Eastern Connecticut Corridor Rail and Transit Feasibility Study (ECRTS)

November 2023

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Acknowledgments

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Glossary

Acronyms	
ACSES	Advances Civil Speed Enforcement System
ADA	Americans with Disabilities Act
BG	Census Block Group
CAGR	Compound Annual Growth Rate
CNT	Center for Neighborhood Technology
COA	Comprehensive Operational Analysis
CTDOT	Connecticut Department of Transportation
ECRTS	Eastern Connecticut Corridor Rail and Transit Feasibility Study
EJ	Environmental Justice
EMU	Electrical Multiple Unit (Train)
FRA	Federal Railroad Administration
GHG	Greenhouse Gas
GWI	Genesee and Wyoming, Incorporated
LOS	Level of Service
MOE	Maintenance of Effort
MOW	Maintenance of Way
MP	Mile Post
NEC	Northeast Corridor
NHL	New Haven Line
NHRY	New Haven Rail Yard
OH	Overhead
POCD	Plan of Conservation and Development
PTC	Positive Train Control
RIDOT	Rhode Island Department of Transportation
RIPTA	Rhode Island Public Transit Authority
ROW	Right of Way
SCCOG	Southeastern Connecticut Council of Governments
SEAT	Southeast Area Transit District
SLE	Shore Line East
SOV	Single Occupancy Vehicle
TDM	Transportation Demand Management
TOD	Transit Oriented Development
TSP	Transit Signal Priority
UG	Undergrade
USCGA	United States Coast Guard Academy
VMT	Vehicle Miles Traveled
VRH	Vehicle Revenue Hours

Definitions	
Cab signaling	A railway safety system that communicates track status and condition information to the cab, crew compartment or driver's compartment of a locomotive, railcar or multiple unit. The information is continually updated giving an easy-to-read display to the train driver or engine driver.
Catenary system	A system that uses overhead wire to supply electricity to rail vehicles.
Deadheading	Train and/or engine crew going from one terminal to another without performing revenue (open to passengers) service.
Grade crossing	A crossing at the same level, either between tracks of different railways or between railway tracks and public roadways.
Headways	The average interval of time between vehicles moving in the same direction on the same route.
High level boarding	To enhance accessibility and optimize dwell times, railway platform heights at stations are standard to allow level boarding for commuters on high platforms where a passenger does not need to climb steps to board the train.
Interlockings	An arrangement of interconnected signals and signal appliances for which interlocking rules are in effect. Signals and movement of signal appliances must succeed each other in proper sequence to move trains between tracks.
Layover space	An area where trains can be stored or reverse direction.
Layover track	A track where trains can be stored or reverse direction, allowing other trains to pass by them on the main track.
Legacy infrastructure	Outdated or aging infrastructure that could be incompatible or in conflict with current or more advanced infrastructure.
Level of service	The amount of transit or rail service provided; a qualitative measure based on the span of service and frequency of service provided.
Microtransit	On-demand transportation service requested via a smartphone application.
Moveable bridge	A bridge that can move to accommodate the passage of boats and ships. Movable bridges include drawbridges, vertical-lift bridges, transporter bridges, and swing (pivot) bridges.
Non-peak	The times in which demand for use of a given transit service is not conventional nor high.
Peak	The period with the highest ridership during the entire service day as determined by the transit or rail provider.

Definitions	
Positive train control	Positive Train Control (PTC) systems are designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zones, and movements of trains through switches left in the wrong position.
Push Pull	Locomotives at both ends of a train are used to move the train, being controlled by one driver.
Queue jump lane	Lane that combines short, dedicated transit facilities with either a leading bus interval or active signal priority to allow buses to easily enter traffic flow in a priority position. [1]
Reverse-peak	Traveling in the opposite direction of the regular service during peak periods.
Rolling stock	Any type of transportation equipment on rail wheels.
Shuttle	A bus, train, or plane service in which vehicles travel frequently between two places.
Sidings	An auxiliary track to move trains off the main track for meeting or passing trains.
Slow order	A speed not exceeding 15 mph or other set limit.
State of good repair	The condition in which a capital asset is able to operate at a full level of performance.
Throw switch	A switch that by a single throw makes an adjustment to the track a train is traveling on.
Track components	The structure on a railway or railroad consisting of the rails, fasteners, railroad ties, and ballast, plus the underlying subgrade.
Track geometry	The properties and relations of points, lines, curves, and surfaces in the three-dimensional positioning of railroad track.
Yard Space	A system of tracks other than main tracks and sidings. A yard is used for making up trains, for storing rail cars, and for other purposes.

