewing and possibly reconfiguring existing public rest areas along I-95 in the near future. Contract leases with current service providers such as Mobil and McDonald's will begin to expire in year 2003. At that time reconfiguration of the facilities may be possible and will be examined. Table 2-2 lists the existing public spaces within the I-95 corridor, as well as the potential new spaces that could be accommodated with the expansion of the existing facilities.

Table 2-2 Public Rest Areas – Existing and Possible Truck Parking Spaces

Route	Area	Existing Spaces	Possible Spaces
I-95 Northbound	Darien	18	63
I-95 Southbound	Darien	19	102
I-95 Northbound	Fairfield	17	28
I-95 Southbound	Fairfield	21	56
I-95 Northbound	Milford	25	78
I-95 Southbound	Milford	24	117
I-95 Northbound	Branford	14	50
I-95 Southbound	Branford	9	17
I-95 Northbound	Madison	10	57
I-95 Southbound	Madison	23	107
TOTALS		**180**	**675**

Note: Madison is outside of the study area.
Source: Truck Stop and Rest Area Parking Study, ConnDOT, January 2001

2.2.6 Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) involve the application of modern information management processing and communications technology to transportation systems. It includes a wide range of techniques capable of improving many different aspects of traffic and transportation systems. The I-95 corridor in the study area employs a variety of ITS technologies including:

- Variable Message Signs;
- Highway Advisory Radio;
- Traveler Information Kiosks; and
- Highway Service Patrol.

In addition to the ITS currently in use along I-95, the following strategies have been evaluated as part of the Vision 2020 study.

- Bus Automatic Vehicle Location and Information;
- Bus Electronic Fare Collections; and
- Weigh in Motion.

To evaluate the benefits of these ITS strategies, the SCRITS model developed by Science Applications International Corporation (SAIC) was used. SCRITS (SCReening for ITS) is a spreadsheet analysis tool for estimating the user benefits of Intelligent Transportation Systems (ITS). It is intended as a sketch-level or screening-level analysis tool to obtain an initial indication of the possible benefits of various ITS applications. It is not intended for detailed analysis.

SCRITS was developed in response to the need for simplified estimates in the early stages of ITS-related planning in the context of either a focused ITS analysis, a corridor/subarea transportation study, or regional planning analysis.

Bus Automatic Vehicle Location and Information

This ITS application allows transit agencies to monitor the locations of vehicles so that real-time information can be relayed to customers of the service. The primary benefits to the users are in the convenience and time savings of knowing when buses will arrive at stops. This technology can also be used for logistics managers to help services maintain schedules. This analysis assumed that approximately 240 vehicles that make up the existing bus fleet in the study area would be equipped with this technology. The anticipated performance measures and system costs are listed in Table 2-3.

Table 2-3 Bus Automatic Vehicle Location And Information

Description of improvement: System-wide bus AVL (275 vehicles)	User Input	Calculated Value
TRAFFIC AND TRAVEL		
Current average wait time per passenger (min.)	7	
Average wait time with AVL system (min.)	4	
Avg. number of weekday daily boardings	52,000	
Avg. number of daily boardings, full week	280,800	
Percent of passengers that use the information	40%	
Hours of time saved per weekday		1,040
Hours of time saved per year, weekdays only		260,000
COSTS		
Installation cost	$2,475,000	
Service life (years)	10	
Annual operating/maintenance cost	$412,500	

Source: Wilbur Smith Associates with SCRITS Model developed by SAIC

Bus Electronic Fare Collection

This ITS application provides benefits to both the transit agency and the transit customer. For the agency, this technology reduces the handling of cash and automates the accounting system. For the transit customer, this technology speeds up the boarding process and allows for faster transit times. This analysis assumed that approximately 240 vehicles that make up the existing bus services in the study area would be equipped with this technology. The anticipated performance measures and system costs are listed in Table 2-4.

Table 2-4 Bus Electronic Fare Collection

Description of improvement: System-wide bus electronic fare collection (275 vehicles)	User Input	Calculated Value
TRAFFIC AND TRAVEL		
Current average bus speed on arterials (mph)	15	
Current bus speed in minutes per mile		4.00
Average percentage of bus travel time devoted to boarding	20%	
Average boarding time per passenger with conventional fare(sec.)	5	
Average boarding time per passenger with electronic fare (sec.)	4	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	50%	
Minutes per mile with this electronic fare scenario		3.92
Average bus speed with electronic fare (mph)		15.31
Estimated % increase in speed with electronic fare		2.0%
Average number of daily passengers weekday	52,000	
Average passenger trip length (miles)	5	
Avg. daily person hours without electronic fare, weekday		17,333
Avg. daily person hours with electronic fare, weekday		16,987
Savings in person hours per day, weekday		347
Savings in person hours per year, weekdays only		86,667
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		318
Percent reduction in average weekday vehicle trips		0.02%
COSTS		
Installation cost	$1,925,000	
Service life (years)	10	
Annual operating/maintenance cost	$96,250	

Source: Wilbur Smith Associates with SCRITS Model developed by SAIC

Weigh-In-Motion

This ITS application provides time saving benefits to the trucking industry by allowing trucks to bypass weigh stations. Weigh-in-motion (WIM) requires loops embedded in the roadway that track the movement of each vehicle through the system. The WIM system registers a vehicle's weight and axle configuration, as well as other information, as it travels over the WIM scale at highway speed. If a truck is determined to be overweight, a message will be displayed on two roadside signs directing it to report to the weigh scales. This message will also be displayed if the system detects an error such as a truck's tires straddling the scale. If the truck is determined to be weight compliant, no message will appear on the signs and the truck can continue on its route.

Other benefits include reduced operating costs for the state, data collection on trucking companies as well as effective enforcement of weight limits. For this analysis, it was assumed that the Greenwich weigh station would be equipped with this technology. The anticipated benefits and costs for the system are listed in Table 2-5.

Table 2-5 Weigh-In-Motion

WEIGH-IN-MOTION		
Description of improvement: Weigh-in-Motion at Greenwich Rest Area	User Input	Calculated Value
TRUCK TIME SAVINGS		
Number of weigh stations to be equipped with WIM	1	
Avg. no. vehicles through each weigh station per weekday	18,500	
Average delay time (min) per vehicle	5	
Percent of vehicles that will not have to pass thru static scales	30%	
Amount of time (hrs.) saved per day		463
Amount of time (hrs.) saved per year, weekdays only		115,625
COSTS		
Installation cost	$20,000	
Service life (years)	10	
Annual operating/maintenance cost	$2,000	

Source: Wilbur Smith Associates with SCRITS Model developed by SAIC

2.2.7 Station Parking

Additional station parking can provide immediate benefits to users of the transportation system by adding critical supply and thus making train service more convenient. Local support must exist for significant expansion of the current level of supply offered.

From Westport to Greenwich, the parking supply is constrained and there is a need for more spaces along with better alternative access. Stations should be carefully planned and designed to meet parking needs without detracting from the community character. Southport, Greens Farms, Rowayton, Old Greenwich, Riverside, and Cos Cob should not be significantly expanded and should remain community-based stations. South Norwalk should be considered for expansion, both with an additional level or two on the existing garage and with a smaller structure on the other side of the tracks. Westport could have tiered parking on either or both sides of the tracks, but the traffic circulation in and out of the station area would need to be improved. Darien has potential for expansion at Noroton Heights along with possible connection of direct interchange access to and from I-95. Stamford is already building additional parking, but the new spaces will not fully satisfy current demand. Greenwich could construct tiered parking on either of its large lots.

Currently there are planning studies underway for additional parking along the New Haven Line at New Haven, West Haven, Fairfield, Bridgeport, Norwalk, Darien and Stratford. If spaces are constructed as a result of these planning efforts, there may be sufficient supply at the east end of the New Haven Line.

In sum, from Westport to Greenwich significant expansion should be targeted to the following stations:

- Fairfield;
- Bridgeport;
- South Norwalk;
- Noroton Heights;
- Stamford; and
- Greenwich.

2.2.8 Rail Fare, Parking Pricing Reductions and Universal Commuter Pass

Reduced fares and parking costs for rail transit hold the potential to generate significant new ridership. These reductions would provide an incentive for commuters to use transit in the study area instead of driving. Evaluating a 50% reduction in the cost of taking the train resulted in a 24% increase in new intrastate rail trips. The impact of reduced out-of-pocket costs for rail passengers was reflected in the evaluation of the intrastate rail strategy in Section 2.2.14.

Additionally, a universal commuter pass may offer convenience to transit customers. This commuter pass would allow riders to transfer among trains and buses in a seamless manner with a minimum of transactions. This concept also holds potential savings for transit agencies and helps automate the accounting process. Making the transit system more convenient to use is a priority of the Vision 2020 Vision.

2.2.9 Travel Demand Management Programs

Travel Demand Management (TDM) strategies/programs evaluated in this section focused on those programs that attempt to remove vehicles from the roadways during peak periods of the day by altering time of travel, encouraging car pooling and providing opportunities to avoid trip making. Generally, these TDM strategies include Employer Based Rideshare, Telecommute Programs and Compressed Workweek and Flextime Programs.

Three TDM scenarios were tested to determine the effect these programs have on traffic reduction. The scenarios included assumed participation rates of 10%, 5% and 3% of the total employees at each employment location with 100 employees or more. These employment locations represent 140,000 jobs or 17% of the total work force in the study area. An optimistic scenario assuming 10% TDM participation resulted in almost 10,000 peak-period trips reduced in the corridor. This reduction accounted for about 1.1% of total peak period work trips. For scenarios with 5% and 3% TDM participation, vehicle reductions were estimated at about 4,200 and 2,200 respectively. These reductions accounted for about 0.5% and 0.3% of total peak period work trips respectively.

The Vision 2020 Study assumed 3% TDM participation as a rate attainable over a 20 year period of time, although higher rates are possible.

2.2.10 Distance Based Pricing

Distance-Based Pricing means that vehicle charges are based on how much a vehicle is driven, so the more one drives the more the cost. Converting fixed costs into distance-based charges gives motorists a new opportunity to save money when they reduce their mileage. Below are examples of distance-based vehicle charges:

<u>Pay-As-You-Drive Insurance</u> - Insurance is one of the largest costs of owning a car. A simple and effective way to make distance-based vehicle insurance is to prorate existing premiums by mileage, incorporating all existing rating factors[6]. This is called *Pay-As-You-Drive* or *Per Mile* insurance. It provides several benefits: more accurate insurance pricing, increased insurance affordability, a 10% reduction in total vehicle mileage, a 12-15% reduction in vehicle crashes and insurance claims,

[6] Todd Litman, Distance-Based Vehicle; Insurance Feasibility, Benefits and Costs; Comprehensive Technical Report, VTPI (www.vtpi.org), 2001.
Aaron Edlin, Per-Mile Premiums for Auto Insurance, Dept. of Economics, University of California at Berkeley (http://emlab.berkeley.edu/users/edlin), 1999.

consumer cost savings, and significant reductions in traffic congestion, road and parking facility costs and pollution.

Mileage-based Registration Fees - Vehicle licensing and registration fees can be prorated by vehicle mileage, so that a $60 annual license fee becomes a ½¢ per mile charge, and a $240 annual license fee becomes a 2¢ per mile charge.

Mileage-based Vehicle Purchase Taxes - Purchase taxes average about $1,200 per vehicle. These could be converted to distance-based taxes, which translate to about 1¢ per mile if paid over an average vehicle lifetime, or 3¢ per mile if paid over the first four years of a vehicle's operating life[7].

Mileage-Based Vehicle Lease Fees - Vehicle leases -which account for approximately 30% of new vehicle acquisitions in the U.S.- and rentals can be restructured to be more mileage-based. Although most leases and rentals include mileage rates for "excessive driving," this is usually set at a high level and only affects a small portion of leased vehicle mileage. Yet, analysis of the vehicle resale market indicates that virtually all mileage increases vehicle depreciation, typically by 5-15¢ per additional vehicle mile. It makes sense that vehicle dealers reward their customers who minimize their mileage on leased and rented cars with discounts[8].

Weight-Distance Fees - Weight-distance fees are a mileage-based road use charge that increases with vehicle weight. These fees would range from about 3.5¢ per mile for automobiles and up to 20¢ per mile for combination trucks[9] and provide a more equitable way to fund roads than fuel taxes because it can more accurately represent the roadway maintenance costs imposed by individual vehicles[10].

Mileage-Based Emission Fees - Mileage-based emission fees that reflect each vehicle's emission rate would give motorists with higher polluting vehicles a greater incentive to reduce their mileage, and conversely, give motorists who must drive high mileage an incentive to choose less polluting vehicles[11]. For example, in a particular area an older vehicle that lacks current emission control equipment might pay 5¢ per mile, while a current vehicle might pay 1¢ per mile, and an Ultra-Low Emission Vehicle might pay just 0.2¢ per vehicle. This strategy would probably result in relatively large vehicle emission reductions, and modest reductions in vehicle mileage

Implementation - Pay-As-You-Drive insurance can be implemented by insurance companies as a consumer option. One insurance company has already implemented a distance-based pricing pilot project[12]. Legislation to encourage or require insurance companies to offer Pay-As-You-Drive pricing has been introduced in Pennsylvania[13], Texas[14] and Oregon[15].

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[7] Allen Greenberg, Mileage-Based Automotive Leasing and Vehicle Taxation, Office of Transportation Policy Studies, FHWA, 2000.
[8] (Greenberg, 2000)
[9] FHWA, 1997 Federal Highway Cost Allocation Study, USDOT (www.fhwa.dot.gov/policy/hcas/summary/index.htm), 1997.
[10] T&E, Counting the Kilometres - And Paying for Them; How to Introduce an EU Wide Kilometre Charging System, European Federation for Transport and Environment (www.t-e.nu), 2000.
[11] USEPA, Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions, US Environmental Protection Agency (Washington DC; www.epa.gov/omswww/market.htm), 1997.
[12] Progressive, *Progressive Autograph*, Progressive Mutual Insurance, (888-928-8647; www.progressive.com), 1999.
[13] Patrick Butler, *Operation of an Audited-Mile/Year Automobile Insurance System Under Pennsylvania Law*
[14] National Organization for Women Insurance Project (Washington DC; www.now.org), 1992.
NOW, *Congress Can End Overcharging By Auto Insurers; Per Mile Auto Insurance Option Act*, National Organization for Women (www.now.org), 1998.
[15] Oregon House Bill 3871 www.leg.state.or.us/01reg/measures/hb3800.dir/hb3871.intro.html.

Other distance-based charges such as registration fees, purchase taxes, weigh-distance fees and emission fees could be implemented by state/provincial legislation. A variety of Pricing Methods can be used to collect vehicle travel data, as summarized in Table 2-6.

Researchers provided respondents with five different taxes and fees, and asked which of them should be created or increased to help fund traffic reduction strategies.

Tax/Fee	
Highway user fees	38.7%
None	29.1
State income tax	19.9
Gas tax	17.0
State sales tax	8.6
Local property tax	3.5

Table 2-6 Summary of Distance-Based Pricing Options

Type	Description	Equipment Costs	Operating Costs	User Inconvenience	Price Adjustability
Odometer Audits	Odometer readings are collected by certified odometer auditors, usually during scheduled maintenance	Low	Low	Low	Low
Vehicle Use Detector And Recording	Vehicle operating hours are recorded by a small VUDAR instrument installed in each vehicle. Data are transmitted annually at a special station.	Medium	Low	Low	Medium
On Board Data Collection	An electronic system in each vehicle tracks mileage. Data are transmitted monthly to a central computer, either automatically or by users.	High	Medium	Medium	Low-Medium
Global Positioning Systems	A GPS system is used to track the location of each vehicle. Data are automatically transmitted monthly.	High	Medium	Low	High

Source: Victoria Transport Policy Institute website (www.vtpi.org)

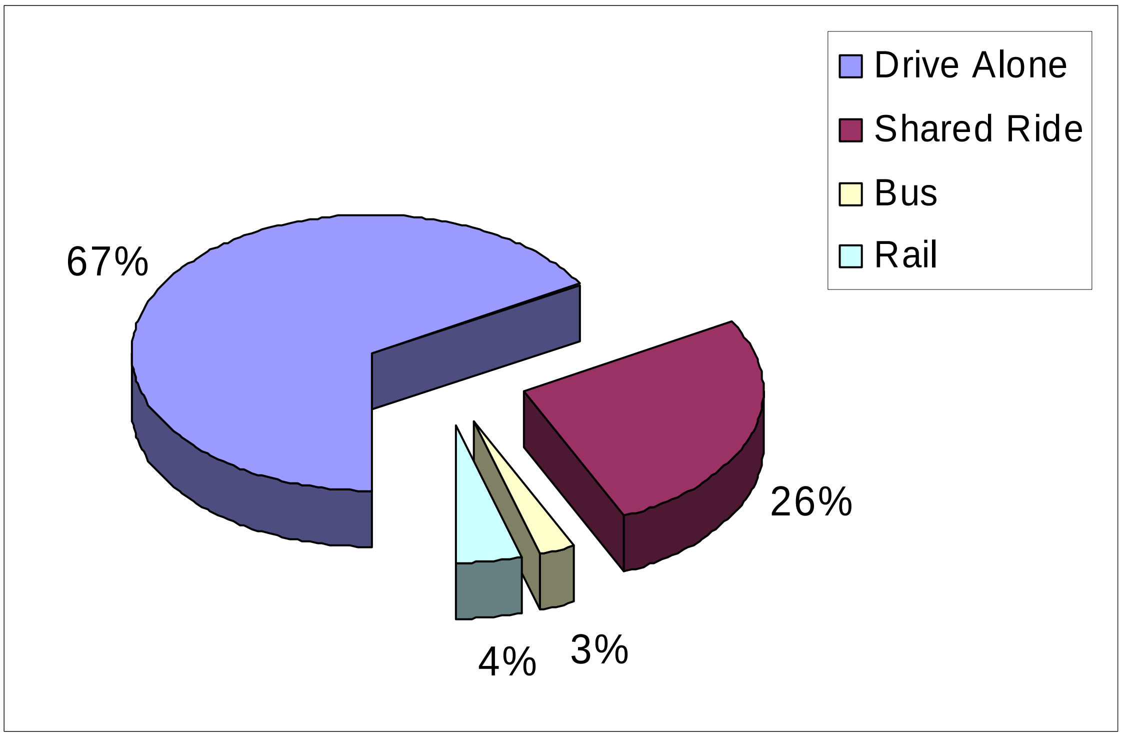
Evaluation - Distance based pricing was evaluated on a global scale to determine the market response to a $0.20 per mile charge for all automobile trips. Figure 2-4 illustrates the peak period mode share that can be expected under this strategy. A significant shift toward non-drive alone modes could be achieved by pricing automobile trips based on distance traveled. Drive alone mode share was forecasted to reduce by about 149,000 trips (-10%) for the total study area.

