Chapter 8
Financing Needs and Next Steps

In Chapter 6, the capital and operating costs for the implementation of both the Start-up Service Recommended Action and a future Full-build on the New Haven to Springfield Line were identified. A major component of implementing the service is the identification of sources for these capital and operating costs. In this chapter, the financing needs and potential sources are discussed, as well as other necessary next steps to implementation.

8.1 Implementation Next Steps

The purpose of this study is to develop an implementation plan for commuter rail service between New Haven, Connecticut and Springfield, Massachusetts. The next steps needed to pursue the recommended Start-up Service implementation plan would include:

1. **Develop a funding plan** – The funding and financing of the service are the most controversial issues remaining before implementation given the current Connecticut and federal fiscal situation. Section 8.2 presents the timeline required for future funding. Section 8.4 gives further information about federal funding options available.

2. **Complete the environmental process outlined in the Connecticut (CEPA) and National Environmental Policy Act (NEPA)** – This process must be undertaken by the State of Connecticut with Federal Transit Administration (FTA) guidance before service can begin. This is a key to obtaining any federal funding for the project as well. Further details about the environmental documentation likely required are available in Section 8.3 of this report.

3. **Complete preliminary design** – This report gives conceptual station plans and double track section locations necessary for the development of cost estimates for future funding. The next stage in implementation of service will require refinements of these plans to the preliminary design level (10% design), including exact locations for station platforms, station parking, new

track and maintenance facilities. This is typically done in conjunction with the environmental process.

4. **Make necessary refinements to the operating plan** – Based upon the results of the preliminary design and environmental process, refinements should be made to the overall operating plan outlined in this document.

5. **Execute operating agreements** – As the State of Connecticut does not currently own the track over which the service would operate, preliminary operating agreements with Amtrak, other commuter rail operators (as needed), freight operators, and transit operators should be executed early in the process to ensure buy-in for the service before capital funds are expended.

6. **Complete final design and property acquisition** – The final design of stations, double track sections, bridges and the maintenance facility should be undertaken simultaneously with the necessary acquisition of property for these facilities (anticipated to be required only for station parking and the maintenance facility).

7. **Procure rolling stock** – The decision as to the type of rolling stock that best fits this service will be a key aspect of the implementation. Section 8.6 of this report gives guidelines on the positive and negative aspects of self-propelled rail car trains compared to traditional locomotive-hauled push-pull coach trains. The procurement of rolling stock for the service requires substantial turn-around time due to the fact that rail equipment is made to order.

8. **Hire an operator** – Although Amtrak currently owns the line between New Haven and Springfield, there are a number of possible operators for the future service. Section 8.5 discusses potential operators for the service in greater detail.

9. **Construct new facilities** – This involves the construction of station areas (including parking and platforms), new track segments (including track, interlockings, signals and bridges), and maintenance facilities.

10. **System testing** – As a final step to opening the system, final debugging modifications and improvements are made prior to start-up. This includes checks of the rolling stock, stations, track and signal improvements, and all other elements of the project to ensure all components are working correctly prior to commencement of revenue service.

8.2 Funding Requirements and Timeline

For the Start-up Service Recommended Action, the timeline associated with the next steps listed above is shown in Table 8-1 and a breakdown of the capital cost requirements by timeline component is shown in Table 8-2.

Table 8-1
Start-up Service Recommended Action Timeline

Activity/Year	2005	2006	2007	2008	2009	2010	2011
Legislative Funding & Authorization							
Environmental Assessment							
Preliminary Design							
Operating Agreements							
Final Design							
Property Acquisition							
Equipment Procurement							
Advertise & Award Operator Contract							
Advertise & Award Construction Bids							
Construction							
System Testing							
	2005	2006	2007	2008	2009	2010	2011

Table 8-2
Start-up Service Recommended Action Capital Costs by Time Component

Element	Design and Construction Inspection	Property Acquisition	Equipment Procurement	Construction
Train Equipment	--	--	$70,140,000	--
Maintenance facility	$2,622,000	$7,800,000	--	$10,274,000
Station Areas	$15,980,000	$3,621,000	--	$61,365,000
Double Track	$4,335,000	--	--	$28,900,000
Bridges	$84,000	--	--	$421,000
New Connecting Buses	--	--	3,600,000	--
Amtrak Flagmen	--	--	--	2,500,000
Subtotal	$23,021,000	$11,421,000	$73,740,000	$103,460,000
Contingency (40%)	$9,209,000	$4,568,000	$29,496,000	$41,384,000
Total	$32,230,000	$15,989,000	$103,236,000	$144,844,000
Time funding required	Winter 2007	Winter 2007	Winter 2007	Fall 2008

8.2.1 State Division of Funding

One major issue associated with the New Haven, Hartford, Springfield Commuter Rail service is the allocation of capital and operating costs between the two states which benefit from the service. The Connecticut-Massachusetts state line occurs at MP 55.8 of the 62-mile corridor. Therefore, 10% of the line is within Massachusetts. Some of the capital costs for the project are attributed to one state or the other, while others are used over the entire line. All of the line in Massachusetts is currently double-tracked, meaning all new double-track will be constructed in Connecticut. Station area costs are attributed to the specific station at which they occur, meaning Springfield Station costs can be attributed to Massachusetts. New connecting buses would be required only in Connecticut. Other costs, such as train equipment and maintenance facilities can be divided based on 10% of the track length. An outline of the possible division of capital costs is shown in Table 8-3.