[1] Transit Street Design Guide. National Association of City Transportation Officials. 2016

Executive Summary

The Connecticut General Assembly, via Public Act 21-175, directed CTDOT to study the feasibility of extending the Shore Line East rail service to the state of Rhode Island, establishing a new passenger rail service from the City of New London to the City of Norwich, establishing a new passenger train station in the Town of Groton and the Borough of Stonington, and extending ground transportation systems in the eastern region of the state and providing interconnection between such systems and rail lines. The Eastern Connecticut Corridor Rail and Transit Feasibility Study satisfies this direction and investigates the feasibility of and market for improving public transportation in southeastern region of Connecticut. The purpose of a feasibility study is to examine high-level existing and future conditions to determine the viability of potential new and expanded service. Though strategies to advance improvements in rail and transit service in southeastern Connecticut are presented in this document, they are preliminary findings. Further steps would be needed to advance the project's development, including additional study, planning, permitting, design, and funding. Any next steps are currently unfunded.

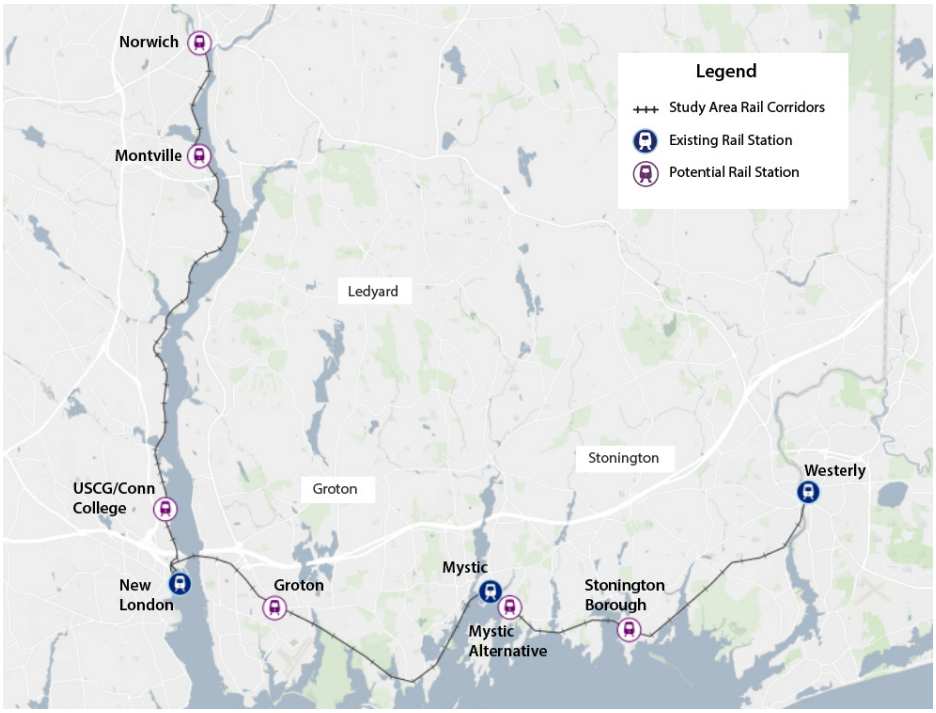
The feasibility study's geographic area includes the nine southeastern Connecticut municipalities of New London, Waterford, Montville, Bozrah, Norwich, Preston, Ledyard, Groton, and Stonington, as well as Westerly, Rhode Island. The study area includes major population and employment centers within New London, home to Connecticut College and the US Coast Guard Academy; Groton, home to the US Navy Submarine Base, General Dynamics Electric Boat, and Pfizer; and Norwich, home to the William W Backus Hospital. The study area also includes major tourist destinations including the Mohegan Sun Casino and Resort in Montville, the Foxwoods Resort Casino in Ledyard, and Olde Mistick Village in Stonington.

Presently, these employment and recreational destinations are served by a limited rail and transit network. During weekdays, Amtrak operates intercity passenger rail from Southeastern Virginia to Boston, Massachusetts with intermediate stops at New London, Mystic, and Westerly less than once per hour. CTrail provides SLE weekday commuter rail service from New Haven to New London approximately once per hour, with reduced service on the weekends. As a result of erosion of usage, SLE services were reduced in the Fall of 2023 to match demand. Southeast Area Transit District (SEAT), the primary local transit provider in the study area, provides hourly fixed route, microtransit, and complementary Americans with Disabilities Act (ADA) paratransit services six days a week, with a limited number of routes operating in the early morning or late evening. To support SEAT and other transit operators, the State of Connecticut included funding for additional transit services in its FY24 budget.