In particular, the shared ride mode would receive the greatest increase in trips. About 112,000 (28%) new shared ride trips were forecasted. This shift is due to the model assumption that the cost of the trip would be shared by the number of occupants in the vehicle.

The evaluation of this strategy assumed maintenance of existing bus and rail services and a significant shift to those modes was reported. Approximately 10,500 new intrastate rail trips were forecasted along with an additional 12,000 new interstate rail trips. Additionally, about 14,000 new bus trips were forecasted. These values represent increases of 72% for intrastate rail trips, 13% for interstate rail trips, and 41% for bus trips.

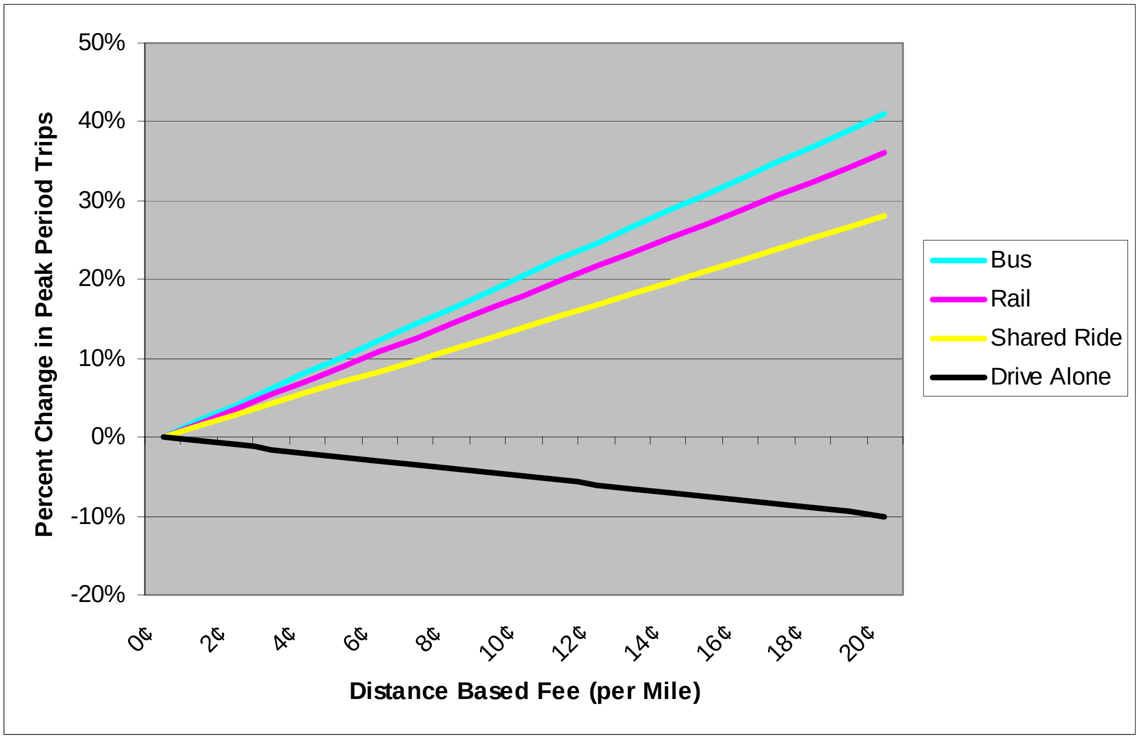
It should be noted that a $0.20 per mile charge is extremely high for distance-based pricing. An average trip length of 15 miles in each direction would result in $6.00 charge to the customer. The purpose of using such a high value was to test the market response to drastic increases in the cost of automobile usage. Clearly, pricing can have a substantial impact on travel mode share. Assuming a linear relationship between pricing and trip making, Figure 2-4 illustrates the impacts to trips by mode based on incremental distance based fees.

Figure 2-4 Mode Share Results for Distance-Based Pricing at $0.20 per Mile



ConnDOT Travel Demand Model

Figure 2-5 Distance Based Pricing Impacts



ConnDOT Travel Demand Model

2.2.11 Managed Lanes on I-95

Heavy single occupant vehicle (SOV) demand and limited highway capacity in the peak periods are the primary contributors to congestion on the I-95 corridor. Future growth in this SOV demand will contribute to increased system stress and ultimately a breakdown of I-95, as well as other highways and arterials during much of the day. Local roads in the corridor will also be impacted as drivers look for shortcuts around congestion. In short, the failure of I-95 to accommodate future demand will lead to lost productivity, increased pollution, economic stagnation, and generally have negative quality of life impacts.

Contrary to popular opinion, the interstate **does** have the necessary capacity to handle current demand. It is the decisions made by drivers such as when and how they use the highways that create pressures that the road cannot handle. For example, traffic on I-95 is largely comprised of single occupant vehicles. The carrying capacity of an automobile is generally greater than one person. If more highway users elected to rideshare, congestion could be eliminated or at least significantly reduced. In addition, most work related trips are concentrated during the morning and afternoon peak periods of the day. If more people adjusted the time of day that they travel, then congestion relief in the peaks would be possible. In theory, these ideas make perfect sense; however existing driver behavior and individual lifestyle are traits that have had decades of reinforcement and are difficult to change.

As part of the Vision, several strategies to manage demand on I-95 were evaluated. It was determined that value pricing presented the means by which to do this. Value pricing is a tool used to help manage peak period travel demand by charging fees that vary according to the level of congestion experienced at a given period of time. Higher fees, or tolls, are typically charged when congestion is heaviest, and in some cases are adjusted in real time to regulate the flow of traffic. The collection of these tolls would occur electronically and use transponder technology similar to EZ-Pass. Physical plazas that handle cash transactions disrupt the flow of traffic and are not recommended.

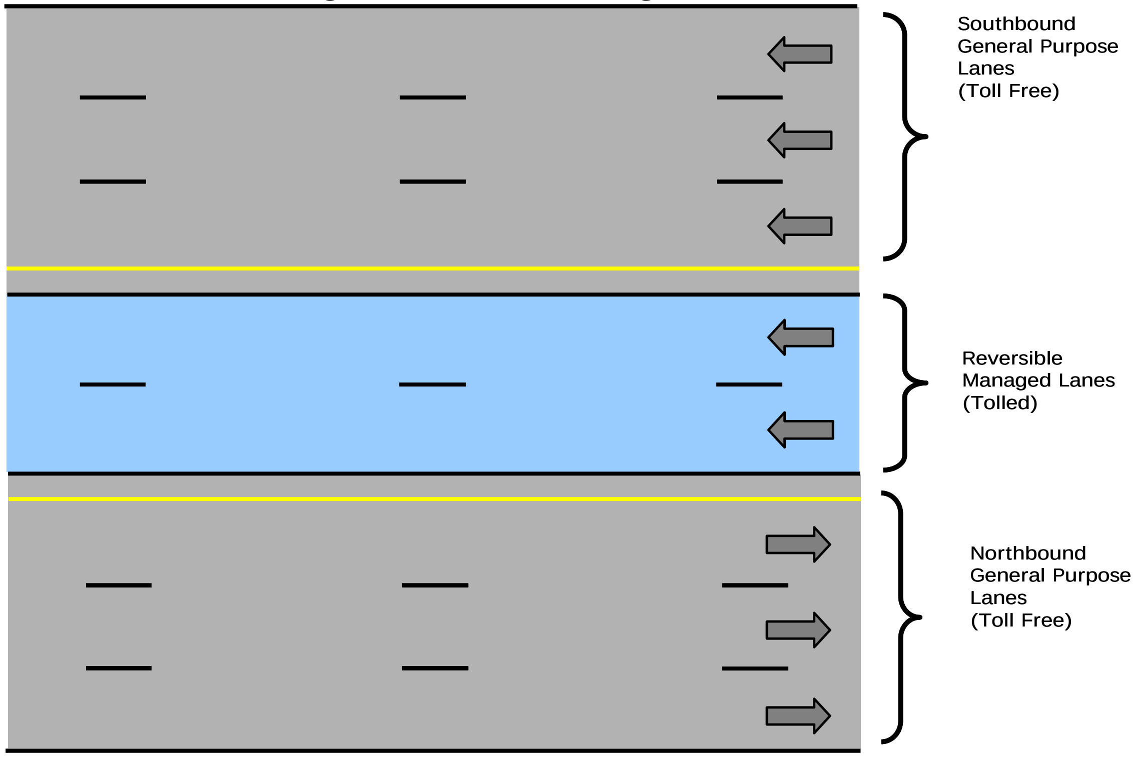
Strategies that force drivers to make changes in their travel routines, such as making tolls on highways mandatory, are generally not acceptable to the public or to elected officials. For this reason, any value pricing strategy might be considered for new capacity only. Value pricing on exclusive lanes are also known as managed lanes.

A preliminary evaluation of I-95 concluded that two additional lanes could be added to the six lanes that currently exist. By physically separating these lanes from the existing lanes, values pricing can be limited to the new capacity. The advantage of this configuration is that it allows users to make a choice: pay a toll for a travel time benefit or remain in the free lanes. Additionally, high occupancy vehicles (HOV) could be allowed to use these lanes for free, thus encouraging ridesharing. Finally, revenues generated by these lanes can be used to help fund enhanced transit strategies or TDM programs.

If implemented appropriately, managed lanes can do much more than just provide a congestion-free roadway for paying customers. Managed lanes offer the potential for encouraging ridesharing, influencing time of travel, and ensuring that competitive and affordable transit options are available as alternatives.

Since I-95 experiences a directional split in traffic volume during the peak periods, the new managed lanes can be reversible as illustrated in Figure 2-6. With this configuration, the two additional lanes would be open to southbound traffic during the morning peak period and northbound traffic during the afternoon peak period. At this stage, it appears feasible to construct additional lanes on I-95 within state-owned right of way. The cost of this improvement would be on the order of magnitude of about $3.5 billion to construct.

Figure 2-6 Reversible Managed Lanes on I-95



Source: Wilbur Smith Associates

The evaluation of the managed lanes concept was modeled to determine the range of toll rates that would potentially result in a balance between efficient lane operation and toll revenue. The new lanes were coded into the highway network with access points only at select locations throughout the corridor. These locations were as follows:

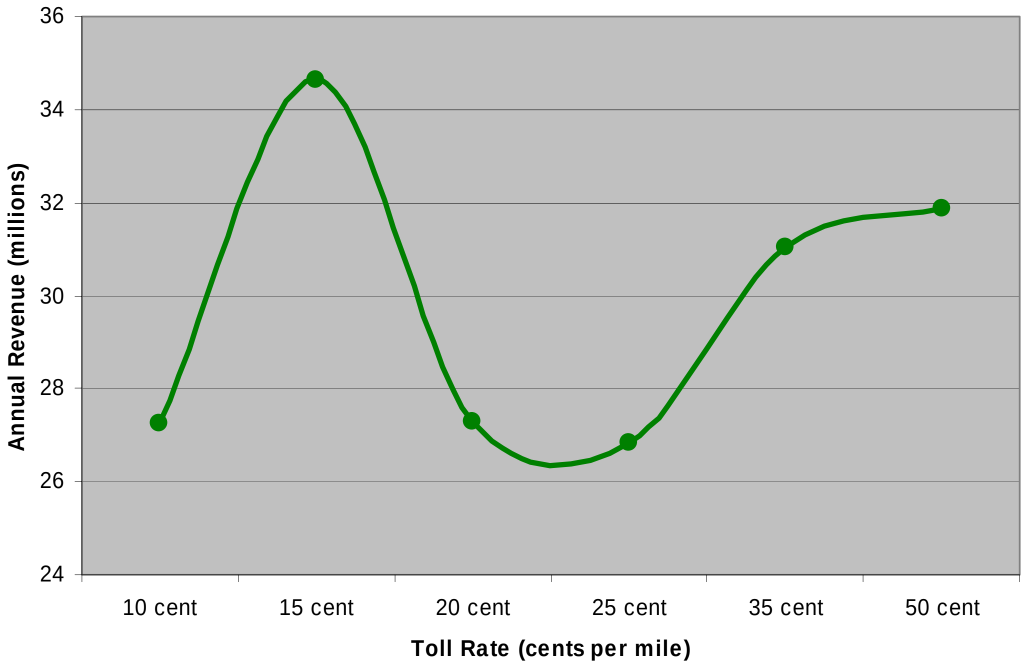
- Greenwich;
- Stamford;
- Norwalk;
- Fairfield;
- Bridgeport;
- Milford; and
- New Haven.

The spacing of access point to and from the managed lanes was maximized to limit merge/diverge operations that would impact the efficient flow of traffic. This spacing would also prevent "local" traffic from using these lanes to make intra-town trips. The managed lanes would primarily serve intermediate to long distance trips while local trips would continue to use the existing general purpose lanes.

The model used average daily traffic to test the market reaction to incremental toll rates. Figure 2-7 illustrates the market sensitivity to various toll rates. The optimal toll rate, in terms of revenue generation, appeared to be $0.15 per mile. The curve dropped sharply after $0.15 and begins to climb again until it maxed out at about $0.50 per mile. This type of sensitivity curve is not typical and further analysis is warranted.

The reason for this trend is that trips on the western end of the corridor are more inelastic to pricing. The heavier congestion experienced from Greenwich to Stamford and the closer spacing of access points makes the managed lanes a very attractive alternative to the general purpose lanes. East of Bridgeport, however, the managed lane segments are not as closely spaced and congestion is less of a factor so traffic drops off of the facility at rates above $0.15 per mile. The curve peaks out again at $0.50 per mile because trips at the western end of the corridor will continue to use the managed lanes even at high toll rates. For the purpose of further analysis, $0.15 cent per mile was used. At this toll rate, approximately $35 million in annual revenues can be expected.

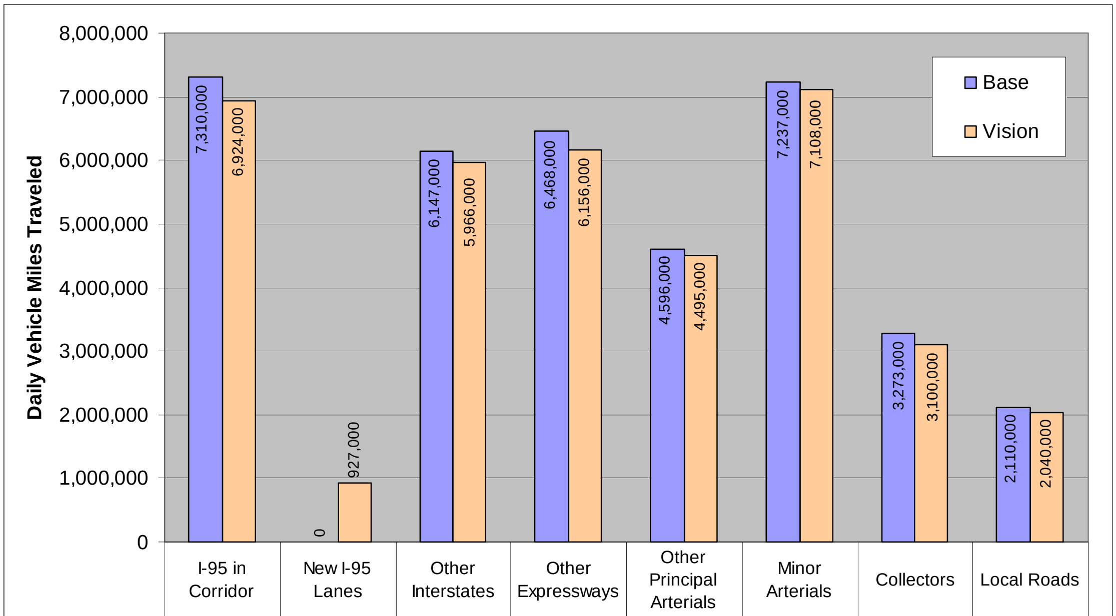
Figure 2-7 Toll Sensitivity Curve



Source: ConnDOT Travel Demand Model

Figure 2-8 illustrates the forecasted diversion of traffic by roadway functional classification due to the managed lane strategy. The new managed lanes would remove approximately 927,000 daily vehicle miles from existing I-95 lanes as well as other study area roads and highways. This diversion would result in an overall increase in VMT on I-95, but virtually all other roads would experience benefits due to this diversion of traffic. Additionally, existing I-95 lanes would realize benefit in terms of improved operations and travel time savings due to the reduction of trips on those lanes.