Table 8-3
Start-up Service Recommended Action Capital Costs by State

Element		Connecticut	Massachusetts
Train Equipment		$63,126,000	$7,014,000
Maintenance facility		$18,626,000	$2,070,000
Stations		$69,741,000	$11,225,000
Double Track		$33,235,000	--
Bridges		$505,000	--
New Connecting Buses		$3,600,000	--
Amtrak Flagmen		$2,500,000	--
Subtotal		**$191,333,000**	**$20,309,000**
Contingency	40%	$76,533,000	$8,124,000
Total		**$267,866,000**	**$28,433,000**

The division of operating costs could be handled similarly to the train equipment and maintenance facility costs outlined above, resulting in a 90% / 10% split of operating costs between Connecticut and Massachusetts. Alternatives for the division of operating costs include basing the formula on the morning boardings or passenger miles. This issue would be the subject of negotiations between the two states as the project continues into the next phase.

8.3 NEPA Documentation

Based on the environmental impact evaluations prepared for this feasibility study, there are relatively few adverse environmental impacts from the project and they are minor impacts. This outcome has largely resulted from locating the proposed commuter rail within an existing rail corridor and avoiding significant resources in the placement of stations. There are broad transportation benefits of the project, the project has substantial public support, and the project is not expected to be highly controversial. As the project

goes forward, the Federal Transit Administration (FTA), as a potential funding source, will evaluate the project for impacts which might be potentially significant and then decide what type of environmental document is appropriate to comply with NEPA. While there are procedural as well as technical considerations for FTA, the magnitude of impacts identified through this study indicate that extensive and/or detailed impact studies at the level of an Environmental Impact Statement (EIS) would not be necessary for this project and that an Environmental Assessment (EA) would adequately address the project's potential minor impacts.

8.4 Funding Plan

It is very useful to understand the difference between "funding and "financing." Funding is the primary stream of revenue used to offset cost or to support various leveraging options. Finance is the means by which the primary revenue streams are manipulated to make funds available when needed or to reduce the costs of borrowing. By way of illustration, in the case of bonds issued against revenues from a tax dedicated to transit use, the revenue stream from the tax pledged as security for the bonds would be the "funding." The bond proceeds, which concentrate the long-term tax revenues into several years to meet construction expense, would be the "financing." This section will examine the potential funding sources for the start-up service.

The largest source of funding for any commuter rail/regional rail transit improvement would be the FTA Section 5309 New Starts program. While certainly not impossible, securing significant federal capital support could be very difficult. The competition for New Starts funding is intense with the political support for a project often being more important than its technical merit. Connecticut is already pursuing New Starts funding for the New Britain to Hartford Busway.

As part of the New Starts process, FTA utilizes the Summit program on the travel demand forecasting model being used for ridership projections to determine user benefits attributed to the project. With previous projects, the format of the ConnDOT model made running the Summit program inaccurate. Therefore, substantial revisions to the ConnDOT model would be required in order to run the program. Alternatively, the three regional travel demand forecasting models, those of the Capital Region Council of Governments, the South Central Regional Council of Governments, and the Pioneer Valley Planning Commission, could be used in combination, creating either one larger corridor model or obtaining results from all three by town and combining the results. In any case, this continued effort at travel demand forecasting would be costly and would not guarantee New Starts funds.

Potential funding sources can come from both the public and private sectors and from federal, state and local sources. This section describes several of the federal sources available.

8.4.1 Primary Federal Funding Options

The Transportation Equity Act for the 21st Century (TEA-21) authorized federal transportation funding levels over a six-year period beginning in federal fiscal year 1998. Funds included both formula and grant funding to be used at the discretion of States and Metropolitan Planning Organizations (MPO).

Beyond earmarked funds, there are formula funds for highways, transit, and "flexible funds" which can be spent on a variety of transportation-related projects, including public roads and sidewalks, transit capital projects, and transportation enhancements, which encompass a broad range of environmentally related activities. Much of this funding is anticipated by State and local transportation departments and is likely to be committed to other projects.

Since the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, the US Department of Transportation has permitted States wide discretion in assigning portions of "conventional" highway funds to the flexible funding pool, thus widening the funds potentially available for transit projects. Legislation currently pending in Congress would continue these provisions of ISTEA and TEA-21. The following paragraphs describe the current federal funding programs available for transit projects. It should be noted that TEA-21 is up for reauthorization, and the list of eligible federal funding sources may change.

- ***Section 5307 Urbanized Area Formula Program*** – Formerly known as the Section 9 program, the urbanized area formula program provides funding to all areas with populations of over 50,000 to be used for locally determined capital projects and transportation-related planning. The amount made available to the Urbanized Area Formula Program (49 U.S.C. 5307) by the FY 2004 DOT Appropriations Act was $3.4 billion.

  The Metropolitan Planning Organization (MPO) in each area annually approves a program of projects that plans for the distribution of Section 5307 funds for various capital projects. Funds are not necessarily distributed to transit agencies on the basis of their service data and the amount of funds brought to the area by that service data. Each grantee must submit a grant application for those projects included in the Program of Projects. Regional rail capital costs are eligible for these funds. Section 5307 funds used for operating assistance is now restricted to urbanized areas of under 200,000 people.

- ***Section 5309 New Start Program*** – The term "New Start" is used to mean a project that involves building a new fixed guideway system, or extending an existing fixed guideway. The new start can be a vintage streetcar, light rail line, heavy rail rapid transit, commuter rail, people-mover, or busway. Also, new start projects can involve the development of transit corridors and markets to support the eventual construction of fixed guideway systems, including the construction of park-and-ride lots and the purchase of land to protect future rights-of-way. The amount made available for New Starts projects in the FY 2004 DOT Appropriations Act was $1.3

billion. Projects can receive up to 80 percent of eligible project costs from the FTA. However, current guidance and practice limits this funding to about 50 percent federal share.