Findings from outreach and engagement efforts – including interviews with anchor institutions, discussions with municipal leaders and working groups, public meetings, and a public survey – demonstrate a potential appetite for increased rail and transit service, namely increased frequency and expanded hours of service to regional destinations. These findings are corroborated by a transit market analysis demonstrating that the region could be negatively impacted by its relatively low level of access to jobs in mature economic sectors, compared to the Northeast United States and Northeast Corridor (NEC). The study area is forecasted to experience population growth and aging over the coming decades, indicating an impending need for enhancements in public transit services, specifically bus and paratransit services. Prioritizing improvements in transit and rail service within the study area is also congruous with previous transit, local, and regional plans, which aim to improve regional connectivity by capitalizing on existing travel patterns to strategically boost development and multimodal accessibility.

This analysis reveals that rail service is not a prerequisite for addressing the region's mobility needs. Transit investment could satisfy existing and future regional mobility needs, independent of any other long-term strategies like enhanced rail service. Given funding and operational constraints associated with passenger rail, discussed below, transit strategies may be the most viable option for improving connectivity along the Thames River Corridor.

The feasibility study investigates existing rail service, infrastructure, and operational constraints along three key corridors: NEC, Thames River Corridor (Palmer Line and Norwich Branch), and Groton Secondary. While it is technically feasible to extend or establish new passenger rail service along each of the railways, the Thames River is a federally regulated and navigable channel and the amount of time the Thames River Bridge can be closed for trains to pass is limited. Achieving a frequency of one commuter train per hour in each direction across the bridge is the maximum possible given Amtrak's planned service increase. It would also require extensive coordination with the US Coast Guard and Amtrak, as well as right of way (ROW) securement and permitting. Extending SLE service to Westerly along the NEC thus precludes passenger rail service along the Norwich Branch and/or the Groton Secondary. Therefore, the combination of commuter rail service serving the highest projected population and jobs is the SLE extension along the NEC from New London to Westerly and new service along the Palmer Line from New London to Norwich.



Study Area Rail Corridors and Station Locations

At a high level, implementing additional commuter rail service along the NEC and new service along Palmer Line could be possible given further analysis of the corridors' existing conditions, though implementation could face significant challenges. The infrastructure improvements needed to run hourly commuter rail service along these lines include upgrades to track, structures, grade crossings, and the construction of new stations/ reconstruction of existing stations to be compatible with operating equipment and meet ADA requirements. Alone, these costs could total $1 billion dollars (2023 Dollars). Additionally, CTDOT does not currently own the ROW along either line and could require an operations agreement with both Amtrak, who owns the study area segment of the NEC, and Genesee & Wyoming Inc., who owns the Palmer Line. Operating along the Thames River Bridge would also necessitate extensive coordination with Amtrak and the US Coast Guard, and other permitting agencies as needed. Despite these challenges, implementing service along both corridors could promote modeshift and increase access to employment opportunities, commercial activities, and recreation. It is anticipated that approximately 286,000 additional rail passenger trips could be taken annually, were new service to be implemented in 2035.

Study Area Rail Corridor Capital and Operating Cost Estimates

	Corridor	Estimated Cost
Estimated Capital Costs (One Time)	SLE	$245+ Million
	Palmer Line	$636+ Million
Estimated Operating Costs (Annual)	SLE	$51 Million
	Palmer Line	$33 Million

The service levels achieved by potential future commuter rail service along the Thames River Corridor could be matched via transit solutions, achieving the same headways using existing roadway infrastructure. Improving the frequency of SEAT's Route 1 buses to an effective 30-minutes and supplementing the corridor with improved infrastructure, such as Transit Signal Priority (TSP), could be a more cost-effective and expedient response to calls for increased access to regional destinations. Raising SEAT's level of service along the Thames River Corridor could enhance connectivity for current and future residents, employees, and visitors, independent of pursuing commuter rail service.