Figure 2-8 Change in Daily VMT by Roadway Classification



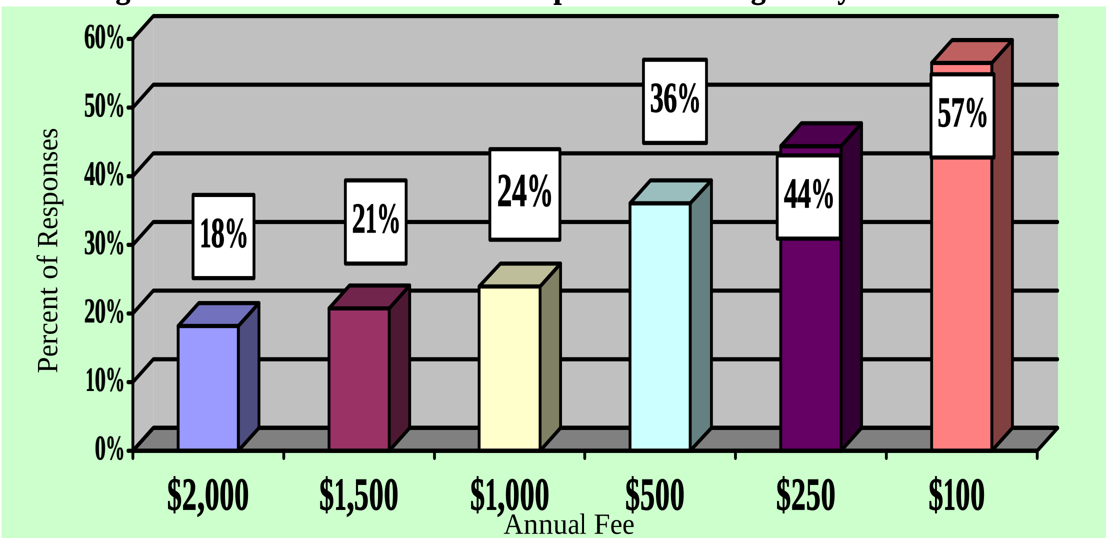
	I-95 in Corridor	New I-95 Lanes	Other Interstates	Other Expressways	Other Principal Arterials	Minor Arterials	Collectors	Local Roads
Base	7,310,000	0	6,147,000	6,468,000	4,596,000	7,237,000	3,273,000	2,110,000
Vision	6,924,000	927,000	5,966,000	6,156,000	4,495,000	7,108,000	3,100,000	2,040,000

Source: ConnDOT Travel Demand Model

Note that Other Interstates includes I-91 and a short segment of I-84 in the study area, Other Expressway includes Route 8 and Route 15, and Other Principal Arterials includes roads such as Routes 1, 7, 10 and 34.

Just under one fifth (18.2%) of respondents reported being very or somewhat likely to pay $2,000 in annual taxes to help fund congestion reduction strategies. Together with those willing to pay $1500, $1000, $500, $250 and $100 or more annually, the cumulative total is 56.5%.

Figure 2-9 Cumulative Percent of Respondents Willing to Pay Annual User Fee



Source: 2002 CRPP Telephone Survey

2.2.12 General Purpose Capacity on I-95

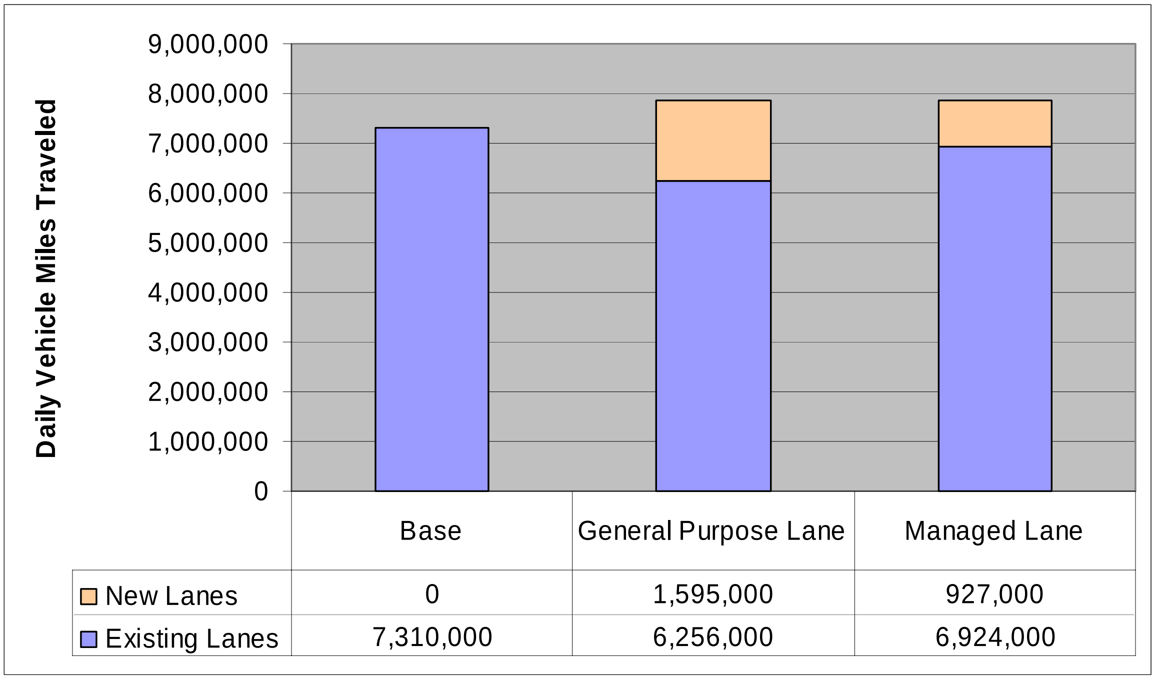
As many transportation decisions are made with short-term gains in mind, it is important to consider the long-term implications of expansion of highway capacity. Additional capacity on the form of additional northbound and southbound lanes for general purpose traffic can provide positive benefits for a limited period of time, but may ultimately fail to alter travel behavior, slow the emission of pollutants and provide choices to customers.

Figure 2-10 illustrates the difference in additional VMT on the managed lanes versus a strategy that uses the additional capacity for general purpose traffic. The general purpose lanes would accommodate about 1.6 million vehicle miles daily, thereby reducing the VMT on the existing I-95 lanes by about 14%. While this strategy will provide some relief to congestion experienced on I-95, this is a one-time gain in capacity. Single occupant traffic growth will likely continue until capacity is reached and congestion results.

The benefits achieved by this improvement would diminish annually as existing traveler behavior is reinforced and growth in single occupant vehicle usage continues.

For comparative purposes, the managed lanes with a $0.15 per mile toll could handle approximately 930,000 daily vehicle miles a day while maintaining efficient traffic flow. The new lanes would reduce daily VMT on the existing I-95 lanes by about 5%, providing an incremental benefit to users of those lanes. In addition, tolls collected from paying customers would generate revenue to help fund other transportation strategies. The flexibility of this strategy is in its ability to increase toll rates to regulate demand and provide incentives for ridesharing and transit users and ultimately improve the person-capacity of the highway. This strategy can also help to spread travel to less congested times of the day.

Figure 2-10 Year 2020 VMT Comparison



Source: ConnDOT Travel Demand Model

A simple example using volume to capacity ratios (V/C) can illustrate the distribution of traffic on I-95 under as well as the anticipated levels of congestion for each scenario. Table 2-7 shows the V/C ratios for existing and added lanes under the general capacity and managed lane scenarios. For this analysis, 2,000 passenger car equivalents per lane per hour was assumed. V/C ratios greater than 0.90 generally reflect congested conditions. As the table demonstrates, general purpose lanes will help to distribute traffic volume on I-95 more evenly, but the managed lanes will remain un-congested and free flowing.

Table 2-7 V/C Ratios for New Capacity

	Number of Lanes	Hourly Capacity	Year 2020 Base	General Purpose Lanes	Managed Lanes
			Approximated Hourly Volume		
New Lanes	2	4,000	0	3,200	1,900
V/C Ratio			**N/A**	**0.80**	**0.48**
Existing Lanes	6	12,000	14,600	12,500	13,800
V/C Ratio			**1.22**	**1.04**	**1.15**

Source: Wilbur Smith Associates

2.2.13 Bus Rapid Transit and Express Bus

Bus Rapid Transit (BRT) strategies in the corridor were proposed to offer inter-regional service throughout the study area. BRT would provide for faster operating speeds, greater service reliability, and increased convenience, often matching the quality of rail transit when implemented in appropriate settings. Many of these bus services would be given priority treatment on conventional urban roadways so that travel time advantages can be gained over automobile traffic.

Numerous BRT routes explored for this study are illustrated in Figure 2-11. These routes were developed to offer frequent service along major corridors in the study area. BRT is expected to run on dedicated lanes to the extent possible, and provide a limited number of strategically based stops in cities and towns throughout the study area. Other BRT features like signal priority for buses and real-time information systems would also be part of the strategy.

Ridership

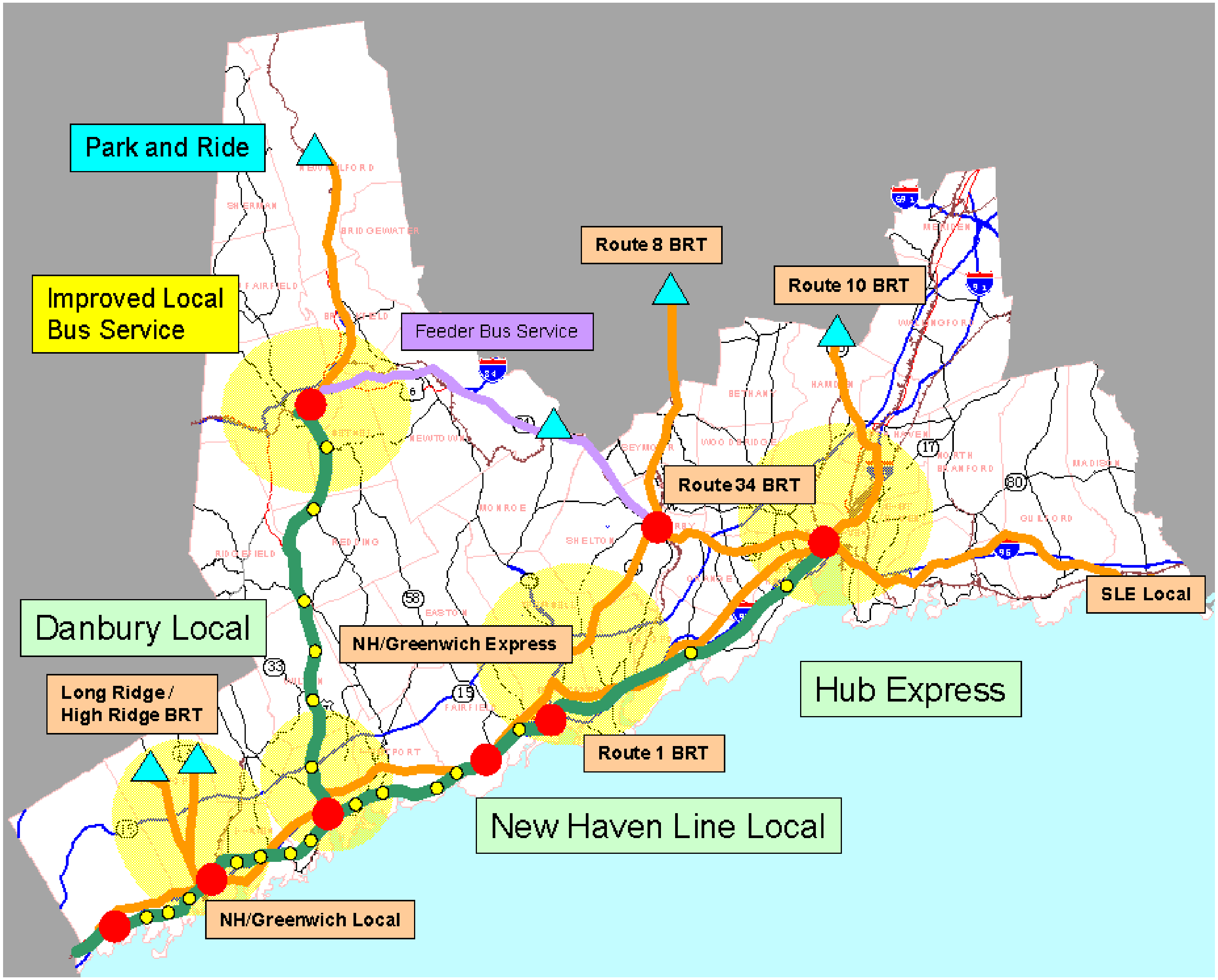
The service and anticipated peak period ridership is listed in Table 2-8. Of the total 8,690 peak period riders, approximately 8,530 are new bus transit trips according to the model. The strongest BRT services, in terms of ridership, are along the Route 1 corridor. With a forecasted demand of 1,420 express trips and 5,320 local trips during the peak periods, these Route 1 services are productive elements of the Vision.

Table 2-8 BRT Service Peak Period Ridership

Proposed Bus Service	**Peak Riders**
NH/Greenwich Express	1,420
NH/Greenwich Local	5,320
Shore Line East Local	410
High Ridge	180
Long Ridge	90
Waterbury/Bridgeport	160
Waterbury/New Haven	410
Route 10/New Haven	620
Derby/Danbury	80
Total	8,690

Source: ConnDOT Travel Demand Model

Figure 2-11 Transit Strategies



Capital Costs

Capital costs for the new services can be divided into two major categories: Rolling stock and infrastructure. The rolling stock requirements are based on the number of vehicles required to operate the service. Infrastructure requirements include the costs of developing dedicated lanes and providing signal priority. The per-mile costs of constructing dedicated lanes on existing arterial roads were derived from similar projects in Los Angeles, California and Orlando, Florida. Portions of routes that utilize existing expressways are not included in the cost estimates. Additionally, right-of-way costs are not included and can be substantial. The feasibility of constructing dedicated lanes would need to be studied in greater detail for more accurate costs. A rough initial estimate of the capital costs for the proposed new BRT services are presented in Table 2-9.

Table 2-9 BRT Infrastructure Capital Costs

Route	Route Miles	Cost per Mile	Total Cost
New Haven to Greenwich	46	$680,000	$31,280,000
Shoreline East Local	21.3	$680,000	$14,484,000
High Ridge Road	4.4	$680,000	$2,992,000
Long Ridge Road	4.1	$680,000	$2,788,000
Waterbury to Bridgeport	45	$680,000	$30,600,000
Waterbury to New Haven (Route 34 segment)	9.5	$680,000	$6,460,000
New Haven to Rt. 691 (Route 10 segment)	12.4	$680,000	$8,432,000
Derby to Danbury	22	$680,000	$14,960,000
TOTALS			**$111,996,000**

Source: Wilbur Smith Associates

Service operating on the proposed BRT routes would require approximately 94 new vehicles, inclusive of spare vehicles necessary to provide uninterrupted service. The total cost of these vehicles would be approximately $47 million. Table 2-10 lists the estimated rolling stock procurement costs.

Table 2-10 Rolling Stock Procurement Costs

	Hub Express
Vehicles Required for Service	78
Spare Vehicles Required	16
Cost Per Vehicle	$500,000
Total Cost	$47,000,000

Source: Urbitran Associates

Operating Costs

An hourly rate of $62.60 per hour has been developed for bus service, based on the experience of operators within the study area. This cost is fully allocated. Driver salary, supervision, maintenance, and administrative and marketing costs are all included in this hourly rate. Based on these costs, an estimate of $8 million has been developed for an annual peak period service.

Table 2-11 Annual BRT Operating Costs

Route	**Hourly Bus Hours**	**Peak Bus Hours**	**Hourly Cost**	**Annual Peak Period Cost**
New Haven to Greenwich Express	24	144	$67.60	$2,433,600
New Haven to Greenwich Local	16	96	$67.60	$1,622,400
Shoreline East Local	4	24	$67.60	$405,600
High Ridge	4	24	$67.60	$405,600
Long Ridge	4	24	$67.60	$405,600
Waterbury to Bridgeport	4	24	$67.60	$405,600
Waterbury to New Haven (Rt 34)	5	30	$67.60	$507,000
New Haven to Rt. 691 (I-91)	10	60	$67.60	$1,014,000
Derby to Danbury	7	42	$67.60	$709,800
TOTALS	**78**	**468**	**$67.60**	**$7,909,200**

Note: Assumes 6-hour peak period

Source: Urbitran Associates

In total, the cost for the proposed services would be approximately $160 million for capital needs with an annual operating cost in the neighborhood of $8 million.

2.2.14 Intrastate Rail

Passenger rail service in southwestern Connecticut is an important asset to the region and the state as a whole. Investment in additional capacity for this mode of transportation can occur incrementally, serving demand as needed. Fast, convenient and affordable rail service in the corridor is essential to meeting the future demand for personal mobility and providing travel options to the transportation customer.

Three rail services have been designed to help increase mobility within the region and are illustrated in Figure 2-11. The proposed services would be integrated with existing peak hour zone-express service patterns with appropriate adjustments to the latter. These new services will supplement, not supplant, the existing services that are already successful in serving travel to and from New York City and beyond.

<u>Hub Express</u> – Hourly service to Grand Central Terminal stopping at only the major transit hubs along the Connecticut coast would serve a substantial market for travel between urban centers in the corridor and strengthen the urban centers as the transportation hubs of the region. The proposed Hub Express would stop at New Haven, Bridgeport, Fairfield, South Norwalk, Stamford, Greenwich and New York City. This service requires four trains, each consisting of four self propelled vehicles, to make the 72.3 mile trip every hour between Branford and Grand Central Terminal. Connections to local bus and rail services would be available at each hub station. The end to end service speed of this proposed route is approximately 46 mph. Service characteristics are listed in Table 2-12.

<u>Danbury Local Service</u> **–** The Danbury Branch has the greatest market potential of Metro North's three Connecticut branch lines. It serves eight commuter stations along the branch then makes local stops between South Norwalk and Stamford. The service would be scheduled so that it would conveniently connect with the New Haven Line Local and Hub Express services. The 31.8 mile route could utilize six trains, each consisting of four self propelled vehicles, to provide half-hourly

service. The end to end service speed of this proposed route is approximately 30 mph. Service characteristics are listed in Table 2-13.

New Haven Line Local Service – Frequent service at all stations between Greenwich and Branford would serve much of the local demand in the corridor. With reduced local fares, free transfers to a network of connecting bus services and supportive land use policies the new local service will provide a new transportation option that will likely grow into a “way of life” for Coastal Connecticut much as rail service to Manhattan is already part of the fabric of life in the corridor. The service runs over 53 miles of track and requires six trains, each consisting of four self propelled vehicles, to provide half hourly service. The end to end service speed of the proposed route is approximately 42 mph. Service characteristics are listed in Table 2-14.