In order to receive new start funds, projects should be authorized by TEA-21 or any subsequent authorizing act. Annual appropriations legislation then allocates available funding in specific amounts to specific projects. In order to receive new start funds, projects must first be rated by the FTA in accordance with criteria for ranking and evaluating new start projects. Such recommendations are included in the Annual Report on New Starts submitted to Congress in the spring of each year along with the President's budget request. FTA manages new start projects in four recognized phases: 1) Systems Planning 2) Preliminary Engineering 3) Final Design 4) Construction. FTA has extensive guidance regarding the requirements of each phase.

Projects of less than $50 million for total construction may qualify for a ***Small Starts*** funding within the New Starts program. Projects must be cost effective, per the New Starts criteria, but are freed from much of the onerous New Starts evaluation process. With reauthorization of TEA-21, the limit may rise to $75 million for total construction[10].

- ***Section 5311 Non-Urbanized Area Formula Program*** – The Non-urbanized Area Formula Program provides capital, operating and administrative assistance for public transportation in areas under 50,000 in population. Each State must spend no less than 15 percent of its FY 2004 Non-Urbanized Area Formula apportionment for the development and support of intercity bus transportation, unless the Governor certifies to the U.S. Secretary of Transportation that the intercity bus service needs of the State are being adequately met. The FY 2004 apportionment was $238 million.

8.4.2 Flexible Federal Highway Funding

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) created opportunities for certain categories of funds to be transferred between highway and transit projects according to State, regional / local discretion and priorities. This flexibility was enhanced further through TEA-21. Highway funds transferred to transit have been used to fund a variety of improvements such as construction and rehabilitation of rail stations, maintenance facility renovations, rolling stock procurements, and development of multi-modal transportation centers. Since 1991, nearly $5 billion in flexible funds have been transferred. Over the life of TEA-21, over $100 billion of highway funds could potentially have been used to finance qualifying transit projects.

FHWA funds designated for use in transit capital projects must be derived from the metropolitan and statewide planning and programming process, and must be included in

[10] The Bush Administration has proposed legislation that would allow the Small Starts projects to be increase to $75 million, but a "streamlined" FTA evaluation process would be put in place to determine which Small Start projects should be financed.

an approved Statewide Transportation Improvement Program (STIP) before the funds can be transferred. The State DOT requests, by letter, the transfer of highway funds for a transit project to the FHWA Division Office. The letter should specify the project, amount to be transferred, apportionment year, State, federal aid apportionment category (i.e. Surface Transportation Program (STP), Congestion Mitigation and Air Quality (CMAQ), or congressional earmark), and a description of the project as contained in the STIP.

Transferred funds are treated as FTA formula funds, but are assigned a distinct identifying code for tracking purposes. The funds may be used for any capital purpose eligible under the FTA formula program to which they are transferred and in the case of CMAQ for certain operating costs. FTA and FHWA have issued guidance on project eligibility under the CMAQ program in a Notice at 65 FR 9040 et seq. (February 23, 2000). In accordance with 23 U.S.C. 104(k), all FTA requirements are applicable to transferred funds except local share – FHWA local share requirements apply. Transferred funds should be combined with regular FTA funds in a single annual grant application.

Other FHWA programs are flexible as well. Under certain circumstances, National Highway System (NHS) funds may be used to fund transit improvements in NHS corridors. Interstate Substitute Funds continue to be eligible for transit use.

- ***Surface Transportation Program (STP)*** – STP is the largest Federal Highway Administration (FHWA) flexible funding program. Funds may be used for all projects eligible for funding under current FTA programs, excluding Sections 5307 and 5311 operating assistance. A portion of STP funds available to each State is sub-allocated to urbanized areas that are programmed at the regional level. States use the balance of STP funds on a statewide level. Each State must use 10 percent of their STP funds for transportation enhancements such as bike and pedestrian facilities, scenic easements, and historic preservation projects. Certain rail projects are eligible to be funded as enhancements, such as rehabilitation and operation of historic transportation buildings and facilities.
- ***Congestion Mitigation and Air Quality Improvement Program (CMAQ)*** – Funds available through the CMAQ program are used to support transportation projects in air quality non-attainment areas. A CMAQ project must contribute to the national ambient air quality standards by reducing pollutant emissions from transportation sources.

8.4.3 Other Federal Funding Options

- ***Railroad Rehabilitation and Improvement Financing (RRIF) Program*** – The Railroad Rehabilitation and Improvement Financing (RRIF) Program enables the Federal Railroad Administration (FRA) to provide loans and loan guarantees for railroad capital projects, including freight railroads, State and local passenger and commuter railroads, and Amtrak. RRIF authorizes $3.5 billion, on a revolving basis, in direct federal loans and /or loan guarantees. Loans can have a term of 25 years with an interest rate that is essentially the cost of money to the federal government. RRIF loans are for railroad purposes only, but can be used for almost

any rail purpose. There are no specific dollar thresholds. RRIF loans must be accompanied by a "credit risk premium", i.e. a premium payment that insures the Government against default. Pursuant to TEA 21, Congress can appropriate funds to cover this credit risk premium, or the applicant or a private or governmental partner may provide such funds.

As Congress has not appropriated funds to cover the credit risk premium, it is up to each applicant to provide or obtain such funds. Obviously, the size of the premiums will be critical to the workability of the program. The Secretary of Transportation, in consultation with the Congressional Budget Office and the White House Office of Management and Budget (OMB), will determine the amount required for the premium. Many factors will be taken into consideration including credit worthiness of the applicant, collateral offered, or experience of other borrowers. It is expected that a credit risk of about 5 percent will be required.