Though the Norwich Branch and Groton Secondary were not determined to be suitable for new commuter rail service, those areas, as well as others within the study area, could also benefit from expanded transit service. Transit service could be enhanced in the near future, allowing CTDOT to address travel demand within the region independent of passenger rail service. This is valuable as long-term rail strategies require additional time, analysis, and funding, which has not been obtained. Transit strategies, using fixed route and demand response service types, to improve mobility within southeastern Connecticut include:

- Increasing frequency and travel speeds along high ridership routes, such as a 30-minute headway from New London to Norwich;
- Implementing new routes to regional destinations, including seasonal service to Mystic and a one-seat ride (no transfers) connecting the US Navy Submarine Base and Electric Boat;
- Expanding hours to include earlier service, later service, and Sunday service on select routes;
- Upgrading bus stop infrastructure at high-volume stops;
- Expanding transit coverage in areas with high proportions of cost-burdened renters;
- Providing competitive transit options during tourist seasons; and
- Improving accessibility to grocery stores, medical facilities, faith-based organizations, and other commercial activities on Sundays along routes.

Study Area Transit Capital and Operating Cost Estimates

	Corridor	Estimated Cost
Estimated Capital Costs (One Time)	Standalone Bus Strategy or Bus with Rail Strategy	$9-10 Million
Estimated Operating Costs (Annual)	Standalone Bus Strategy	$12.3 Million
	Bus with Rail Strategy	$11.7 Million

Together, these rail and transit improvements have the potential to result in benefits for the region. From an economic and market standpoint, successful and effective Transit Oriented Development (TOD) can provide lower-income residents with improved access to higher-paying jobs and attract investments that have the potential to create higher-paying employment opportunities on a regional scale. These shifts could support the increase in the number of jobs, economic competitiveness, and regional economic productivity. From an environmental standpoint, implementing transit and rail enhancements could result in an abatement of 53 million vehicle miles traveled each year, equal to more than two thousand trips around the globe. The rail improvements could also result in a reduction of nearly 20,000 tons of carbon dioxide annually. Transit fleet electrification and expanded service could result in an additional 2,500-ton carbon dioxide reduction of tailpipe emissions annually.

From a public health and environmental standpoint, TOD can decrease negative impacts of automobile usage including traffic congestion, localized air pollution, traffic fatalities, and costly wear-and-tear on road infrastructure. From a social standpoint, proposed transit infrastructure improvements might encourage TOD across a considerable footprint of underutilized and vacant land from Norwich toward New London and Groton. The analysis identified considerable vacant acreage that could support future TOD investment and corresponding benefits to property and sales taxes with associated transit supportive zoning regulations.

These transit strategies could be implemented to satisfy short- and long-term needs along the Thames River Corridor. In the future, long-term strategies for enhancing commuter rail service along the Northeast Corridor may be viable. However, all of these strategies are preliminary findings, and future steps are needed to advance each project through the project lifecycle stages.

For the transit strategies the Federal Transit Administration (FTA) outlines four steps for each project: Project Planning, Project Development, Engineering and Construction. For the rail strategies, the Federal Railroad Administration (FRA) outlines a project lifecycle to include six steps: Systems Planning/Project Planning, Project Development, Final Design, Construction, and Operation. Each one of these steps has a number of components that need to be completed before moving to the next step. The project lifecycle can take approximately six to 20 years to complete, depending on the project.

Project Lifecycle Stages

While the projects identified in this feasibility study are presented as a group of short-term and long-term strategies, if one strategy or a combination were to be identified as a viable option upon further study and/or availability of funding, that strategy could move forward independently of the others and be incrementally phased. Each strategy listed could be implemented, if feasible, as an individual project and proceed through the project lifecycle stages. All approaches would require further study. At present, advancing transit and rail solutions in accordance with the findings of the feasibility study is unfunded.

1 Introduction


EXIT

1.Introduction

The Connecticut Legislature directed the Connecticut Department of Transportation (CTDOT) to conduct a feasibility study for expanding passenger rail service and ground transportation options in southeast Connecticut[1]. This effort, referred to as the Eastern Connecticut Corridor Rail and Transit Feasibility Study (ECRTS) investigates the feasibility of and market for the following transportation improvements (Figure 1):

- Extending the Shore Line East (SLE) rail service to the State of Rhode Island (RI) via the Northeast Corridor (NEC)
- Establishing a new passenger rail service from the City of New London to the City of Norwich
- Establishing a new passenger train station in the Town of Groton and the Borough of Stonington
- Extending other ground transportation systems in the eastern region of the state and providing improved connectivity between such systems and rail lines

This final report of the feasibility study summarizes the analysis and findings of thirteen detailed technical reports, which are presented separately as appendices to this document[2].