Table 2-12 Hub Express Service Run Times

Travel Time towards New Haven	Station	Miles From GCT	Travel Time towards GCT
0:00	GCT	0	1:34
0:44	Greenwich	28.1	0:50
0:50	Stamford	33.1	0:44
1:00	So. Norwalk	41	0:34
1:11	Fairfield	50.6	0:23
1:17	Bridgeport	55.4	0:17
1:34	New Haven	72.3	0:00
Read Down	Station	Miles From GCT	Read Up

Source: KKO Associates

Table 2-13 Danbury Local Service Run Times

Travel Time towards So. Norwalk	Station	Miles From GCT	Travel Time towards Danbury
0:00	Danbury	64.9	1:04
0:05	Bethel	61.9	0:59
0:12	Redding	58.6	0:52
0:20	Branchville	54.0	0:44
0:28	Cannondale	50.2	0:36
0:33	Wilton	48.6	0:31
0:38	Merritt 7	45.0	0:26
0:48	So. Norwalk	41.0	0:16
0:52	Rowayton	39.2	0:12
0:55	Darien	37.7	0:09
0:58	Noroton Heights	36.2	0:06
1:04	Stamford	33.1	0:00
Read Down	Station	Miles From GCT	Read Up

Source: KKO Associates

Table 2-14 New Haven Line Local Service Run Times

Travel Time towards Branford	Station	Miles From GCT	Travel Time towards Greenwich
0:00	Greenwich	28.1	1:16
0:03	Cos Cob	29.6	1:13
0:05	Riverside	30.3	1:11
0:07	Old Greenwich	31.3	1:09
0:09	Stamford	33.1	1:07
0:15	Noroton Heights	36.2	1:01
0:18	Darien	37.7	0:58
0:21	Rowayton	39.2	0:55
0:25	South Norwalk	41.0	0:51
0:28	E. Norwalk	42.1	0:48
0:31	Westport	44.2	0:45
0:35	Greens Farms	47.2	0:41
0:38	Southport	48.9	0:38
0:41	Fairfield	50.6	0:35
0:47	Bridgeport	55.4	0:29
0:52	Stratford	59.0	0:24
0:57	Milford	63.3	0:19
1:09	New Haven	72.3	0:07
1:16	Branford	81.1	0:00
Read Down	Station	Miles From GCT	Read Up

Source: KKO Associates

Ridership

The three rail services discussed previously were evaluated by the Vision 2020 Study. In addition, the effects of reduced transit fare and parking pricing were factored into the analysis. The service and anticipated peak period ridership is listed in Table 2-15. These routes were also illustrated in Figure 2-2. Of the total 8,320 peak period riders, approximately 5,780 are new rail trips. The strongest rail services, in terms of ridership, are along the New Haven Line. With a forecasted demand of 3,410 express trips and 2,790 local trips during the peak periods, these services yield increases to New Haven Line intrastate ridership of approximately 47%.

Table 2-15 Rail Service Peak Period Intrastate Ridership

Proposed Rail Service	Peak Riders
Hub Service	3,410
New Haven Local	2,790
Danbury Local	2,120
Total	8,320

Source: ConnDOT Travel Demand Model

Capital Costs

Capital costs for the new services can be divided into two major categories: rolling stock and infrastructure. The rolling stock requirements are based on the number of vehicles required to operate the service. Infrastructure requirements include the costs of developing new track and signals. Additionally, the costs for providing additional maintenance facilities are included.

Rolling Stock - Service operating exclusively on the New Haven Mainline must operate with Electric Multiple Unit (EMU) technology as required by the State of Connecticut. The Danbury Branch is not electrified, thus Diesel Multiple Units (DMU) technology must be operated on the line. Both EMUs and DMUs are self propelled vehicles. For the purpose of this study it was assumed that four vehicle trains would operate the service.

DMUs require a 17.5% spare ratio (the number of additional vehicles needed to keep service operating while ongoing maintenance takes place). Colorado Rail Car sells DMUs at $2.5 million a vehicle.

EMUs require a 17.5% spare ratio. ConnDOT estimates that new M-8 EMUs will cost approximately $3.5 million per vehicle.

Table 2-16 Rolling Stock Procurement Costs

	Hub Express	New Haven Local	Danbury Local
Vehicles Required for Service	16	24	24
Spare Vehicles Required	3	5	5
Cost Per Vehicle	$3,500,000	$3,500,000	$2,500,000
Total Cost	**$66,500,000**	**$101,500,000**	**$72,500,000**

Source: KKO Associates

Infrastructure - The infrastructure requirements for the right of ways used in the new services are limited to the Danbury Branch. Service on the New Haven Mainline will use existing infrastructure to operate service. Maintenance facilities for the 77 new vehicles will also have to be constructed in order to keep the services running smoothly.

Danbury Line Upgrades - To operate the improved passenger service on the Danbury Branch, the line will require the installation of signal system and would operate seamlessly by double tracking the line. Improvements to the Danbury Branch would cost approximately $94 million.

Table 2-17 Infrastructure Costs of the Danbury Branch

	Unit	Quantity	Unit Price	Total
New track construction	mile	23.9	$753,000	$17,996,700
Typical railroad low station platform	each	7	$150,000	$1,050,000
Typical grade crossing	each	35	$300,000	$10,500,000
CTC signals	mile	48	$600,000	$28,800,000
Interlocking (West of Stamford with turn-back tracks)	each	1	$20,000,000	$20,000,000
Subtotal				$78,346,700
20% contingency				$15,669,340
Total				**$94,016,040**

Source: KKO Associates

Maintenance Facility – ConnDOT has already identified the need for a new maintenance facility to accommodate its projected fleet expansion. Implementation of the Vision requires 77 additional vehicles. This increase may require additional maintenance facility expansion at an estimated cost of $150 million.

Operating Costs

Providing passenger train service involves three types of operating costs: Vehicle Maintenance, Transportation and maintenance of way. The new services would cost between $8 and $11 million to operate annually.

Vehicle Maintenance - To keep the rolling stock in working conditions, operating funds must be spent on parts and labor. The cost of maintenance is based on 1999 Metro North data inflated to 2002 dollars. (Vehicle maintenance varies with the number of vehicles maintained. If the service could be offered with fewer new vehicles costs would be reduced.)

Table 2-18 Annual Vehicle Maintenance Costs

	Hub Express	New Haven Local	Danbury Local
Labor Cost per Year per vehicle	$57,308	$57,308	$56,814
Total Vehicles	19	29	29
Overhead Cost and Parts Vehicle/Year per vehicle	$111,984	$111,984	$44,729
Vehicle Maintenance/Year Total	**$3,216,545**	**$4,909,463**	**$2,944,730**

Source: KKO Associates

Transportation Costs - The costs associated with transportation can be divided into three subcategories: fuel/propulsion costs, operator costs and switching costs. Again, these costs were developed based on 1999 Metro North data inflated to 2002 dollars. (Transportation costs vary with service levels, if some of the proposed services could be integrated with other ConnDOT/MNR services the costs estimated here could be reduced).

Fuel/Propulsion - EMUs will operate on services exclusive to the New Haven Mainline. The propulsion cost for this service is based on the peak vehicle electricity requirement to operate the service.

Table 2-19 Electric Propulsion Annual Cost

	Hub Express	New Haven Local
Annual Peak Propulsion per EMU	$101,344	$101,344
Total Peak Propulsion	**$1,621,502**	**$2,432,253**

Source: KKO Associates

The Danbury Local service will operate using DMUs, which use diesel fuel to operate. Fuel costs were determined using September 2002 diesel type 2 prices in the State of Connecticut and 1999 Metro North data inflated to 2002 dollars.

Table 2-20 Diesel Fuel Annual Costs

	Danbury Local
Cost of Fuel Per Gallon	$1.016
Cost of Fuel Per Mile	$0.68
Length of trip	31.8
One way trips per day	64
Daily mileage	2,035
Days of service	300
Miles Per Year	610,560
Annual Fuel Cost	**$413,553**

Source: KKO Associates

<u>Crew Cost</u> - Each of the new train services may be operated with a three person crew: an engineer, a conductor and a brakeman. The crew is paid by the hour and costs are accumulated for every hour that the train operates. 1999 Metro North data inflated to 2002 dollars was used to calculate this cost.

Table 2-21 Annual Operator Cost

	Hub Express	New Haven Local	Danbury Local
Daily Train hours	72.0	64.0	64.0
Annual Train Hours	21,600	19,200	19,200
Operator Cost per Train Hour	$151.45	$151.45	$151.45
Annual Operator Cost	**$3,271,362**	**$2,907,878**	**$2,907,878**

Source: KKO Associates

<u>Maintenance of Way Costs</u> - Since the New Haven Mainline is already maintained, the only new maintenance of way costs that will be generated will be for the Danbury Branch. The maintenance of way cost is based off of new track mileage and layover facilities costs. This data was generated from 1998 National Transit Database data that was inflated to 2002 dollars.

Table 2-22 Danbury Branch Maintenance of Way Annual Cost

	Total	Total Cost
Track Miles	23.9 miles	$627,459
Layover Track	0.5 miles	$12,903
Subtotal		**$640,362**
Administration	55.9%	$358,089
Total		**$998,451**

Source: KKO Associates

Conclusions

In total the capital cost for the proposed services would be approximately $450 million with an annual operating cost in the neighborhood of $25 million. The Hub Express service has the lowest cost per track mile at $1.3 million. The Hub Express service also generates the greatest ridership of the three. The Danbury Local service is the most expensive, largely due to the cost of double-tracking the line to accommodate fast and reliable service, and yields the lowest number of riders.

A conceptual estimate of the capital and operating costs for the proposed new rail services are presented in Table 2-23 and Table 2-24.

Table 2-23 Summary of Capital Costs

	Hub Express	New Haven Local	Danbury Local
Rolling Stock	$66,500,000	$101,500,000	$72,500,000
Infrastructure	$0	$0	$94,016,040
Maintenance Facility		$150,000,000	
Total[16]	**$107,500,000**	**$147,170,193**	**$212,186,233**
Cost per mile	**$1,333,600**	**$2,776,800**	**$6,672,500**

Source: KKO Associates

Table 2-24 Summary of Operating Costs

	Hub Express	New Haven Local	Danbury Local
Vehicle Maintenance	$3,216,545	$4,909,463	$2,944,730
Fuel/Propulsion	$1,621,502	$2,432,253	$413,553
Crew Cost	$3,271,362	$2,907,878	$2,907,878
Maintenance of Way	$0	$0	$998,452
Total	**$8,109,409**	**$10,249,593**	**$7,264,612**
Cost per mile	**$112,200**	**$193,400**	**$228,400**

Source: KKO Associates

2.2.15 Intermodal Hubs

Improved intermodal transfer points strategically placed along transit corridors will provide inter-regional BRT and rail connections to a number of local transit services. These intermodal hubs are strategically placed at reasonable distances to allow for a maximum of single-seat rides. These transfer locations will provide links between key areas with service connections and timed transfers to create a user-friendly service in the region. The following locations have been identified for these hubs:

- New Haven State Street Train Station
- Bridgeport Train Station
- South Norwalk Train Station
- Stamford Train Station
- Danbury Train Station
- Derby Train Station

[16] The cost of the maintenance facility was distributed to each of the new services based on the number of new rail vehicles the service generated.

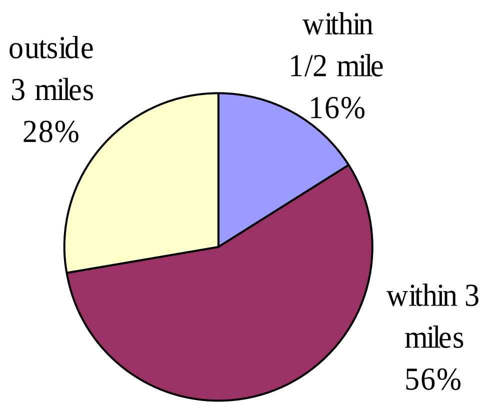
As an important element of all proposed bus and rail based alternatives, new connections between the main hubs would be provided to improve regional mobility. In addition, new secondary hubs would be fostered at Greenwich, New Canaan, Derby/Ansonia and Branford.

An important element of the intermodal hub concept is the improvement of bicycle and pedestrian connectivity to transit stations. With the high number of residents and employment locations within reasonable proximity to a rail station, improvement to bicycle and pedestrian facilities becomes very important.

An analysis of population and employment in the vicinity of stations indicated that 177 high employment locations – more than 100 employees per location - are within ½ mile of existing rail stations. These stations provide access to about 45,100 employees. An additional 800 high employment locations are within 3 miles of existing rail stations, which includes another 222,621 employees. Figure 2-12 illustrates the percentage of high employment locations within ½ and 3 miles of an existing rail station.

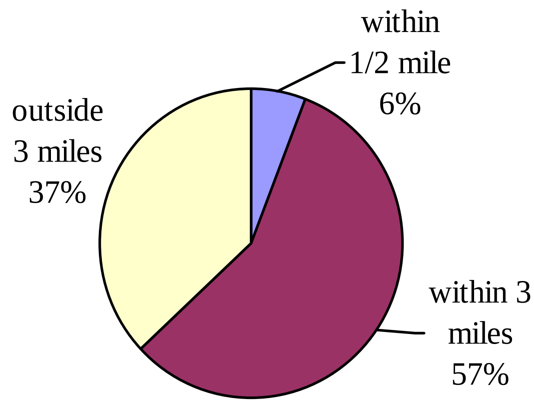
In addition, approximately 88,500 people live within ½ mile of rail stations. About 948,300 people, live within 3 miles of rail stations. Figure 2-13 shows the percentage of population living within within ½ and 3 miles of existing rail stations.

Figure 2-12 Distance from Employment



Source: Wilbur Smith Associates

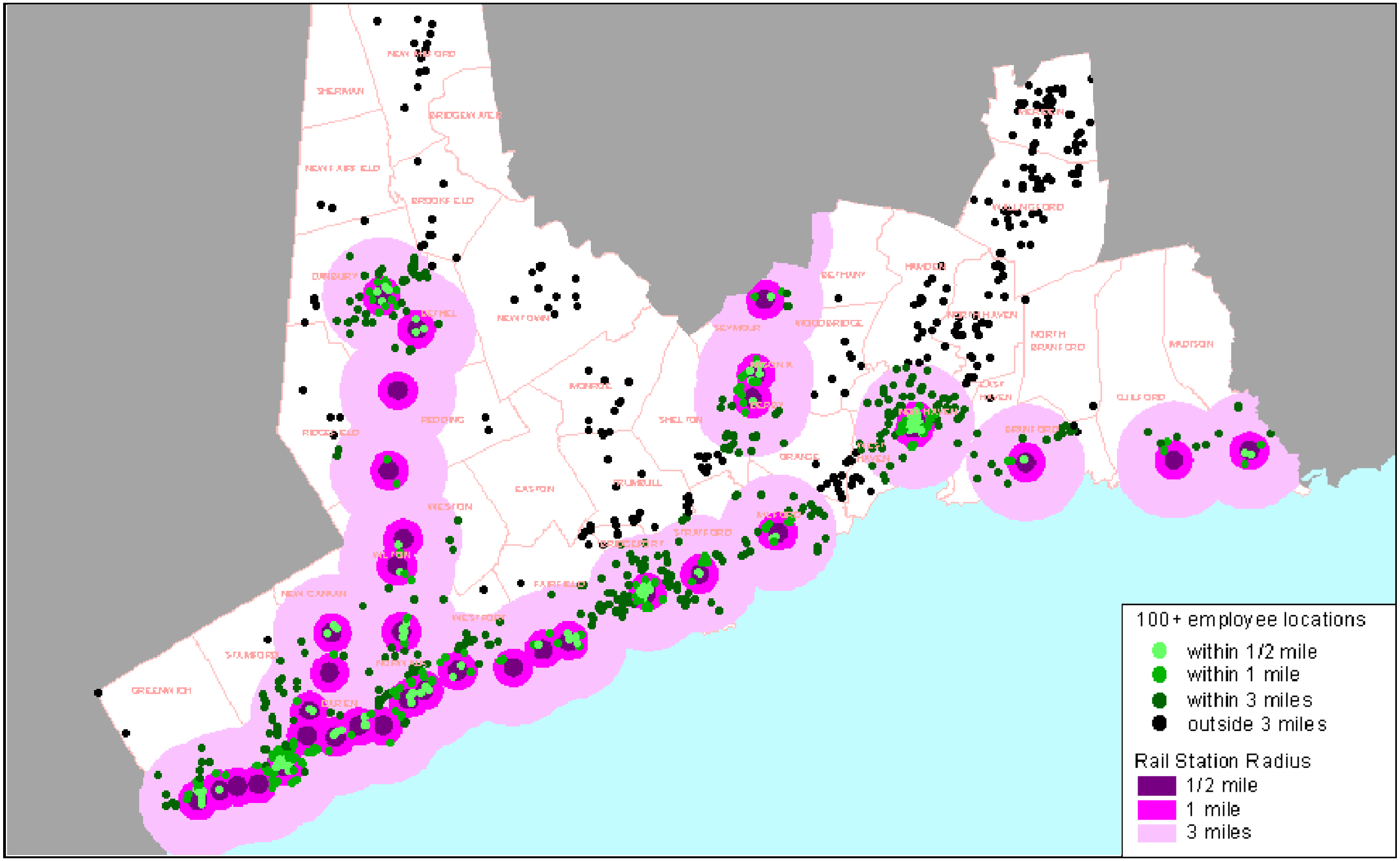
Figure 2-13 Distance from Residence



Source: Wilbur Smith Associates

Figure 2-14 illustrates the concentration of high employment locations to existing rail stations. The trips that have the greatest potential for transit usage via bicycle and pedestrian connections are those within ½ mile of a station on the destination end. This is because trains currently do not allow the transport of bicycles. Providing storage for bicycles on trains can further encourage both transit and bicycle trips. On the origin end of the trip, 63% of trips are within a reasonable 3-mile bike distance from a station, which indicates that bicycle trips to stations could be increased provided the proper amenities at stations exist. In general, a sensible bicycle and pedestrian strategy that focuses investment in areas with proximity to existing rail station locations would serve to synergistically enhance transit usage and help overcome current parking constraints at stations.

Figure 2-14 Bicycle and Pedestrian Access to Transit Stations



Source: Wilbur Smith Associates

2.3 The Land Use Strategies

Land use and transportation policies are inextricably linked. In any community, land use policies and practices are factors in determining the feasibility and, hence, the availability of transportation options. For example, elasticity values can be calculated to assess the influence of development patterns on travel patterns. These elasticity values indicate that population density, balance of residential and commercial land uses, connectivity of travel routes and regional accessibility impact vehicle trips, vehicle miles traveled, and availability and choice of travel options.[1]

For the purposes of this analysis, three land use strategies have been identified for evaluation. Each land use strategy is comprised of any number of elements, some of which may be implemented independently and others that require the support of one or more additional elements. These elements may be implemented at the municipal level through zoning regulations, master plans, plans of conservation and development or site plan review. Some of these techniques may also be utilized by private developers and property owners and in the absence of regulatory mandates or incentives.