- ***Section 130 Grade Crossing Program*** – TEA 21 requires each State to use 10 percent of the funds apportioned each year under the Surface Transportation Program (STP) to be used for carrying out rail-highway crossing and hazard elimination activities. Under the Section 130 grade crossing program, each State is required to identify crossing needs within the State and establish and implement a schedule of projects to meet those needs. This is the primary source of funding for crossing improvements. The 10 percent set aside represents the minimum amount of federal funding available for highway safety. Other federal highway programs may also be used for grade crossing projects, including additional amounts of STP funds. Private grade crossings currently are not eligible for Section 130 funds. Although the Section 130 program is set at a 90 percent federal share, States have the discretion to waive the non-federal match for most Section 130 projects. Because motorists are the primary beneficiaries of grade crossing projects, federal regulations prohibit States from requiring a railroad contribution toward the cost of Section 130 projects. However, railroads often will make voluntary contributions.

- ***Job Access and Reverse Commute Grants*** – A new federal funding source was created to increase access to jobs for low-income workers. This program is authorized to receive up to $150 million per year in FY 1999-2003, with 20 percent of the grant going to urbanized areas with less than one million people. The FY 2004 apportionment was $104 million. Up to $10 million per year can go to reverse commute projects, defined as transportation to suburban job opportunities. Funds from non-DOT Federal programs can be used to pay for the local match, which is 50 percent. The program offers discretionary grants for transportation to qualified low-income individuals. Funds can be provided for capital, operating and maintenance expenses, for promoting transit use by workers with non-traditional work hours, for promoting the use of transit vouchers by appropriate agencies, and for promoting the use of employer-provided transportation and transit pass benefits.

- ***TIFIA Financing*** – The Transportation Infrastructure Finance and Innovation Act of 1998 (TIFIA). The program established a new federal credit program called TIFIA under which the U.S. Department of Transportation may provide three forms of credit assistance secured (direct) loans, loan guarantees, and standby lines of

credit – for surface transportation projects of national or regional significance. Transit projects are eligible. A project's eligible costs, as defined under 23 U.S.C 181, must be reasonably anticipated to total at least $100 million, or alternatively, equal 50 percent or more of the state's federal-aid highway apportionments for the most recently completed fiscal year, whichever is less.

- ***DMU Demonstration Grant*** – In 2004, the FRA began an advanced-technology DMU demonstration project with the Florida DOT for revenue service between Miami and West Palm Beach as part of the Next Generation High-Speed Rail Technology program. The first DMU is already in service, with additional cars currently being manufactured by Colorado Railcar to begin service in 2005. The purpose of the demonstration was to determine the current availability of DMUs which comply with FRA safety requirements for operation on track shared with freight and conventional passenger trains and the suitability of this equipment for regularly scheduled revenue service in the United States. Although this particular demonstration project is underway, the federal government may re-solicit interest in demonstrating this technology from time to time.

8.5 Operator Comparison

In order to understand better the advantages and disadvantages of hiring various entities for the operation and equipment maintenance of the new commuter rail service, the consultant team contacted five public agencies that sponsor commuter rail services. These agencies employ operators as varied as (1) Amtrak, (2) private rail operating companies like Herzog Transit Services and Connex which specialize in providing commuter rail operating and maintenance services, and (3) Metro North.

The contacted agencies using Amtrak are Southern California Regional Rail Authority (SCRRA), sponsor of the Metrolink commuter service in the Los Angeles area; North County Transit District (NCTD), sponsor of The Coaster commuter rail service in the San Diego area; and the Peninsula Corridor Joint Powers Board (PCJPB), sponsor of the Caltrain commuter rail service in the San Francisco Bay Area.

The contacted agency using Herzog is the San Joaquin Regional Rail Commission (SJRRC), sponsor of the Altamont Commuter Express (ACE) commuter service between Stockton and San Jose, California.

The Connecticut Department of Transportation (ConnDOT) Bureau of Public Transport was contacted for insight on Metro North which provides the commuter service on ConnDOT's New Haven Line. SCRRA also offered comments on Connex, which will begin providing commuter rail services for Metrolink in 2005, replacing Amtrak as the operator.

All the agencies were asked for their insights on the advantages and disadvantages of using their respective operators. The comments are summarized in Table 8-4. Generally

speaking, Amtrak and Metro North offer the advantages of leveraging their sizable pool of labor for train operations and maintenance. Amtrak costs specifically tend to be lower, as commuter rail staffers are incremental to intercity staff and do not trigger any major expansion of overhead expenses.

Table 8-4
Operator Comparison

Operator	Advantages	Disadvantages
Amtrak	- National experience in commuter rail operations - Deep reserve of labor for operations and maintenance - Trained to Class 1 railroad standards - Incremental costing - Established Labor Relations Department dealing regularly with rail unions - Economies of scale in purchasing train parts and supplies	- Inefficient work rules - Inflexibility on liability insurance - Fate tied to the annual Congressional budget process - Centralization puts commuter rail operations at risk: if Amtrak does not get the federal and state dollars it needs for intercity services, it may cut back on offering services for regional commuter operations as a way to pare costs
Private Contract Operator, e.g. Herzog and Connex	- "Tailored" operation - Flexibility in labor deployment: workers tend to be cross trained	- Potentially higher cost than Amtrak
Metro North	- Deep reserve of labor, more than Amtrak in Connecticut - Trained to Class 1 railroad standards - Established Labor Relations Department - Economies of scale in purchasing	- Inefficient work rules - Higher costs than Amtrak

In contrast, private operators can more easily "tailor" or customize their operations to the circumstances of the commuter rail operation. Whereas with Amtrak, commuter rail operations for one agency may largely mirror how Amtrak works elsewhere. Furthermore, private operators are not as tied to strict work rules as are Amtrak and Metro North, as workers may not be represented by the traditional rail unions At ACE, Herzog employees are represented by the Carpenters Union, the largest labor union in California. Under their contract, Herzog workers can be cross trained to fulfill various

roles, as needed. For example, a clerk on ACE can serve as a conductor today. Amtrak and Metro North workers cannot do the same. The potential for providing tailored operations and workforce flexibility can mitigate potential higher costs versus Amtrak.