This summary document presents short- and long-term strategies for expanded and improved commuter rail and local transit operations in southeastern Connecticut. It builds upon a previous document, the Preliminary Feasibility Assessment (Appendix H), which investigated the potential for commuter rail service along four alignments within three corridors:

- The NEC Corridor from New London to RI;
- The Thames River Corridor including two alignments: the west side of the river from New London to Norwich (owned by Genesee and Wyoming, Inc. (GWI), referred to as the Palmer Line) and the east side of the river including the rail line from Groton to Norwich (owned by GWI, referred to as the Norwich Branch); and
- A rail line spur off the NEC in Groton (owned by GWI, referred to as the Groton Secondary).

Figure 1
Study Area Regional Context

[1] Substitute House Bill No. 6484, Public Act 21-175, Section 20

[2] All sources of data and information used for the analyses are cited in the appendices.

The primary finding from this work identified the Thames River Bridge, its existing operations, and future Amtrak scheduling, as key constraints for expanding rail service in the region. A corridor capacity analysis revealed only one additional commuter rail train per hour in each direction can be accommodated across this movable bridge with existing and future rail operations. Extending service along the NEC would preclude passenger rail service along the eastern banks of the Thames River and the Groton Secondary, as operations in those corridors would require trains to traverse the bridge more than once in each direction. For this reason, the Transit Service Plan (Appendix I), Rail Service Plan (Appendix J), Conceptual Station Technical Memo (Appendix K), and Economic Market Analysis (Appendix L) focus on the NEC and the western banks of the Thames River. These appendices document corridor capacity, station siting, ridership projections, environmental benefits, economic development potential, and the estimated capital and operating costs associated with equipment needs, infrastructure upgrades, alignment changes, and strategies for improving level of service along the NEC and establishing passenger service on the west side of the Thames River. An overview of those findings from Appendices I, J, K and L is presented in this document, as well as a high-level summary of the findings from the preceding work completed in Appendix H.

The ECRTS is the first step in a data-driven decision-making process. The purpose of this feasibility study is to examine high-level existing and future conditions to determine the viability of potential future commuter rail and local transit improvements in the study area. Though short- and long-term strategies to advance improvements in rail and bus transit service are presented, they are preliminary findings. Additional detailed analyses would be needed to further evaluate potential service along the corridors. Additional actions in the capital investment project development lifecycle could include an environmental review process that more thoroughly develops and reviews alternatives and selects locally preferred alternatives. Any next steps are currently unfunded.