The first strategy is the maintenance of existing land use policies and practices. This strategy is defined as the continuation of land use practices that emphasize neither regional coordination nor the comprehensive use of planning practices that promote development of sustainable travel options. The common result of such a land use strategy is the creation of an automobile-centered community.

The second land use strategy involves strengthening existing transportation corridors. Transportation corridors are defined as both roadway and transit corridors. These corridors are characterized by heavy development either along an entire corridor or at particular intersections. Some mixing of land uses is present, although commercial development often dominates. Although transportation corridors may have sufficient destination densities to support transit, the automobile remains the most popular mode of travel.

The final land use strategy promotes transit-oriented neighborhoods. This strategy is characterized by transit hubs surrounded by dense, mixed use development. The clustering of origins, destinations, complementary land uses and transit hubs create an environment where reliance on the automobile for daily personal and business travel becomes unnecessary.

2.3.1 Evaluation of Land Use Measures

For evaluation purposes, the land use strategies, transportation investments and projected outcomes of the pairing of these two variables have been ordered on a matrix in Table 2-25. The first of those strategies represents the community characteristics resulting from existing land use policies. The remaining strategies represent increased integration of transportation planning principles and land use policy.

Evaluation of land use strategies

Each of the land use planning techniques and design elements have been evaluated with regard to their potential to: (1) contribute to regional congestion mitigation; (2) support sustainable travel options; and (3) produce direct or indirect environmental benefits. To allow for quantitative comparison of the relative benefits of strategy, ratings of “1,” “3,” or “5” have been assigned, with a rating of “1” representing little or no measurable benefit, a rating of “3” representing moderate

[1] Reid Ewing and Robert Cervero, “Travel and the Built Environment: A Synthesis,” Transportation Research Record 1780, Paper No. 01-3515, p. 107

benefit and a rating of "5" representing a high or visible benefit. These ratings are the result of both professional judgment and the review of land use-travel elasticity values reported in planning literature. Each land use strategy has also been assessed on the strength of its component elements and techniques.

Evaluation of transportation investments

Supporting transportation investments have been evaluated using a similar rating system, however, three significant differences exist. First, prior to rating each transportation investment, an assessment of the level of support given by the land use strategy is provided. A "low" assessment indicates that the transportation strategy requires little or no support from a land use perspective. A "moderate assessment" indicates that the transportation strategy could perform better with some support from land use, but not enough to achieve maximum benefits. A "high" rating indicates that sufficient land use supports are required to sustain the transportation investment at a level that would yield maximum benefits.

Second, the rating received by transportation investments changes based on the level of support required from land use strategies. This difference underscores the strength of the relationship between land use and transportation policy. Assume, for example, each commuter rail car put in service has the potential to seat approximately 100 persons. In a semi-rural community without convenient access to a rail services, only 20 persons use the train. Twenty persons on the train may mean 20 fewer cars on the roadways. In a transit-oriented community, the same rail car may be filled with 85 people, each of whom leave their cars at home or at a rail station. Both communities contribute to the goals of congestion mitigation and improved environmental conditions, but the impact of one commuter rail car in an urban center is thus greater than in a semi-rural community. In other words, even comfortable, reliable and affordable transportation options may fail or fall short of expectations without the support of complementary land use policies.

Finally, since the transportation investments largely represent travel options, the wording of the second goal has been modified to reflect the sustainability of each transportation investment. For the purposes of this analysis, sustainability is a function of development density, accessibility, diversity of land uses and potential market demand.

Identification of projected outcomes

In recent years, over 50 empirical studies of the relationship between the built environment and transportation have been conducted.[2] These studies have measured the impact of land development patterns on mode share, vehicle miles traveled, person miles traveled, and average trip lengths.[3] The derived elasticies form the basis for the projected outcomes reported in the evaluation matrix.

The projected outcomes relate to the land use-travel elasticity values that were used to help assign values to the supporting transportation investments. Four primary elasticity values have been identified: density, diversity of land uses, design and regional accessibility.[4] Of these elasticity values, regional accessibility has been calculated to have the greatest impact on vehicle miles traveled.[5] Development density and diversity of land uses play strong supporting roles.[6]

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[2] *See* Ewing and Cervero.
[3] *See* Ewing and Cervero.
[4] *See* Ewing and Cervero, pp. 113-114.
[5] *See* Ewing and Cervero, pp. 113-114.
[6] *See* Ewing and Cervero, pp. 113-114.

A reading of the projected outcomes by land use strategy shows the predictive value of the land use-travel elasticities. What the projected outcomes – and the elasticities – say is simple: Opportunities for the creation of sustainable travel options increase with the intensification of development densities, the mixing of land uses and the creation of transit nodes or hubs. The performance of the transportation investments supports this analysis.

Table 2-25 Land Use Evaluation

Key to Scoring: 1=minimal or no impact on goal 3=moderate impact 5=high or visible impact	Study Goals Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit	Vision Strategies	Level of land use support?	Study Goals Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit	Resulting Relationships/Projected Outcomes
Land Use Scenario 1 - Maintain existing land use policies.									
				Basic System Maintenance	low	1	1	1	
				Arterial Operations and Safety	low	3	1	3	
Elements: (7)				Highway Operations and Safety	low	3	1	3	
				Transit System Operations	low	1	3	1	
Segregated land uses	1	1	1	Demand responsive transit	low	1	3	1	
Segregation of housing types and styles	1	1	1	Truck Parking	low	1	1	1	
"Branching" street patterns and cul-de-sacs	1	1	1	Intelligent transportation systems -- roadways	low	3	1	3	
Parcel-dictated parking requirements	1	1	1	Intelligent transportation systems -- transit	low	1	3	1	➢ Automobile is dominant choice ➢ Development densities limit travel choices, e.g. insufficient to support transit ➢ Trip frequency higher than for Land Use Visions 2, 3 ➢ Travel times longer than for Land Use Visions 2, 3
"Sub-division" style neighborhoods	1	1	1	Additional parking at rail stations	mod	1	3	1	
Low density residential development	1	1	1						
Limited infrastructure development, e.g. sewer	1	1	3	Ridesharing and vanpooling	mod	1	3	1	
				Telecommuting, Flex-Time, Staggered Work Week	high	3	1	3	
				Distance-Based Pricing	low	3	1	3	
				Managed Lanes	mod	3	3	3	
				Highway capacity expansion	low	5	1	1	
				Intermodal Hubs	high	1	5	1	
				Bus rapid transit on Route 1	high	3	3	3	
				Inland BRT Routes	high	1	5	1	
				Express and Local passenger rail service on NH Line	high	3	5	3	
				Danbury Branch Line passenger rail service	high	1	5	1	
Average Rating for Land Use Scenario 1	**1.0**	**1.0**	**1.3**	**Average Rating for Vision under Land Use Scenario 1**		**2.2**	**2.0**	**1.9**	

Key to Scoring:
1=minimal or no impact on goal
3=moderate impact
5=high or visible impact

Table 2-25 Continued

Land Use Scenario 2 - Promote development of transportation corridors.

	Study Goals: Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit	Vision Strategies	Level of land use support?	Study Goals: Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit	Resulting Relationships/Projected Outcomes
				Basic System Maintenance	low	1	1	1	
Elements: (9)				Arterial Operations and Safety	low	3	1	3	
Promote mixed use development along existing corridors	3	3	3	Highway Operations and Safety	low	3	1	3	
Increase development densities along existing corridors	3	3	3	Transit System Operations	low	1	3	1	➢ Transit trip rate rises with development densities
									➢ Bike/Pedestrian/Transit shares higher with complementary land uses
Rehabilitate abandoned or underutilized properties along existing corridors	3	3	3	Demand responsive transit	low	1	3	1	➢ Transit share >in mixed use areas, in the presence of vertical density
Develop transit "nodes" at or near destinations	3	3	3	Truck Parking	low	1	1	1	➢ PMT < in locations with good local/regional access
Allow shared parking facilities	3	3	3	Intelligent transportation systems -- roadways	low	3	1	3	➢ VMT < higher population densities
Reduce parking requirements	3	3	3	Intelligent transportation systems -- transit	low	1	3	1	➢ VMT < choice of mode for employment trips
									➢ transit share > with increases in land use mixing
Consolidate curb cuts/access management	3	3	1	Additional parking at rail stations	mod	3	3	3	➢ bicycle/pedestrian share > with increases in land use mixing
Targeted infrastructure development, e.g. sewer	3	3	3						➢ transit share > with increased in employment densities
Encourage "park and walk" patterns among development parcels	3	3	3	Ridesharing and vanpooling	mod	3	3	3	➢ transit share for shopping trips > population and employment densities
				Telecommuting, Flex-Time, Staggered Work Week	high	3	1	3	
				Distance-Based Pricing	low	3	1	3	➢ bus ridership > high employment densities
				Managed Lanes	mod	3	3	3	➢ greater regional accessibility = less dependence on the automobile
				Highway capacity expansion	low	5	1	1	
				Intermodal Hubs	high	3	5	3	
				Bus rapid transit on Route 1	high	5	5	5	
				Inland BRT Routes	high	3	5	3	
				Express and Local passenger rail service on NH Line	high	3	5	3	
				Danbury Branch Line passenger rail service	high	3	5	3	
Average Rating for Land Use Scenario 2	**3.0**	**3.0**	**2.8**	**Average Rating for Vision under Land Use Scenario 2**		**2.9**	**2.3**	**2.6**	

Key to Scoring:
1=minimal or no impact on goal
3=moderate impact
5=high or visible impact

Table 2-25 Continued

Land Use Scenario 3 - Promote transit-oriented development.

Elements: (15)

	Study Goals: Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit
Promote mixed use development	5	5	3
Increase development densities	5	5	3
Promote mix of housing types and styles	5	5	3
Allow compact design	5	5	5
Rehabilitate abandoned or underutilized properties	3	3	3
Enact village district ordinances	3	3	1
Encourage "park and walk" patterns	3	3	3
Encourage use of bicycles	3	3	3
Promote development of a "street grid"	5	5	3
Develop transit stations as neighborhood centers	5	5	3
Allow shared parking facilities	3	3	3
Reduce parking requirements	3	3	3
Consolidate curb cuts/access management	3	3	1
Purchase/transfer of development rights	3	3	3
Use design guidelines to shape community	3	3	3
Develop "freight villages"	5	5	5
Average Rating for Land Use Scenario 3	**4.1**	**4.1**	**3.2**

Vision Strategies	Level of land use support?	Study Goals: Goal 1: mitigate congestion	Goal 2: support travel options	Goal 3: environmental benefit
Basic System Maintenance	low	1	1	1
Arterial Operations and Safety	low	3	1	3
Highway Operations and Safety	low	3	1	3
Transit System Operations	low	1	3	1
Demand responsive transit	low	1	3	1
Truck Parking	low	1	1	1
Intelligent transportation systems -- roadways	low	3	1	3
Intelligent transportation systems -- transit	low	3	3	3
Additional parking at rail stations	mod	3	3	3
Ridesharing and vanpooling	mod	5	3	5
Telecommuting, Flex-Time, Staggered Work Week	high	3	1	3
Distance-Based Pricing	low	5	1	5
Managed Lanes	mod	5	3	5
Highway capacity expansion	low	5	1	1
Intermodal Hubs	high	5	5	5
Bus rapid transit on Route 1	high	5	5	5
Inland BRT Routes	high	5	5	5
Express and Local passenger rail service on NH Line	high	5	5	5
Danbury Branch Line passenger rail service	high	5	5	5
Average Rating for Vision under Land Use Scenario 3		**3.9**	**2.9**	**3.6**

Resulting Relationships/Projected Outcomes

- ➤ Transit options competitive with automobile
- ➤ Transit share >in mixed use areas, in the presence of vertical density
- ➤ rail transit commutes > high density residential areas
- ➤ higher densities = walk access trips to rail
- ➤ transit share > with increased in employment densities
- ➤ transit share for shopping trips > population and employment densities
- ➤ VMT < higher population densities
- ➤ Bike/Pedestrian/Transit shares higher with complementary land uses
- ➤ PMT < in locations with good local/regional access
- ➤ VMT < choice of mode for employment trips
- ➤ bicycle/pedestrian share > with increases in land use mixing
- ➤ transit share > in TOD neighborhoods
- ➤ vehicle trips less frequent at high densities
- ➤ TOD supports mode choice, availability of choice promotes TOD
- ➤ balanced land uses = greater use by bicycles/ pedestrians
- ➤ walking to stations > where retail uses predominate around stations
- ➤ trip length < with higher population and residential densities

Source: Wilbur Smith Associates, South Western Regional Planning Agency, Reid Ewing and Robert Cervero, “Travel and the Built Environment: A Synthesis,” Transportation Research Record 1780, Paper No. 01-3515.

3 Benefit and Cost Evaluation

Economic evaluation is an important component of transportation decision-making and can help identify the value of an improvement, policy or program. Economic evaluation of transportation strategies often tends to overstate the benefits of highway capacity expansion and understate the benefits of strategies that encourage more efficient use of existing transportation resources. For these reasons, a multiple accounts evaluation was performed to account for changes in land use policy that would likely enhance the effectiveness of various transportation strategies. While this analysis incorporates some subjectivity into the analysis, it is largely based on real world experience relating to transportation performance relative to land use variables.

The Surface Transportation Efficiency Analysis Model (STEAM) model was used to process the results of the ConnDOT travel demand model and generate annual performance impacts. STEAM is able to monetize these impact estimates for a wide range of transportation investments and policies including major capital projects, pricing and travel demand management (TDM). The following sections explain some of the costs used in the analysis.

3.1 Transportation Costs

Most transportation decisions involve marginal changes: an incremental increase or reduction in travel options, travel costs, and the amount of mobility that occurs. Once a basic road system exists, most additional roadway improvements provide marginal reductions in travel time, vehicle costs and crash risk. Similarly, a new transportation service, such as a new bus or rail system, or a freight delivery service, provides marginal benefits compared with the travel options that would otherwise be available. [1]

Cost refers to the trade-offs between uses of resources, which can involve money, time, land, or the loss of an opportunity to enjoy a benefit. Costs and benefits have a mirror image relationship: a cost can be defined as a reduction in benefits, and a benefit can be defined in terms of reduced costs.

Benefits tend to be maximized in a market that reflects certain principles, including consumer choice, efficient pricing and economic neutrality. High levels of mobility do not necessarily reflect optimal benefits if transportation and land use markets are distorted in ways that reduce transport options or under-price vehicle travel.

3.1.1 Vehicle Costs

Vehicle costs include those costs that are required to own and operate an automobile. They typically include the price of the vehicle, cost of fuel and maintenance, and insurance and registration. The average cost per mile to own and operate a car is about $0.50. Costs can be separated into the following:

- Fuel Cost is the dollar value of a gallon of fuel.
- Non-Fuel Operating Cost is the cost incurred by highway users that are not included in fuel costs. They may include items such as vehicle operating costs (tires, oil, maintenance, etc.).

[1] EU, *Towards Fair And Efficient Pricing in Transport*, European Union (http://europa.eu.int), 1996; Todd Litman, *Socially Optimal Transport Pricing and Markets*, VTPI (www.vtpi.org), 2000; "Market Reforms," *Online TDM Encyclopedia*, VTPI (www.vtpi.org/tdm/tdm29.htm), 2002.

- Other Mileage-Based Cost includes the external costs of congestion, pollution and noise that are imposed on society.
- Out-of-Pocket Cost includes items such as tolls or parking charges.

The cost of automobile use is often under-valued because drivers do not pay for the costs imposed on society by driving. These costs would include government expenditures on roadway facilities, and rent paid on land used for roadways. It can also include charges for other external costs caused by motor vehicles, including un-priced parking, congestion, uncompensated crash damages and environmental damages.

A major portion of automobile costs are not recognized by the user. The perceived costs are significantly lower than the total costs, which include those costs imposed on society. Vehicle owners generally perceive economies of scale for driving; the more a car is driven the lower its average cost. This under-pricing leads to transportation patterns that are economically inefficient and inequitable, and exacerbates environmental and social problems. On average, each dollar spent on vehicle operating costs imposes about $2.70 in costs to society.

3.1.2 Travel Time Costs

Travel time cost refers to the value of time spent in travel. Typically, these costs are separated by in-vehicle and out-vehicle travel time. In-vehicle travel time refers to the time spent driving or riding while Out-vehicle time refers to time spent waiting for transit, stopping at a park and ride, or walking to a vehicle. Travel time savings are the benefits that result from reduced travel time.

Travel time is considered one of the largest transportation costs, and travel time savings are often the greatest potential benefit of transportation improvements.[2] Travel time costs and the benefits of travel time savings vary widely depending on factors such as the type of trip, traveler and travel condition.

3.1.3 Accident Costs

Accident costs refer to the economic value of damages caused by vehicular accidents. Injuries and fatalities generate the greatest costs because of the high cost of property damage, personal injury or death, emergency response services, and medical treatment. Property damage only accidents only include the cost of damage to the vehicle.

These costs can be separated into internal and external costs. Internal accident costs are those that are perceived by the transportation user – or accident victim – such as damage, pain and suffering, death, lost income and mobility, and medical expenses. External costs are those that are imposed on society such as incident delay, insurance costs, and emergency response services.

3.1.4 Air Pollution Costs

Air pollution costs refer to damages caused by motor vehicle emissions. This includes human health and environmental damage resulting from various air emissions produced by motor vehicles.

Motor vehicles produce various harmful air emissions, most notably:

- Hydrocarbons (HC), which produces ozone;

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[2] Ian Heggie and Simon Thomas, "Economic Considerations," *Transportation and Traffic Engineering Handbook, 2nd Edition*, Institute of Transportation Engineers/Prentice-Hall (www.ite.org), 1982.

- Carbon Monoxide (CO), which undermined the blood's ability to carry oxygen;
- Nitrogen Oxides (NOx), which are toxic compounds that contribute to ozone production; and
- Particulate Matter (PM10), which are inhalable pollutants.

In addition, Carbon Dioxide (CO_2) is emitted which is a byproduct of combustion and contributes to global warming.