Table 8-4 compares Amtrak, private companies, and Metro North as potential operators of a "stand alone" commuter rail service, with its own equipment and maintenance facilities. However, if the service were to be fully integrated with existing Amtrak services on the New Haven-Hartford-Springfield line (sharing the same work forces and type of rolling stock), there is a clear advantage of employing Amtrak as the operator. This is that Amtrak as the operator would be disposed to seeking ways to better utilize crews and equipment than if it were not the operator. The bottom line for the commuter rail sponsor would be consequently lower capital and operating costs for an integrated service versus a stand alone service operated by Amtrak or anyone else.

8.6 Rolling Stock Procurement

The procurement of rolling stock for the corridor is a process that requires a significant amount of lead time and as such, should begin as soon as funding is identified. This section outlines potential equipment for the start-up service.

The analysis is limited to the six consists making a total of 16 daily local ConnDOT trips. As discussed in previous sections, combining Amtrak and ConnDOT equipment would provide some efficiencies. The forecast seating requirement is 180 seats per train, based on analysis of the projected ridership numbers presented in earlier chapters of the report. Two basic classes of rolling stock can be considered for operation of the proposed service.

1. Locomotive-Hauled Push-Pull Coach Train
2. Self-Powered Rail Car Train (SPRC) also referred to as Diesel Multiple Unit (DMU)

This section describes these two basic classes of passenger rolling stock in terms of operational and economic characteristics for the proposed 62-mile commuter rail service.

8.6.1 Locomotive-Hauled Push-Pull Coach Service

Locomotive-hauled diesel push-pull operations characterize most of the commuter railroads in North America. In this configuration, a diesel electric locomotive is employed to provide propulsion, lighting and HVAC power for the train. The diesel engine drives an electric generator that supplies power to electric motors on the locomotive's drive-wheels. A separate diesel engine and generator typically provides electric power to heat, cool and light the passenger coaches. The typical minimum length for a push-pull train is a locomotive and three coaches. Trains with two cars are occasionally deployed, but are not favored. It is assumed that a two-car train could be deployed for New Haven to Springfield commuter rail service. The typical diesel locomotive is 60 to 70 feet long and weighs 125 tons. The maximum practical train length for a single passenger locomotive is typically 8 or 9 cars.

The locomotive hauls the train in pull configuration. When the consist reaches the end of its trip and turns to head back toward its origin, the engineman shifts the locomotive into push mode and changes his seating position from the locomotive to a work station at the far end of the last car in the consist. This work station provides a throttle, brakes, and other controls that allow him to operate the locomotive and the train in the push configuration.

The passenger coaches are unpowered trailers. Coaches can be either single-level or bi-level. Regardless of height, the typical coach is 85 feet long. A single-level car generally weighs about 50 tons. A bi-level weighs approximately 60 tons. The Massachusetts Bay Transportation Authority (MBTA) in Boston and the Long Island Railroad (LIRR) in New York operate a mix of single-level and bi-level equipment. Metro-North and ConnDOT only operate single coaches at this time. The Water Street Bridge would restrict the use of bi-level cars on the New Haven to Springfield corridor.

For shorter commuter type trips each single-level coach typically seats 95 to 125 passengers. Higher seating capacities are achieved by narrowing the center aisle of the car and providing five seats in every row - two seats on one side of the aisle and three on seats on the other (3-2 seating). Structurally, the typical single-level coach rests on a center sill above the wheels sets ("trucks") at either end of the car. Passenger entry and egress from the car requires either a high-level platform designed to match the height of the car floor or uses short three step stairways (called "traps") located at each corner of the car.

Very few single-level coaches are currently being built for North American commuter railroads. Most railroads are migrating to bi-level coaches to lower capital and operating expenditures and to maximize the number of passengers that can be carried on very popular trains. Three manufacturers have been producing most of bi-level coaches used on this continent. Bombardier builds a large high capacity unit that is favored by western and southern railways. Kawasaki builds a more compact unit that fits with the tighter vertical clearance profiles typical of established eastern commuter railways. Nippon Sharyo has built "gallery cars" for Chicago and San Francisco. However, this discussion focuses on the Bombardier and Kawasaki cars. Rolling stock that is compatible with high-level platforms is the only type being considered for this service.

Bi-level coaches are generally employed to provide more passenger capacity at a maintenance and operating cost equivalent to a single-level coach. With 3-2 seating, capacities exceeding 180 passengers can be achieved. The typical bi-level coach has a depressed seating level below the center sill (between the "trucks") and a second higher level above. Stairs provide access to the higher level, therefore bi-level cars increase dwell time and impact fare collection.

Crewing for a push-pull train requires an engineman and generally at least one conductor to check fares, supervise boarding and alighting, and ensure order on the train. For on-board fare collection, one conductor is typically deployed for every two coaches in the

train. For a high density of short passenger trips, a higher level of train manning might be required to support on-board fare collection.

The push-pull configuration offers several advantages and disadvantages for the proposed New Haven-Hartford-Springfield regional rail service.

What are the advantages of Locomotive-hauled services?