3.1.5 Noise Costs

Noise refers to unwanted sounds and vibrations. Motor vehicles cause various types of noise, includes engine acceleration, tire/road contact, braking, horns and vehicle theft alarms.[3] Trucks can cause vibration and low frequency noise.

3.1.6 Other External Costs

Other external costs refer to costs associated with the consumption of natural resources - primarily energy consumption - for the production and operation of motor vehicles not borne directly by users. These external costs can include environmental damage, health risks, national security costs and risks, macroeconomic impacts on individual economies, depletion of non-renewable resources and various financial subsidies. The benefits to society of reduced consumption are increased efficiency and conservation.

3.1.7 Revenue Transfers

Revenue transfers occur as a result of changes in fares, tolls, and other out-of-pocket costs paid by transportation system users. Increase in fares and tolls implemented as part of a package of transportation system improvements reduces the benefits of the improvements to system users. If the fare and toll increases are very large, the net effect of the package on transportation system users may be negative. However, fare and toll increases do not necessarily result in a loss to society as a whole since they cause revenues to be transferred from system users to the agencies that collect tolls and fares.

Conversely, decreases in fares and tolls increase benefits to users because revenues are being transferred to them from the collecting agencies. Hence, in calculating the net benefits of a package of actions, revenue transfers to or from collecting agencies were added to user benefits to capture the full effect of the package of actions on society.

3.2 Effect of Land Use on Benefits and Costs

More accessible and resource efficient land use patterns can increase economic productivity and development. Increased density and clustering provides efficiencies due to increased accessibility - the ability to reach desired activities and destinations - and interactions. For example, businesses can more easily interact and trade among themselves, customers can find competitive goods and services, suppliers can easily provide inputs, and specialized workers can expect greater employment opportunities. Concentration of density benefits are why cities develop. Although concentrated development benefits are difficult to measure, they appear to be large.[4] Activities that involve

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[3] *Indicators of the Environmental Impacts ofT ransportation*, Office of Policy and Planning, USEPA (Washington DC; www.itre.ncsu.edu/cte), 1999.

[4] Alex Anas, Richard Arnott and Kenneth Small, *Urban Spatial Structure*, University of California Transportation Center (Berkeley; www.uctc.net), No. 357, 1997.

interaction among numerous people, such as education, finance and creative industries are particularly affected by concentrated development.

Some people assume that near universal automobile ownership and telecommunications improvements have eliminated the value of proximity, but the evidence indicates otherwise. Although automobile transport allows activities to be more dispersed within an urban region, the economic importance of cities has increased, as indicated by the increasing portion of residents and businesses located in urban areas. The clustering of computer development in areas such as Silicon Valley indicates that even information-based industries benefit from proximity and concentration.[5]

In the Vision 2020 study area, urban areas have experienced the kind of sprawl that has contributed to automobile dependence. The under-pricing of vehicle usage combined with the prestige of suburban lifestyle has resulted in the congestion experienced today. Sprawl has made it difficult for cities to survive economically because the cities typically support a variety of services that are valuable to society, but in return the cities are losing tax revenues from the migration of population and employment seeking suburban opportunities. For transit strategies to be successful, cities must encourage a high density of mixed use development. Such development will lower municipal costs and provide the concentrated base of people and business to make mass transit a competitive and self-sustaining mode.

While the study Vision strongly supports mass transit as the mechanism for providing long term capacity in the corridor, the existing development patterns of southwestern Connecticut should not be ignored. Mass transit alone is not likely to bring high concentrations of population and employment back to the cities. In fact, the more probable scenario is that population and employment will continue to seek out locations away from cities that are cheaper to develop, provide more parking, have less congestion, and have lower taxes. In short, continued sprawl will reinforce automobile dependence, reduce the efficiencies of proximity and concentration, and incur high municipal cost burdens.

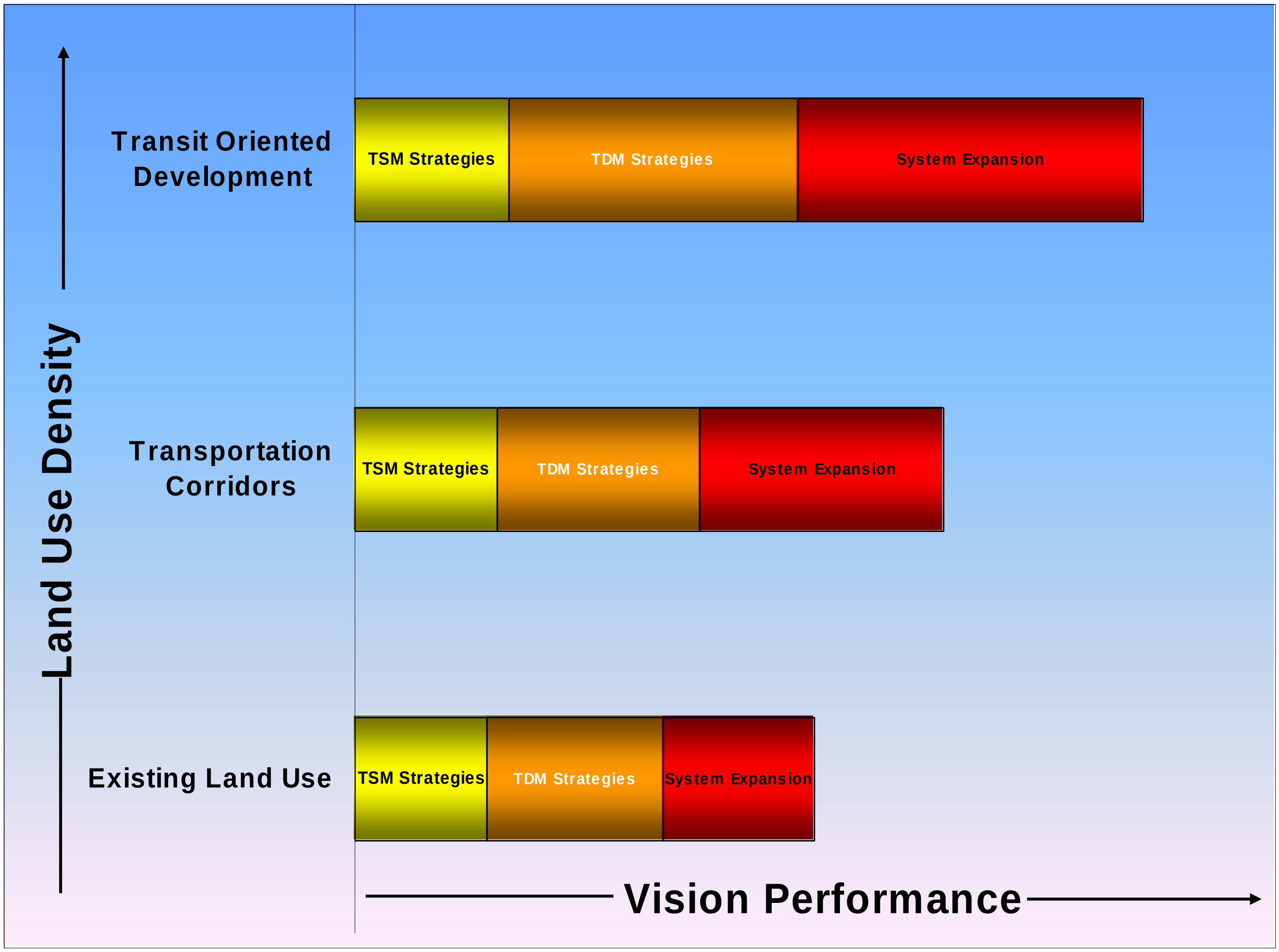
For the Vision 2020 Study, rankings were developed to provide some perspective on the impact to transportation strategies due to land use policy decisions.[6] The ranking system was developed because traditional economic analysis tends to overstate benefits from roadway improvements and underestimate benefits from strategies that improve mobility and accessibility.

Based on the land use evaluation discussed previously, Figure 3-5 was developed to illustrate how overall system performance can be improved if land use reform occurs. The graph indicates that as urban density increase, Vision performance also increases. Land use density has little effect on TSM strategies, while the TDM and System Expansion components of the Vision can be significantly enhanced by density and mixed used development patterns.

Since the transportation evaluation methodology assumes no significant changes in development or demographic trends into the future, the results tend to be conservative. The success of the Vision will ultimately depend on a coordinated effort to strongly link land use decision making to the transportation strategies presented in this Vision.

[5] Transportation Cost and Benefit Analysis – Land Use Impacts, Todd Litman, Victoria Transport Policy Institute (www.vtpi.org), June 2002.
[6] See Chapter 2.3.1 for details.

Figure 3-1 Land Use Impact on Transportation



Source: Wilbur Smith Associates

3.3 Vision Performance

The evaluation of system performance for the Vision 2020 Vision included the following strategies:

- Bus Rapid Transit System,
- Enhanced Intrastate Rail,
- Reduced Rail Fare and Parking Costs,
- Enhanced Connectivity at Intermodal Hubs,
- Travel Demand Management assuming 3% participation rate,
- Signal Coordination on Route 1,
- Bus Automatic Vehicle Location,
- Bus Electronic Fare Collection,
- Weigh In Motion, and
- Managed Highway Lanes on I-95 with $0.15 per mile toll.

The combination of these strategies resulted in the annual performance impacts listed in Table 3-1. Negative values represent a reduction from the Year 2020 Base condition.

The results for each performance measure are presented by mode of travel. The first five modes – Drive Alone, Carpool, BRT, Local Bus, and Rail – represent peak period work trips only. Peak period work trips are defined as home-based work trips occurring during the two peak periods of the day (roughly six hours). The peak period work trips were evaluated because of their recurrent travel characteristics and are therefore the trips most likely to be impacted by transportation improvements. In addition, External Auto and Total Truck trips were included because these modes include trips that have at least one trip end outside of the study area and would accrue additional benefits of highway improvements all day long. Truck trips were isolated because they have higher costs associated with operation and emissions production than do automobiles.

3.4 Accessibility Analysis

Accessibility is a measure of proximity between people and places, measured over a transportation system. It can be used assess the effectiveness of alternative transportation investments in increasing employment, shopping or other opportunities for geographic submarkets within the region.

The STEAM model was used to perform the accessibility analysis using outputs from the ConnDOT travel demand model. The accessibility analysis used data including:

- Population and employment for each traffic analysis zone
- A definition of which zones made up the municipalities in the study area
- Travel time skim matrices from each origin and destination zone in the study area

The accessibility analysis reported the number and percentage of regional jobs or persons within a certain time threshold for each municipality. STEAM calculated the total travel time for each origin/destination pair and then identified all destination zones and the number of jobs within the travel time thresholds specified. Results from each origin zone were aggregated by municipality and weighted by zonal population.

The results of this analysis show a separation of employment destinations from residential origins in the study area. For the Year 2020 Base condition, about 46% of employment in the corridor is in a travel time category of 50 minutes or more away from residential origins. This does not mean that the actual average work trip duration takes that long, rather it indicates that on average most of the jobs in the study area are significantly separated by distance and time. This is a typical result of land use sprawl.

The Vision was designed to help bring people and jobs closer together by providing transportation options that connect population to employment cluster. The analysis concluded that the Vision can be effective in reducing the average time impedance between all residential origins and commercial destinations. The analysis reported overall travel time reductions for each transportation mode for all work related trips made by that mode.

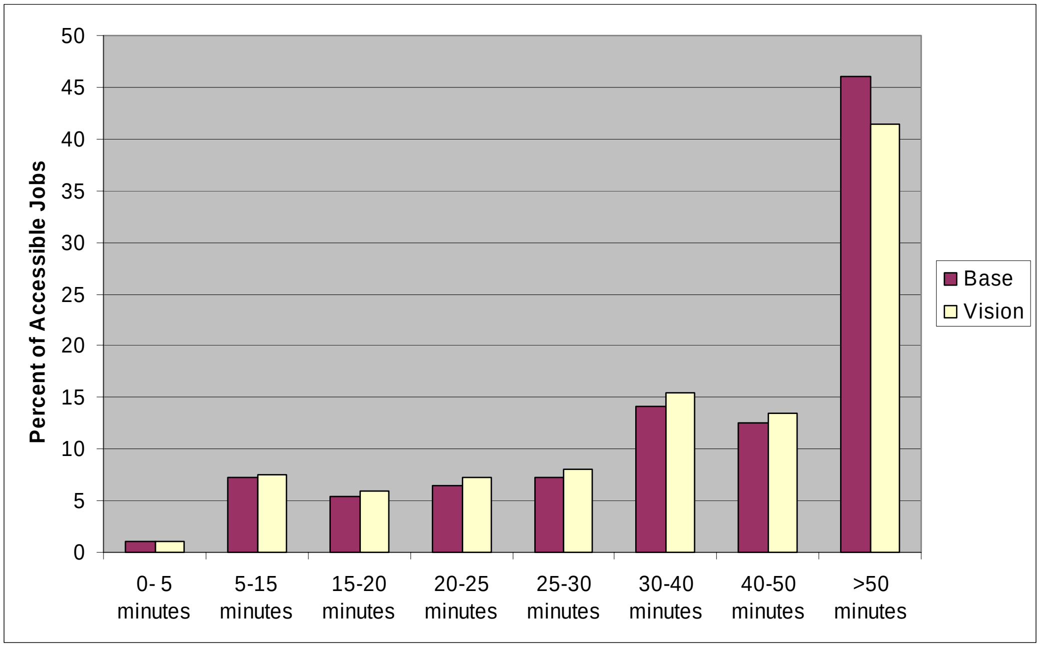
Figure 3-2 illustrates the percent of travel time separation for the Base and the Vision using automobile as the transport mode. In this figure, a 5% reduction in the number of jobs that are separated from residential origins by more than 50 minutes was reported. Other time categories increased slightly to account for the improved accessibility. This analysis is valuable because economic efficiency is increased when people and jobs are closer together. Proximity leads to less wasted time, improved quality of life, and economic productivity.

Table 3-1 Vision Performance as Compared to Year 2020 Base

Performance Measure	Home Based Work Trips					ADT Trips		TOTAL
	Drive Alone	Carpool	BRT	Local Bus	Rail	External Auto	Total Trucks	
Vehicle Miles Traveled per Year	-53,358,215	-7,504,735	N/A	N/A	N/A	-1,400,000	900,000	-61,362,950
Person Trips per Year	-3,338,250	-813,500	2,133,500	79,500	1,444,250	-400,000	0	-894,500
Total Travel Time (Vehicle Hours per Year)	-2,470,002	-290,909	N/A	N/A	N/A	-2,176,991	-470,000	-5,407,902
Total Travel Time (Person Hours per Year)	-2,470,002	-640,000	-60,000	-346,667	-60,000	-2,460,000	-470,000	-6,506,669
Tons of Emissions per Year								
HC	-70	-9	Neg.	Neg.	N/A	-32	-20	-130
CO	-1,951	-226	Neg.	Neg.	N/A	-1,174	-110	-3,461
NOx	-37	-5	Neg.	Neg.	N/A	12	4	-26
PM10	-2	0	Neg.	Neg.	N/A	0	0	-1
Energy Consumption (1000 BTU/yr)	-247,000,000	-38,000,000	0		0	-67,500,000	-130,000,000	-482,500,000
CO2 Emissions (Tons per Year)	-19,000	-2,280	Neg.	Neg.	N/A	-5,504	-10,400	-37,184
Accidents per Year								
Fatalities	-2	0	Neg.	Neg.	N/A	0	0	-3
Injuries	-378	-16	Neg.	Neg.	N/A	-90	-12	-496
Property-Damage-Only	-203	-16	Neg.	Neg.	N/A	-3	2	-221
Gallons of Fuel (Gallons per Year)	-2,275,111	-238,450	0		0	-552,096	-958,200	-4,023,857

Source: Wilbur Smith Associates based on output from STEAM model

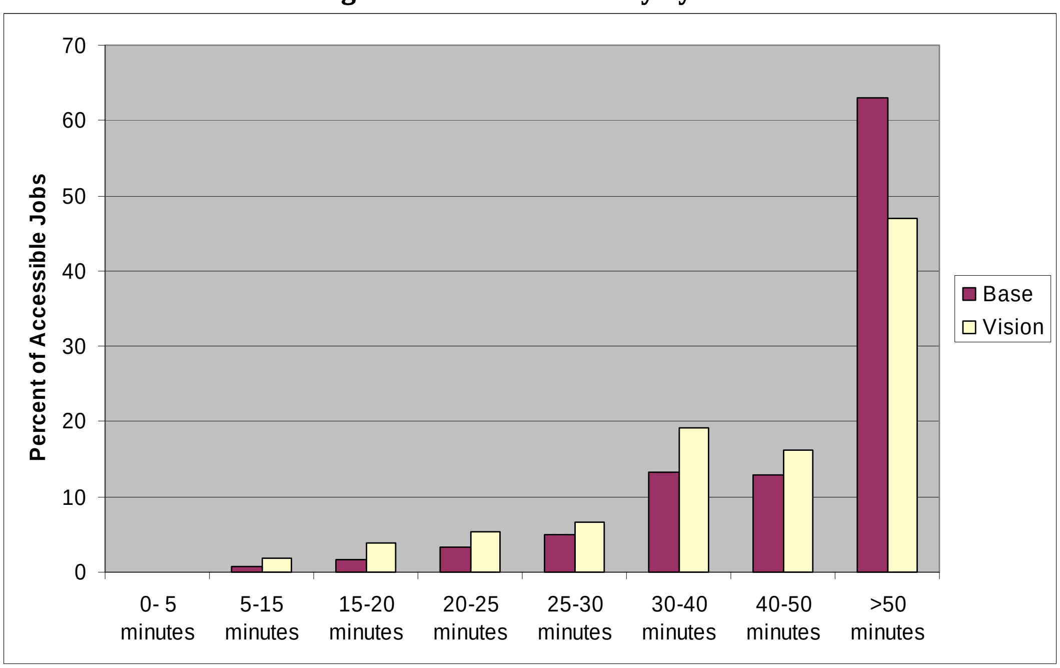
Figure 3-2 Job Accessibility by Automobile



Source: STEAM analysis of ConnDOT model demographic data

Figure 3-3 illustrates the percent of travel time separation for the Base and the Vision using bus as the transport mode. In this figure, a 16% reduction in the number of jobs that are separated from residential origins by more than 50 minutes was reported. Other time categories increased slightly to account for the improved accessibility.

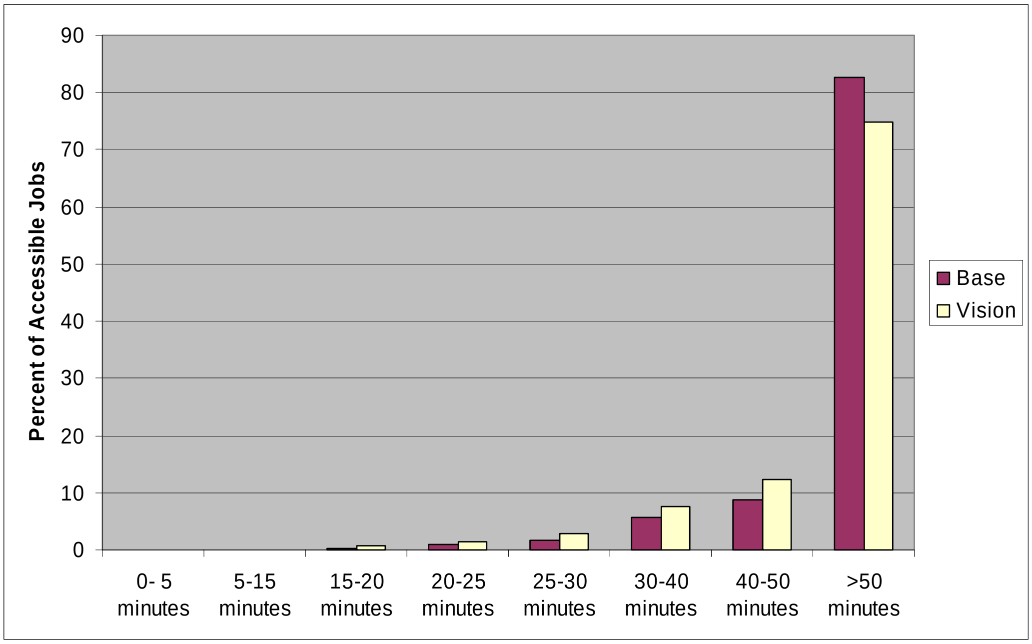
Figure 3-3 Job Accessibility by Bus



Source: STEAM analysis of ConnDOT model demographic data

Figure 3-4 illustrates the percent of travel time separation for the Base and Vision using bus as the transport mode. In this figure, an 8% reduction in the number of jobs that are separated from residential origins by more than 50 minutes was reported. Other time categories increased slightly to account for the improved accessibility.

Figure 3-4 Job Accessibility by Train



Source: STEAM analysis of ConnDOT model demographic data

3.5 User Benefit and Cost Analysis

The improvements in system performance generated by the STEAM model were translated to annual costs by assigning average monetary values for changes in travel time, accident reduction, and emission reduction. The benefits (positive values) and costs (negative values) are presented in Table 3-2.

For *new* users of a transportation mode, savings are valued at one-half the rate used for former users - as suggested by consumer surplus theory - since new users do not really save the full amount saved by former users, but approximately half. Former users are those who used the specified mode under the Base scenario. New users are those users attracted to the mode, or to a new destination, due to facility or service improvements. For users who shift *away* from a mode or destination, costs are computed similarly.

User-perceived benefits are reduced as a result of increases in user costs. Since user payments for fares, fuel taxes and tolls represent monetary transfers to the government, it is necessary to account for these revenue transfers as "benefits" to government agencies in the estimation of total societal benefits of the actions under consideration.

In summary, the total benefits due to the transportation strategies in the CMS2020 Vision are estimated to be approximately $150 million per year. These benefits, and the performance of the transportation system, can be significantly increased if land use policies are changed to promote urban centers and transit oriented development.

By continuing with the existing policies and trends in development and travel behavior, southwestern Connecticut will be faced with costly improvements without a comparable return on investment.

Figure 3-5 illustrates the towns and cities that will be impacted the greatest by increasing congestion, as well as those communities that will receive the greatest benefits from the CMS2020 Vision.

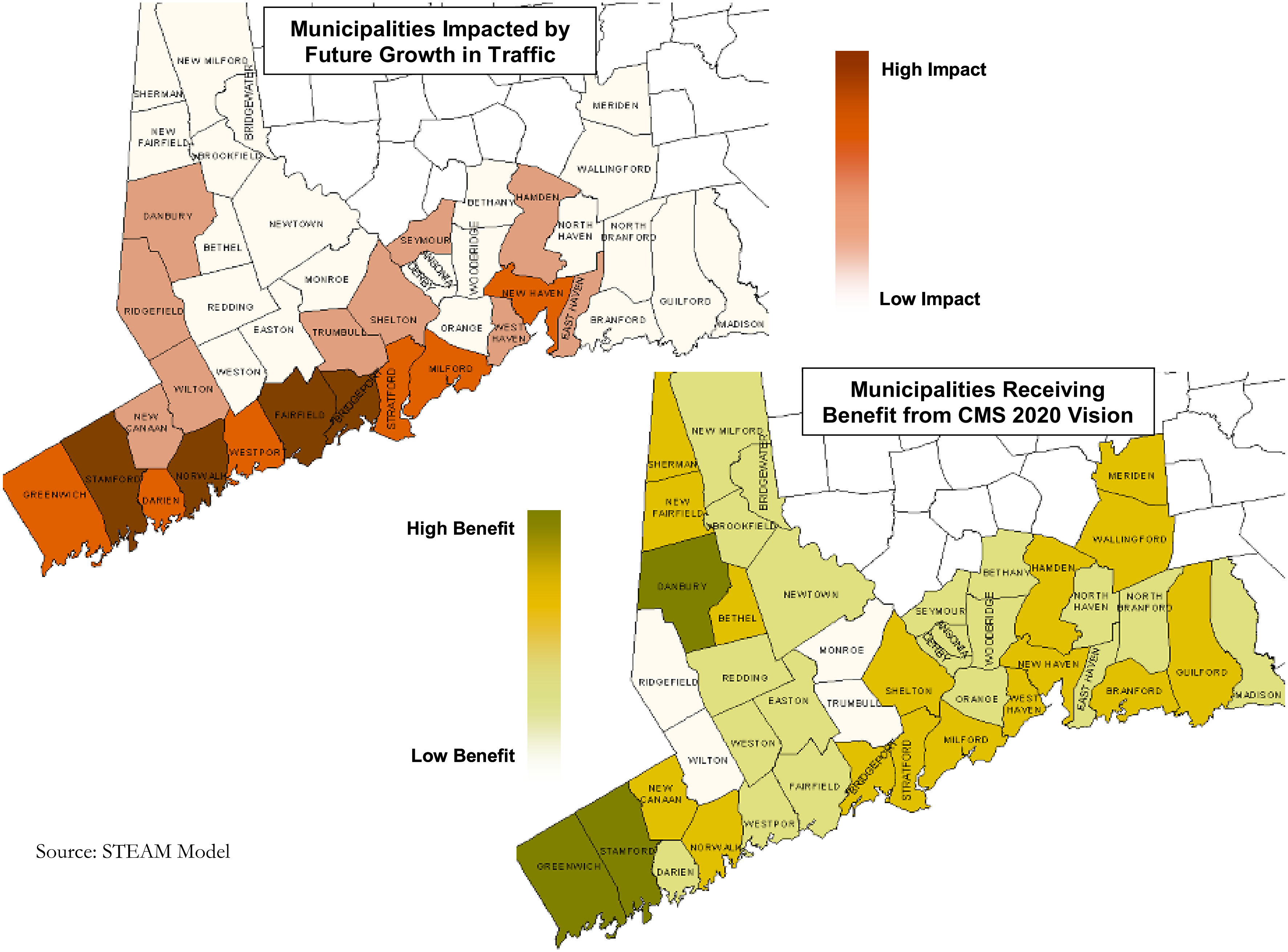
Capital and operating costs were not annualized due to the uncertainty of implementation specific details such as year of opening, construction period, useful life and salvage value.

Table 3-2 Vision Benefits

	Drive Alone	Carpool	BRT	Local Bus	Rail	External	Trucks	TOTAL
User Benefits				***Benefits (1000$/yr)***				
In-Vehicle Travel Time	57,912	8,378	5,649	953	1,871	4,320	20,269	99,352
Out-of-Vehicle Travel Time	0	0	3,481	2,860	5,030	0	0	11,371
Fuel Costs	1,315	3	0	0	0	828	1,102	3,248
Non-Fuel Operating Costs	-161	-16	0	0	0	-123	323	23
Out-of-Pocket Costs	0	0	-181	0	354	0	0	173
Internal Accident Cost	10,070	1,359	0	0	0	5,156	731	17,315
Subtotal	69,135	9,724	8,948	3,813	7,256	10,182	22,424	131,482
Revenue Transfers	-385	-47	570	243	95	-661	-408	-595
Reduction in External Costs								
Emissions	7,866	916	Neg.	Neg.	N/A	4,578	446	13,806
Global Warming	68	8	Neg.	Neg.	N/A	19	37	132
Noise	39	5	Neg.	Neg.	N/A	0	107	151
Accident	1,595	195	Neg.	Neg.	N/A	0	0	1,790
Other Mileage Based	1,932	267	Neg.	Neg.	N/A	0	0	2,199
Subtotal	11,499	1,392	0	0	0	4,597	590	18,078
Total Benefits	**80,249**	**11,069**	**9,517**	**4,056**	**7,350**	**14,117**	**22,605**	**148,965**

Source: Wilbur Smith Associates based on output from STEAM model

Figure 3-5 Impacts and Benefits to Municipalities



Source: STEAM Model

4 External Connections

External connections are transportation strategies that have regional significance but were outside the primary study area and therefore not evaluated as part of the Vision 2020 study. In virtually all cases, these strategies were or are being studied independently, and available results have been included in this section. It should be noted that the Vision 2020 Study was intended to focus on intrastate strategies, however many of these external connections to points beyond the Vision 2020 study area could provide additional benefit to the study area.

4.1 Interstate Passenger Rail Service

Based on 1999 Metro North ridership data, the New Haven Rail Line carries approximately 67 million trips per year. Of these trips, over 80 percent are interstate. The expansion of intrastate rail service was evaluated as part of the study Vision however the primary rail market is currently oriented to and from New York. The overwhelming share of the passenger rail market by interstate trips naturally requires continued investment to service the demand into the future.

A significant investment by the state will be required to upgrade and replace the existing fleet of locomotives and coaches. A fleet configuration study has been performed by ConnDOT and an estimated $2.9 billion will be required just to provide equipment and infrastructure to meet future demand through year 2030.

4.2 Passenger Ferry Operations

To address the potential of diverting intrastate trips in the corridor to alternate modes of transportation, an evaluation of a conceptual ferry service from major ports was evaluated based on travel time comparisons with the existing highway and rail modes in the corridor. This evaluation was based on The Interstate Passenger Commuter Ferry Study done in March of 2001 by the Connecticut Department of Transportation’s Office of Intermodal Planning. The study analyzed the need and opportunity for establishing an Intrastate Passenger Commuter Ferry service along the Long Island Sound. This strategy was not part of the model evaluation.

This study investigated existing and planned ferry and transit operations along the southwest corridor and the Long Island Sound. The passenger ferry service focused on ports in Stamford, Norwalk, Bridgeport, New Haven and Branford. The study eliminated Branford due to inadequate water depth for the ferry to operate safely. One route would provide service at New Haven/Bridgeport/Stamford, while a second route would provide service at New Haven/Norwalk/Stamford. Two ferry vessels, with a seating capacity of 150 passengers each, would make two round trips each morning and evening during commuter hours. It was projected that the vessels would carry approximately 50 passengers daily in each direction.

While the service could operate at a speed of 30 knots in open water, the ferries would have to slow down significantly upon entering harbors. The service would not be travel time competitive with other modes of transportation. The fares would be comparable to the Shore Line East rail service.

With the anticipated ridership of the new passenger commuter ferry being 50 passengers daily in each direction, the service would have an insignificant impact on the peak traffic period in the southwest corridor. Perhaps the greatest potential for passenger ferry service in the region is between Connecticut and Long Island or the New York airport market areas. These linkages are beyond the scope of this study, but are currently being studied in detail as part of the Long Island Sound Waterborne Transportation Plan.

4.3 Air

With the concentration of major international and regional airports in the metro New York/New Jersey area, improved transit connections can offer opportunities to reduce vehicle trips to these major destinations.

4.4 Goods Movement

The efficient movement of goods is critical to a sustainable economy. In southwestern Connecticut, the primary movers of goods are trucks. Even where rail connections exist to transport freight into the state, trucks still serve as the final delivery mechanism for businesses and consumers. While movement of goods by truck is economical, flexible and efficient, competition for space on the state's roadway system is great. The mixing of automobiles and trucks on roads and highways that can no longer handle the volume of traffic creates instability in flow. On an increasingly frequent basis, truck and automobile conflicts create hours of delay on study area roads. As the demand for goods increase, so will the number of trucks. This section of the report will identify some potential opportunities for reducing the number of trucks on study area roads as well as explore strategies to make it safer for trucks that must remain on the roads.

4.4.1 Barge Service

Container Barge Service is being or has been evaluated within the study area by the Greater Bridgeport Regional Planning Agency, the South Central Regional Council of Governments and the Connecticut Department of Transportation. The ConnDOT study investigated operations along Long Island Sound between the Port of New York and New Jersey and various deep-water ports in Connecticut. Initial studies have found that barge feeder service may be feasible, however, capital costs vary widely with the equipment and infrastructure requirements.

Although barge service may be feasible, studies done by both GBRPA and ConnDOT have shown that the effect of barge service on roadway congestion will be minimal. GBRPA expects barge service to have the potential of up to 400 containers per week. This would mean only approximately 80 trucks per day would be removed from I-95. ConnDOT's "Container Barge Feeder Service Study" had similar results, expecting 40 to 80 containers per day.

Due to the minimal effect on congestion reduction, impacts from barge service in the corridor were considered negligible. Despite the limited effect on congestion, barge feeder service may still be a viable option for the region due to the lesser noise and air pollution and greater safety associated with barge service. If barge service is deemed cost effective through further ConnDOT and regional studies, the service would provide another option for goods movement in the study area and the removal of any vehicles from I-95, no matter how small the number, would be an inherent benefit.

4.4.2 Rail Freight Service

Some circumstances, such as changing industrial geography, leading to the decline of rail freight in the region cannot be easily changed or addressed. Other circumstances can be addressed with public investment. The City of New York is very interested in building a rail tunnel under New York Harbor that would be tall and wide enough to handle all modern freight cars. The proposed Cross Harbor Freight Tunnel would run from the rail yard in Northern New Jersey to a freight only branch line in Brooklyn. The freight only branch line would be upgraded to provide access to the balance of Long Island and potential connections to New England via the Hells Gate Bridge. This tunnel could save at least one day and hundreds of dollars for carload shipments to Long Island from origins such as Chicago, Atlanta and Houston. For shipments to Southern New England, time savings from the Middle Atlantic and southeastern states could be as much as three days.

To make the tunnel most attractive for transport of New England freight, some institutional issues would need to be addressed:

- Presently, the Northeast Corridor is managed by Amtrak and Metro North to minimize freight traffic that might interfere with passenger movements. Changes in train dispatching and freight car mileage charges are needed to make the new route economically competitive with current routes for rail traffic into the region – southward from the Boston and Albany mainline via interchanges at Pittsfield and Springfield, Massachusetts.

- The freight rights to the New Haven main line between New York and New Haven belong to CSX, which also owns the Boston-Albany freight artery. CSX has limited incentive to operate a New Haven route that would be largely redundant with its Boston-Albany route. However, if the Norfolk-Southern Railroad (NS) and the major short lines in Connecticut operated by the Providence and Worcester Railroad (P&W) were granted access to the New Haven Line via the proposed tunnel, it is expected that substantial volume of truck traffic could be diverted from the I-95 to rail freight.

Preliminary analyses by the New York City Economic Development Council (NYCEDC) indicated that developing the Cross Hudson Rail Freight Tunnel with competitive access to New England for P&W and NS could reduce the tractor-trailor volume along I-95 in Connecticut. According to forecasts presented by the City of New York to the Transportation Strategy Board on September 6, 2002, the proposed tunnel could create freight market and service opportunities that could divert substantial volumes of freight moving in Southwestern Connecticut from truck to rail.

The forecasts in Table 4-1 indicate that the tunnel could reduce tractor-trailor truck trips on I-95 by 2.9% at the New York-Connecticut border and by 5.9% in New Haven. The increase in truck trip reduction in New Haven can be attributed to an assumed increase of rail freight traffic into/through Connecticut. In addition, there is some backfill of truck traffic at the New York border due to southwestern Connecticut intermodal destinations being served by truck from Maspeth. Thus, the proposed tunnel is expected to remove nearly 50,000 annual through truck trips from I-95 in New Haven, but is also expected to result in almost 38,000 "new" truck trips into southwestern Connecticut that could be moved by rail. It should be noted that the proposed tunnel would remove through truck trips that do not directly benefit the State of Connecticut, and add local trips that could provide economic development benefits.

Table 4-1 Major Highway Impacts Due to Proposed Tunnel

Highway Link	Reduced Annual "Commodity" Truck Trips	Percentage Reduction of "Commodity" Trucks	"Commodity" Trucks as a Percent of Total Link Volume
Gowanus Expy.	180,708	17.9%	3.1%
Brooklyn-Queens Expy.	-27,534	-13.8%	0.6%
Cross Bronx Expy.	155,988	9.4%	2.0%
Staten Island Expy.	303,669	33.4%	1.8%
Long Island Expy.	61,428	4.4%	2.6%
New Jersey Tpk.	172,080	7.4%	15.8%
New England Thruway	**11,793**	**2.9%**	**2.4%**
Clearview Expy.	34,350	6.0%	3.1%
Major Deegan Expy.	104,358	4.1%	2.5%
I-95 in New Haven	**49,470**	**5.9%**	**2.8%**

Source: NYCEDC – year 2025 annual forecasts

According to NYCEDC forecasts, the proposed tunnel is projected to substantially reduce tractor trailer traffic on highways in metropolitan New York. The forecasts in Table 4-2 indicate that the proposed tunnel could reduce southwestern Connecticut's regional commodity truck Vehicle Miles Traveled (VMT) by 4.4 percent and Vehicle Hours Traveled (VHT) by 4.8 percent. This represents an annual reduction of 5 million miles in southwestern Connecticut regional truck VMT and 200,000 annual hours in truck VHT. Vehicle miles and hours of travel are the primary determinants of regional air quality.