- **Known Proven Technology –** Locomotive and coach technology is readily available in North America and used extensively at large properties including Amtrak, Metro-North in New York, the MBTA in Boston, LIRR in New York and Metra in Chicago. The technology is also well known by the entire US railroad industry, given the numerous years in use. The rail technology is proven off-the-shelf hardware and the local railroad workforce and management community is familiar with push-pull coach technology.
- **Capital and Operating Cost for Longer Trains –** Capital cost per seat declines as the train length increases, making locomotive-hauled services ideal for higher ridership services. The capital cost per seat is reduced with the addition of each coach as a large proportion of the consist cost is due to the locomotive. In an SPRC consist, the capital cost per unit does not vary with the length of the consist when each additional unit is powered.
- **Availability of Used Equipment -** Remanufactured locomotives and used coaches can be employed to reduce capital outlay for equipment. ConnDOT is the nation's most recent buyer of used single-level coaches, having acquired 33 used Mafera coaches from Virginia Railway Express (VRE)[11]. Chicago's Metra has just retired a large fleet of bi-level gallery cars some of which are being recycled into service by commuter railroads in Virginia and Maryland. Chicago's Metra and Amtrak are the two North American passenger railroads that have most recently retired locomotives. It is understood that most of these units have found their way onto the used market with the primary buyers being leasing firms that are providing them to short line freight operators.
- **ADA Accessibility –** A single-level locomotive-hauled consist on a service with high-level platforms is fully accessible for the disabled population with level boarding.

What are the disadvantages of Locomotive-hauled services?

- **Minimum Consist Size –** The typical minimum length for a push-pull train is a locomotive and three coaches. Trains with two cars are occasionally deployed, but are not favored. A service with smaller ridership would suffer from an excess of equipment.

[11] VRE is pressed for passenger capacity, storage space and maintenance capacity. Consequently VRE is replacing its single-level coaches with used bi-levels from Chicago.

- **Fuel Efficiency –** Fuel consumption for a push-pull operation is in the range of 0.25 to 0.5 miles per gallon. By contrast, a Self-Powered Rail Car / Diesel Multiple Unit consumes fuel in the range of 1.5 to 3.4 miles per gallon.
- **Noise, Vibration and Power –** The typical diesel locomotive is 60 to 70 feet long and weighs 125 tons and runs a 3000 HP engine. The 3000 HP 125 ton locomotive creates noise and vibration that may pose a problem for neighbors. The locomotive also generates more power than required to move the short consist required for subject service.
- **Internal Combustion Engine and Fossil Fuel** – The fumes and fuel associated with locomotive operations are not considered compatible with passenger operations and stations in long tunnels. A significant fraction of the urban transit systems in North America and the world penetrate the core of the central city in tunnels. The proposed New Haven to Springfield service has no tunnel elements.

8.6.2 Self-Powered Rail Car / Diesel Multiple Units

A Self-Powered Rail Car (SPRC) is a passenger rail car with a self-contained, on-board source of motive power, making reliance on a locomotive or electric power distribution system unnecessary. Historically nearly all SPRCs have used on-board diesel engines for propulsion power and have been capable of operation as a single train with multiple cars. SPRCs have commonly been called Diesel Multiple Units, or DMUs. While motive power may be a diesel internal combustion engine or an alternative self-contained, on-board source, all SPRCs in common use rely on diesel propulsion.

SPRCs are often used in Europe in circumstances where service is operated with short (generally less than four cars) trains and the infrastructure for electric traction is not available. In the last two decades, European transit officials have been very actively exploring the flexibility offered by an SPRC to operate in a mix of operating environments.

In the 1950's, SPRCs were growing in popularity in North America for conventional railway service until market, technological, and regulatory forces undermined the viability of low-density passenger services. With recent increased interest in urban rail passenger transport, SPRCs have been reintroduced in North America over the last 10 years in Texas, New Jersey, and Ontario. New systems are in advanced states of development in Florida, North Carolina, California, and Oregon. In 2003, Amtrak negotiated to purchase a fleet of SPRCs for several of its low-density routes. Amtrak did not consummate the purchase when the capital cost of the units barely exceeded its rigid capital funding and budget limits. Amtrak remains interested in using SPRCs for services such as its Springfield Line local service in the future.

Worldwide, SPRCs are designed for use in a wide variety of operating environments ranging from main line intercity railways to street running trolley car type service. Different vehicle designs are employed depending upon service requirements. TCRP

Report 52 "Joint Operation of Light Rail Transit or Diesel Multiple Unit Vehicles With Railroads" describes SPRC vehicles in three categories:

- Category 1 – FRA Compliant Cars
- Category 2 – Non-FRA Compliant Cars – generally too lightly built for FRA crashworthiness standards.
- Category 3 – Diesel Light Rail Vehicle – generally shorter, lighter, articulated cars for street running trolley operations

For the New Haven, Hartford, Springfield service, SPRCs that comply with FRA crash-worthiness standards for operation on track shared with freight and conventional passenger trains will be required.

FRA Compliant SPRCs / DMUs

FRA compliant SPRCs are relatively heavy cars primarily designed for safe and unrestricted use on the nation's conventional railroad network sharing track with other trains including freight, commuter rail and Amtrak operations. They comply with all regulations stipulated by Federal Railroad Administration (FRA) for operation on the US conventional railroad network. Examples of the use of this equipment include:

- Trinity Railway Express linking Fort Worth with Dallas uses a fleet of 13 rebuilt vintage Budd RDC's originally constructed in the 1950's.
- South Florida RTA's Tri Rail service linking Miami, Fort Lauderdale and West Palm Beach has ordered two new DMU's from Colorado Railcar.
- The Colorado Railcar offering is the first Category 1 SPRC built in more than 40 years. North Carolina's Triangle Transit Authority has ordered 28 cars for its Raleigh-Durham service opening in 2008.

What are the advantages of SPRCs / DMUs?

- **Capital and Operating Cost for Short Trains** – Passenger rail rolling stock planning and selection studies generally agree that SPRCs offer superior overall economics to locomotive-hauled equipment when the typical train length falls below four cars. For short trains, the SPRCs offer savings in fuel consumption and vehicle acquisition. As train lengths increase, the lower costs to acquire and maintain additional seating capacity with unpowered coaches more than compensate for the relatively high costs of acquiring, operating, and maintaining a locomotive[12].

  Colorado Railcar has discovered that its single-level SPRC powered by two 600 hp diesel engines produces sufficient tractive effort to haul one or two unpowered coaches for some service applications. The economic and operating implications of using a mix of SPRC's and coaches in the same train are theoretically very attractive but not well documented and likely to vary considerably between

[12] While some railways use SPRC's in services designed for one-person train operation, the savings noted here focus on vehicle acquisition, vehicle maintenance and propulsion energy costs and do not consider the reduced transportation staff possible with one-person train operation

service applications. The option of using SPRCs as "power cars" to pull short coach consists should be seriously studied in any rail corridor where SPRC's alone appear potentially attractive. A demonstration project of this configuration is currently underway at Tri-Rail in Florida.

In summary, it is less expensive to purchase and maintain SPRC's with the lower capacity required for proposed New Haven-Hartford-Springfield operation.

- **Noise and Vibration** – Compared with locomotive-hauled equipment, the heaviest SPRCs are less than half the weight and horsepower of the typical passenger locomotive, leading to lower noise and vibration impacts.

- **Fuel Efficiency** – A single SPRC consumes fuel in the range of 1.5 to 3.4 miles per gallon[13]. A conventional passenger locomotive consumes fuel in the range of 0.25 to 0.5 miles per gallon. For a single car operation, the fuel savings with a SPRC are impressive and often compelling. (However, the fuel savings available from SPRC operations erode with increased train length since the fuel consumption increases linearly with SPRC train length. Locomotive fuel consumption does not increase linearly as coaches are added to its train.)

- **Acceleration** – Owing to more favorable weight-to-horsepower ratios and greater tractive efficiency of more powered wheels on the train, SPRCs generally offer better acceleration than locomotive-hauled coach trains.

- **Reduced Infrastructure Requirements** – Compared with locomotives, the infrastructure to maintain SPRCs is more modest. Lifts and hoists to manipulate 125-ton units are not required. Huge diesel engines of 3,000 to 6,000 HP are replaced with lighter engines seldom exceeding 600 HP. Therefore, it is easier to maintain the SPRC without elaborate shop facilities.

- **Flexibility** – SPRCs offer the flexibility to demonstrate, initiate and operate passenger rail services in circumstances where the use of alternative rolling stock technologies would be daunting. Factors contributing to the flexibility of the SPRC include the ability to use existing tracks, ability to operate short trains more economically than push-pull diesel operations, and reduced noise and vibration compared with diesel locomotive operations. The SPRC can operate in short trains of one to three cars anywhere a diesel train runs without the noise, vibration, cost or fuel consumption of a locomotive-hauled train.

- **Regulatory Compliance and Tolerance** – The Category 1 SPRC being considered for this service is compatible with FRA regulations for general use on North America's conventional railroad network.

[13] KKO and Assocates, Industry Survey of DMU Manufacturers interested in US Market. October 1996.

What are the disadvantages of SPRCs / DMUs?

- **Capital and Operating Costs for Long Trains** – As discussed above, when the train lengths routinely exceed three cars, the economic advantages of SPRCs over locomotive-hauled equipment quickly erode due a combination of costs for rolling stock acquisition, maintenance and fuel. The purchase price of an unpowered commuter coach is generally less than half the cost of a SPRC unit. Maintenance for a commuter coach is also less work than for an SPRC. Most commuter and regional rail lines in North America operate with average peak train lengths well in excess of three cars.

- **Internal Combustion Engine and Fossil Fuel –** The fumes and fuel associated with SPRC operations are not considered compatible with passenger operations and stations in long tunnels. A significant fraction of the urban transit systems in North America and the world penetrate the core of the central city in tunnels. The proposed service has no tunnel elements.

- **Rolling Stock Supply and Availability –** With the mid-20th century demise of North American intercity passenger railroading, the supply industry stopped producing SPRCs compatible with the US conventional railway environment. The Budd RDC, last produced in the 1950's, was the last commercially viable SPRC specifically manufactured to operate on the North American conventional railway network.[14] Budd's successor to the RDC, the SPV 2000, was introduced in the 1970's to replace aging RDCs used on lightly used lines in Connecticut and New York. The "Seldom Propelled Vehicle" proved unreliable and expensive to operate.

  The failure of the SPV 2000 forced some of the last SPRC operations to shift to less economic locomotive-hauled services because no other manufacturer was willing to consider building units for the limited US market. In the late 1970's, Boston gave up trying to operate its large but aged RDC fleet as self-powered units but towed the old cars behind locomotives for another 10 years until replacement coaches could be purchased. In the early 1980's, Philadelphia's last SPRC services were discontinued due to the confluence of a poor fiscal climate and an aging RDC fleet that could not economically be replaced.