Table 4-2 Forecast Reduction in Annual Freight Truck VMT and VHT

Subregion	Vehicle Miles Traveled (VMT)		Vehicle Hours Traveled (VHT)	
	Reduction	Percent	Reduction	Percent
New York City	6,206,400	4.8	267,000	4.7
Long Island	696,300	1.0	21,600	1.2
Hudson Valley	20,364,300	6.2	224,750	2.7
Northern New Jersey	30,185,400	4.0	1,101,300	4.8
Southwest Connecticut	**4,926,000**	**4.4**	**197,100**	**4.8**
Total	67,995,600	4.5	2,078,700	4.3

Source: NYCEDC – year 2025 annual forecasts

5 Conclusion

5.1 Project Development

The Vision 2020 study is the first step in an ongoing planning process. The Vision developed as part of this study is intended to establish a platform for future action. The strategies included in this Vision are the result of extensive public outreach, market research and quantitative evaluation. While the conclusions of this study begin to paint an overall congestion management plan for southwestern Connecticut, the analysis performed lacks the detail and precision required for specific project implementation. Several steps must follow any endorsement of recommendations in this study. The steps of project development are as follows:

1. Vision Study;
2. Feasibility Study/Corridor Study/System Plan;
3. Environmental Evaluation as required by the National Environmental Policy Act (NEPA);
4. Design Documents; and
5. Construction.

These next steps include more detailed feasibility of specific improvements and programs. Physical constraints and opportunities and detailed estimates of transportation and land use impacts must be identified. Following feasibility, environmental review and documentation may be necessary to progress project development to a design and construction phase.

5.2 Recommendations

The evaluation results have indicated that there is no single solution for mitigating congestion in the study area. Transportation and land use strategies must be coordinated to form a comprehensive transportation system that includes immediate, mid-term and long-term actions. These actions include: improving the efficiency, operation and safety of existing transportation systems; better managing the demand for travel; and increasing the supply for transport services. Ultimately, these recommendations serve to address the goals established by this study. Meeting mobility needs and providing options to customers are paramount to success. Establishing land use policies that focus on centers rather that continued sprawl will lead to better overall system performance.

A transportation system that offers fast, convenient and affordable options to customers and provides long-term capacity necessary for growth will provide southwestern Connecticut with the framework to compete competitively in the emerging global marketplace.

5.2.1 Immediate Actions (Foundation)

Immediate actions focus on examining ways to improve upon existing programs and establish a foundation for evaluation, implementation and monitoring of the Vision. Immediate actions are intended to take place in a zero to two year timeframe. The actions are as follows:

Public Education

Education must be an ongoing process to inform the public and decision makers of the benefits and costs of transportation strategies. In addition, the importance of the transportation and land use connection needs to be emphasized to local and state officials. Implementation needs to be consensus driven and broad-based support needs to be attained. SWRPA should continue to engage various media outlets to keep awareness of transportation issues on the forefront, and continue to work with state and local officials to gain additional support and funding for transportation improvements.

Land Use Review

Local land use boards should begin to review master plans and plans of conservation and development to identify how transportation is supported by local zoning regulations. Municipalities should coordinate with the regional planning organizations to discuss how changes can be made to local policy to support elements of the Vision.

SWRPA should conduct a detailed land use study to evaluate potential for additional transportation corridor and transit-oriented development in the study area. At a minimum, this study should analyze existing zoning regulations and master plans of development, identify realistic potential for growth, and recommend development densities and land use mixes capable of supporting a range of travel options.

Expand Travel Demand Management Programs

Travel Demand Management (TDM) programs should be expanded to help reduce the number of peak-period single occupant automobile trips in the study area. A number of strategies have been identified in the Vision to encourage work schedule changes, shorter trip making and ridesharing. It is recommended that continued efforts to implement, market and monitor TDM strategies be stressed. TDM strategies that focus on providing incentives to modify travel behavior are preferred to those that penalize. Examples of programs that can have an impact on peak period trips are as follows:

- Telecommuting;
- Flexible Work Weeks;
- Staggered Work Hours;
- Organized Vanpools; and
- Voluntary Distance Based Pricing.

SWRPA – in partnership with ConnDOT and transportation management organizations – should study the performance of existing TDM programs. This study should assess the effectiveness of current outreach and marketing strategies, develop creative strategies for altering traveler behavior, calculate the total cost of removing single-occupant vehicles from roadways during peak periods and identify methods that may be implemented to more closely track TDM program participation and monitor program performance.

5.2.2 Short-Term Actions (Incremental)

The short-term actions are intended to further evaluate and implement improvements over a two to seven year period to enhance the existing transport system and better manage transport demand in the study area. These improvements do not involve significant expansion in transport services, but can help to alleviate localized constraints and improve safety incrementally. These improvements are as follows:

Transit Operational Improvements

1. There is an immediate need for additional parking at Metro North rail stations. Providing additional spaces will increase the convenience of using the train for both intra- and interstate customers. In general, all stations should include provisions for additional parking capacity, but significant expansion should be targeted at the following locations:

    - South Norwalk;
    - Noroton Heights;
    - Stamford; and
    - Greenwich.

    SWRPA should continue to work with local municipalities to explore opportunities to expand parking capacity at rail stations. Landscape architects should be employed to help chief elected officials and the public envision parking structures that do not detract, but enhance community character. Stated preference surveys can be helpful in determining the expected impact that increased parking has on rail ridership.

2. Intelligent Transportation Systems (ITS) should be used to improve the efficiency and operation of existing bus service in the corridor. Automatic Vehicle Location (AVL) and Electronic Fare Collection will make bus trips more convenient for customers and reduce overall travel times. These technologies will also provide saving to transit agencies by improving operations, automating transactions and optimizing fleet management.

    In addition, Weigh-In-Motion technology should be evaluated for use at the Greenwich weigh station. This strategy can provide savings for both the state and the trucking industry.

    SWRPA should evaluate current ITS technologies for applicability in the study area. Pilot programs can be established to test the impacts to bus operations and truck weight limit enforcement.

3. Reducing rail fare and parking costs for intrastate customers can achieve significant benefits by making rail trips more affordable. Providing free transfers between local bus and rail connections would make intrastate travel by transit a more viable alternative to automobile travel.

    SWRPA should engage Metro North and ConnDOT in discussions about intrastate rail pricing. SWRPA should continue to build upon the positive discussions facilitated by the Vision 2020 study and look for opportunities to implement pilot programs to test market response to reduced intrastate fares.

4. Implementation of a universal commuter pass, such as a SmartCard, can make transit trips more attractive from a convenience perspective. A universal commuter pass could be designed to enable commuters to use a single fare medium to pay for a full range of transport services including bus, rail and parking and to seamlessly transfer among service providers. Use of SmartCard technology also would facilitate implementation of pricing programs such as value pricing of transit services.

    ConnDOT has expressed an interest in using a universal commuter pass to simplify use of transit services. SWRPA should continue to market the results of its Regional Transit Card Implementation Study to ConnDOT and transit providers. SWRPA should also continue to pursue the recommendations contained in the "Next Steps" section of the Transit Card Study.

5. Establishing intermodal hubs with strong bicycle and pedestrian connectivity is essential to both strengthening urban revitalization efforts as well as making transit a competitive alternative. Transit cannot reach its full potential unless significant density exists to support it. Urban centers in southwestern Connecticut have the opportunity to embrace development practices that favor high density and mixed land use clustering around rail stations. The stations themselves should be upgraded where appropriate to become highly visible and accessible nodes for the collection and transfer of transit customers. Station areas should include safe and direct bicycle and pedestrian facilities to facilitate access by non-motorized modes of transport. In addition, ITS technology should by available to keep passengers informed of schedules and other pertinent transit information. Major hubs should be developed at the following locations:

    - New Haven State Street Train Station
    - Bridgeport Train Station
    - South Norwalk Train Station
    - Stamford Train Station
    - Danbury Train Station
    - Derby Train Station

   SWRPA should continue to work with municipalities, transit agencies and the state bicycle and pedestrian coordinator to improve bicycle and pedestrian facilities and amenities in and around transit hubs and on transit vehicles. Improved connectivity is essentially to strengthening hubs and providing a foundation for traditional neighborhood and transit oriented development. The other critical element to the hub concept is ensuring that frequent connections to rail and bus service are offered and stations are attractive and highly visible. The long term growth of transit and cluster development is predicated on strong connections.

I-95 Operational Improvements

Along I-95, numerous deficiencies were identified relating to the spacing and operations of interchange ramps. Improvements to deficient locations would focus mainly on safety and operations. While improvements to several segments of I-95 in the study area are ongoing, the greatest remaining need for improvement exists between Interchange 6 in Stamford and Interchange 16 in Norwalk. The congestion along this segment of I-95 was measured to be the worst in the corridor.

To properly evaluate the feasibility of such improvements, the physical improvements need to be conceptually engineered. The practical considerations of construction, maintenance of traffic, right of way and environmental impact would need to be addressed in greater detail. Additional evaluation of these interchange locations should be conducted to determine specific project feasibility. Future evaluation should consider the following:

- Safety and operational improvements at specific interchanges;
- Additional operational lanes;
- Geometric modifications of entrance and exit ramps;
- Consolidation of interchanges;
- Horizontal and vertical alignment modifications;

- Ramp metering or peak period ramp closures;
- Increased ramp spacing; and
- Deployment of additional ITS technology.

SWRPA should seek funding for a detailed operational study of I-95 between Stamford and Norwalk. Environmental and social impacts should be considered. Preliminary engineering should be performed to estimate alignment options and costs. Improvement to this section of I-95 can reduce localized congestion and improve safety.

Traffic Systems Management (TSM)

Improvements to the safety and operation of major arterial roads in the study corridor can reduce congestions and decrease accidents. These strategies do not generally include increases in roadway capacity, but instead maximize the efficiency of existing capacity with location specific improvements. Some of the techniques that could be used include:

- Signal timing and coordination;
- Access management; and
- Operational improvements – i.e. turn lanes, shoulders, geometric modification.

Specifically, the Route 1 corridor from New Haven to Greenwich should be targeted for TSM improvements. Continued evaluation and implementation of signal coordination can offer substantial benefits in terms of travel time savings, emissions reductions and accident reduction. Intersections that experience above average accident rates or poor Levels of Service should be prioritized for improvement. Design modification should be considered for intersections and segments of Route 1 that are currently substandard from an operational or safety perspective. In addition, access management practices should be applied to segments of Route 1 that exhibit congestion due to high frequencies of driveways and poor site access planning.

SWRPA should coordinate with ConnDOT to identify intersections on Route 1 that could be improved through signal coordination or operational modification. SWRPA should encourage municipalities to incorporate access management practices when approving new development or revising existing site plans. SWPRA should engage ConnDOT on discussions to allow member representation on the State Traffic Commission when regional impacts resulting from development is concerned.

Truck Parking at Rest Area

The current demand for truck parking at rest areas far exceeds supply. The spillover of trucks onto highway lanes and ramps creates significant safety issues along the I-95 corridor. Efforts to evaluate the future capacity needs for truck parking should be supported.

SWRPA should assist ConnDOT with efforts to expand existing rest areas while minimize impacts to communities. Opportunities for new rest areas should be explored.

Changes to Zoning Regulations

SWRPA should work with municipalities to structure zoning regulations to embrace transit friendly development, walkable communities, increased density and mixing of land uses, reduced parking requirements, and access management along transportation corridors and in town centers.

5.2.3 Long-Term Actions (Vision)

Long-term actions include the visionary elements of this study. They involve long range efforts to increase system capacity that is complementary with study goals and expandable to meet future needs. Long-term actions would likely take place in a seven to twenty year period due to the variability in state and federal processes required for project implementation.

Transit Capacity Expansion

SWRPA should advance transit system expansion as a necessary strategy to meet future demand for transportation mobility. Providing fast, comfortable and affordable service can penetrate the intrastate market and help shape land use policy that favors centers over sprawl. A detailed implementation study is recommended to determine how new rail transit services could be integrated into the existing Metro North schedules. In addition, Bus Rapid Transit should be tested for practicality along the Route 1 corridor from New Haven to Greenwich. The success of the Coastal Link service and the relative strength of the Vision indicate potential for improved interregional bus service. By providing improved transit along the coastal corridors, opportunities to reach inland with improved rail and BRT services will become available. Establishing a strong trunk system is the necessary first step to creating a sustainable regional transit vision. Key elements are as follows:

1. Improving Metro North service for intrastate customers would serve a growing market that is largely unmet. Capitalizing on the Hub Express and New Haven Line Local concepts of the Vision would make intrastate rail travel faster, more convenient and less expensive for commuters. The Hub Express has the greatest potential for success, both in the peak periods as well as the off-peak periods of the day. Fast and frequent service between major intermodal hubs can help support urban revitalization efforts and serve a large number of existing employment centers.

2. Bus Rapid Transit (BRT) opportunities should be explored to offer high end bus service that is both flexible and fast. BRT should, to the extent possible, have preferential treatment that provides travel time advantages to buses over cars. In some locations preferential treatment would require exclusive lanes on roads and highways, while in more heavily developed areas signal prioritization can be used to give buses an advantage.

   Specifically, BRT should be explored as a high priority for the Route 1 corridor. The high concentrations of population and employment along this corridor require the flexibility that bus transit can offer. Where additional widening can be accommodated or on-street parking reduced, exclusive bus lanes should be constructed. In more heavily developed areas where widening is not an option, signal priority should be considered at intersections. BRT can provide enhanced mobility for existing bus riders and attract new customers by providing a competitive alternative to automobile transport.

3. Danbury Branch Service should be evaluated further to determine the feasibility of enhanced rail service along this corridor. Perhaps the greatest challenge to providing fast and reliable service in this corridor is in constructing dual tracks. Although the forecasted ridership is significantly less than that of the New Haven Line, the Danbury Local Service can provide a strong inland connection to a growing market.

4. Inland BRT services should be evaluated once the successful implementation of the Route 1 service is attained. Good north-south connections are an essential component to the Vision in terms of providing enhanced mobility and accessibility.

I-95 Capacity Expansion

The expansion of I-95 to include two additional lanes should be considered as a strategy to help alleviate congestion along the corridor. These lanes should be managed through pricing to optimize performance and encourage ridesharing. The managed lanes represent a creative approach to improving the I-95 corridor. Making them become a reality will require careful study to assess their physical and operation feasibility. Key issues such as providing conflict-free access to and from the lanes must be addressed in greater detail. These lanes will likely require major structural modifications to many bridges over I-95.

SWRPA should pursue the managed lanes strategy of the Vision as the preferred configuration for expansion. Providing value priced reversible lanes can offer opportunities to encourage ridesharing, enhance transit, improve vehicular flow, offer travel time savings and generate revenues. The uses for these lanes are flexible and expandable through pricing. SWRPA should seek funding for additional study of how value pricing can be used to manage traffic on the I-95 corridor as well as on other corridors in the state.

Addition of lanes for general purpose use is not recommended.

5.2.4 Support for Other Strategies

Although not formally evaluated as part of the Vision 2020 Study, other strategies exist that can have a significant impact on future transport needs in southwestern Connecticut. These strategies were excluded either because they formed a connection with regions that are external to the defined study area or are being evaluated as part of a more detailed study. SWRPA should continue to be involved with these issues to determine potential synergy with the Vision. Other strategies needing continued monitoring are as follows:

Interstate Rail

More that eighty percent of rail trips in southwestern Connecticut are interstate. The heavy attraction to the New York market and high costs associated with automobile use make rail transit a highly competitive alternative along the coastal corridor. Improvements to this service including fleet configuration, infrastructure upgrades and service upgrades should be coordinated with intrastate service improvements so that optimum system performance can be achieved.

Freight

Since a majority of freight moves into and through southwestern Connecticut by truck, efforts should be made to explore opportunities to utilize alternate modes to reduce truck traffic. Several constraints currently exist to providing more rail freight service, not the least of which is economics, however continued assessment of alternate freight possibilities should be undertaken. Opportunities for improved freight service are tied to the following issues:

- Need for another lower Hudson River crossing to access New York City and Connecticut,
- A rail capacity study similar to the Mid-Atlantic Rail Study to determine the actual track capacity due to passenger and freight rail services and schedules, and
- Market analysis of the viability of Feeder Barge Service from intermodal ports in New Jersey to a deep water port in Connecticut.

Ferry

Passenger ferry service may offer some opportunities for additional transit connections between Connecticut ports, Long Island's North Shore, lower Manhattan and LaGuardia Airport. SWRPA should continue to monitor the results of the Long Island Sound Waterborne Transportation Plan and other studies of potential interstate passenger ferry services.

Airport Connections

Opportunities for improving transit connections between southwestern Connecticut and regional airports should be examined. Connections to Bradley International, J. F. Kennedy International, LaGuardia, Newark and Westchester County airports should be included in any evaluation of airport connections.

Route 7

Plans to widen Route 7 to a four-lane arterial with full roadside access from Wilton to Danbury should be supported. Plans should incorporate ITS, where appropriate, to further improve the safety and operation of the roadway and to support use of priority signal treatments for transit.

Interstate 84

Plans to widen I-84 from Danbury to Southington should be supported. The existing configuration of two lanes in each direction contributes to significant delay and safety issues, especially during inclement weather. In addition, I-84 is a route heavily traveled by trucks. The rolling terrain in the corridor contributes to significant grade issues along the highway, which trucks must overcome. The slowing of these trucks to climb hills creates turbulence in the traffic flow and often conflicts with higher speed vehicles.

Merritt Parkway

Although the Merritt Parkway was not evaluated as part of the Vision, it is recommended that SWRPA evaluate this roadway and its interchanges for safety and operational deficiencies. Such evaluation should include a study of opportunities for improved emergency access and response and use of ITS to further improve the safety and operations of the roadway.

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