  From the 1970's until the turn of this century, no manufacturer offered a Category 1 SPRC at an attractive price. Consequently, North America transit planners interested in SPRC's for North American applications had no choice but to consider how to use European Category 2 vehicles. The new Category 1 offering by Colorado Railcar has been purchased for use on Florida's Tri-Rail service. United Transit Systems (a consortium of Tokyo-based Sojitz Corp. and Seoul-

[14] The archetypical US SPRC is the Budd RDC. Hundreds of Budd cars were built in the 1950's for operation on rail passenger branch lines and some main line services. The New Haven and Boston and Maine railroads owned more Budd RDC cars than any other railways in the world.

based Rotem Co.) is building 28 Category 1 SPRCs for North Carolina. A planned transit operation in Oregon will soon be awarding a contract for its Category 1 SPRCs. The North Carolina cars are expected to be fully compliant with all FRA regulations with 2x2 seating for 170 passengers.

In summary, the pool of used or remanufactured vehicles for capital cost savings is very thin.

- **Regulatory Compliance and Tolerance –** Without a ready supply of SPRCs tailored to operate within safety parameters established for North American operations, considerable energy in the urban rail passenger planning community over the last decade has been focused on how to safely use equipment designed for European operation in the North American operating context. The Federal Railroad Administration has deliberated with the public transportation planning community to develop and explore strategies that allow for the safe sharing of track between conventional rail equipment and light passenger rail cars (both electric and diesel). Together, federal regulators and transit officials have been exploring and reconsidering the barriers to safe operation of conventional and light rail cars on the same tracks, with slow but perceptible progress. In the last four years, the FRA has issued waivers to several transit systems allowing their light Category 3 trains to share track with conventional railroad equipment where the service periods of the transit and freight operations do not overlap. The transit services generally operate 16 to 18 hours during the day and evening with freight operations restricted to the overnight hours.

  Regulators and transit officials continue to evaluate strategies that may allow more operational flexibility. An industry working-group meets periodically to review progress toward new options for sharing track. However, the relatively new prospect of suppliers willing to produce economical quantities of Category 1 SPRCs for attractive prices has ameliorated the pressure to find ways to use Category 2 units for some proposed services.

  In summary, regulatory compliance is only available for limited pool of Category 1 SPRCs.

8.6.3 Comparison and Evaluation of Options

Two general equipment options for ConnDOT's use on the New Haven-Hartford-Springfield commuter rail service were identified and evaluated. These were:

- Locomotive-hauled Push-Pull Coach Train
- Self-Powered Rail Car Train

Details on two possible equipment configurations are listed in Table 8-5. For this comparison, the following equipment were assumed. For locomotive-hauled equipment, a conventional locomotive type (F-59 PHI by General Motors Electro Motive Division)

and Comet V cars (from Alstom) are detailed. For SPRCs/DMUs, the Colorado Railcar three-car DMU consist is detailed. Both train set types are compatible with high level platforms and FRA crashworthiness standards for operation on track shared with freight and conventional passenger trains. The seating capacity of each is comparable, and matches the requirements for the NH-H-S service. Both types can be operated in a push-pull mode, obviating the need to turn the train set for a reverse movement.

Table 8-5
Comparison of Locomotive-hauled Train Set and SPRC/DMU Train Set Options

	Locomotive-Hauled Train Set	**SPRC/DMU**
Summary of Typical Equipment Options	Typical New Three-Car Push-Pull Train Set (Single-level)	Colorado Railcar Single-level DMU
Minimum Configuration	One Locomotive, Two Coaches and One Cab Car	One Powered Coach and Two Trailing Coaches
Seating Capacity	327	278
Capital Cost (Millions)	$8.6	$6.8
Horsepower	3,000	1,200
Weight (Tons)	290	224
Length (Feet)	315	255
Tons/Seat	.96	1.24
Typical Annual Fuel Cost for NH-H-S Service[15]	$1,070,864	$342,676
Capital Cost/Seat	$26,330	$24,460
HP/Ton	10	5
High Platform Boarding?	Yes	Yes
Noise and Vibration	High	Medium/Low
Total Fleet Size (Units)	27	21
Minimum capital cost for seven[16] complete train sets (Millions)	$58.9	$47.6

Table 8-6 shows a summary evaluation of the two types of train consists per evaluation criteria deemed important to both riders and operators/maintainers of the equipment. Overall, SPRC/DMU train sets appear to have several advantages over locomotive-hauled rail cars. But it is important to remember that few new SPRCs / DMUs are in

[15] Assuming 992 daily revenue train miles, 254 annual days of operation, $1.70 per gallon for diesel fuel not including tax, 0.4 mpg for locomotives, 1.25 mpg for DMU/Coach pairs. (per statistics prepared by Colorado Railcar Manufacturing, LLC for Dave Carter of New Jersey Transit, 13 April 2004)
[16] Six consists required for service plus one spare.

operation today. Therefore, the quantifiable superiority of SPRCs / DMUs in the areas cited below is pending further operational assessments of this type of rolling stock. To be conservative, this study has developed its operating plan using conventional commuter rail equipment. As the study progresses, SPRCs / DMUs will be looked at again for potential application in the Springfield line commuter rail service.

Table 8-6
Summary Comparison of Locomotive-Hauled Train Sets and SPRC/DMU Technologies

	Locomotive-hauled Train Set	**SPRC / DMU Train Set**
Operating Cost		+ [17]
Capital Cost		+
Minimum Fleet Size		+
Comfort	Even	
Acceleration	Unknown	
Availability	+	
Reliability	High	Unknown
Noise and Vibration		+
Air Quality Impacts		+
Fuel Consumption		+
Maintenance Costs		+
Image		+
Flexibility		+
One-Person-Train-Operation		+

[17] Indicates superiority for proposed New Haven-Hartford-Springfield service.