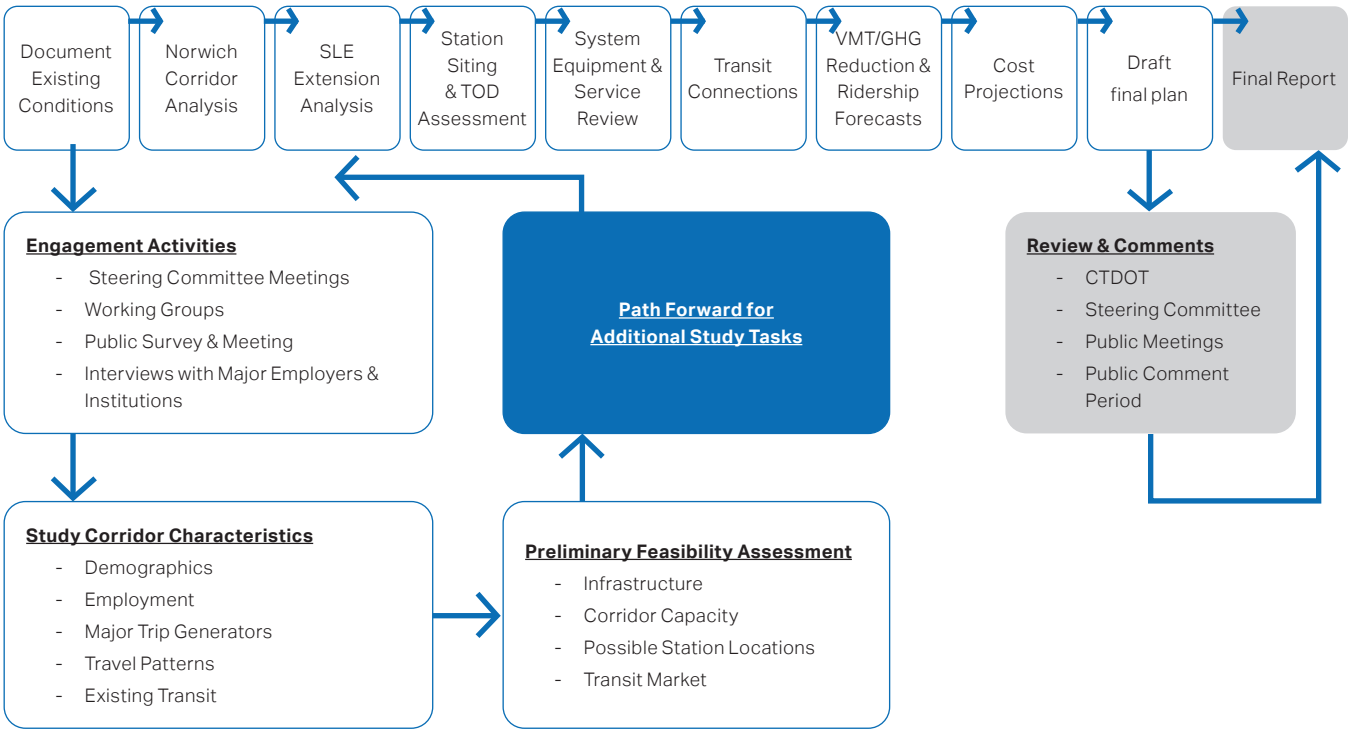


Figure 2
Overview of the Study Process and Timeline

2

Existing Conditions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2.Existing Conditions

The geography for this feasibility study is defined as the ten municipalities through which the proposed rail service passes, including Bozrah, Groton, Ledyard, Montville, New London, Norwich, Preston, Stonington, and Waterford in Connecticut, and Westerly, Rhode Island. The corridors of interest considered in this study include those along both sides of the Thames River from New London and Groton to Norwich, as well as the corridor extending from New London, CT to Westerly, RI via the shoreline communities and the Groton Secondary. The terminal location in the State of Rhode Island was discussed between the Connecticut Department of Transportation and the Rhode Island Department of Transportation (RIDOT). RIDOT expressed the preference to terminate the study corridor at the existing Westerly (Amtrak) Station.

2.1. Study Area Characteristics

The study area is characterized by a mix of urban, suburban, and rural communities, with the highest population densities in Norwich, Groton, and New London. Fifty-one percent of the study area's total population resides in these municipalities[3], which also exhibit higher proportions of ethnic diversity, lower average household income, and increased poverty levels in comparison to their neighbors[4] . These three towns, in addition to Westerly, also contain census tracts[5] identified as disadvantaged in the Climate and Economic Justice Screening Tool developed to support the Federal Justice40 Initiative. Tracts are considered disadvantaged when they meet more than one burden threshold and an associated socioeconomic threshold; burden types include climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development[6] . On a state level, Connecticut's Department of Economic and Community Development annually designates its "Distressed Municipalities", which are the 25 Connecticut towns experiencing the highest unemployment rates, greatest job decline, and lowest per capita incomes.

As shown in Figure 3, New London, Norwich, and Groton exhibit a disproportionate prevalence of Justice40 census tracts; additionally, the municipalities rank 3rd, 4th, and 22nd respectively on Connecticut's 2022 Distressed Municipalities list. Montville is also included in this list, ranked at 15th[7] . Further, Groton is also home to over 4,500 cost-burdened renters, meaning that those renters contribute more than 30% of their income to housing costs[8]. The study area overall has the lowest concentration of professional jobs and the lowest average earnings in these professional jobs compared to other Connecticut cities of Bridgeport, New Haven, Stamford, and Hartford, all of which have a higher level of access to transit. While these four cities have all seen steady reductions historically in their shares of households earning less than $20,000 per year (decrease of 4.8% annually), the study area's share of households earning less than $20,000 has increased slightly (0.86%) since 2010. These indicators signal that study area municipalities of Norwich, New London, and Groton are the municipalities that could potentially most benefit from expanded access to transportation, transit oriented development (TOD), and other growth opportunities.

[3]US Census Bureau, 2019 American Community Study.

[4]Ibid.

[5]The US Census Bureau defines census tracts as statistical subdivisions of a county or statistically equivalent entity, generally having a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. Census tracts are comprised of census block groups, which generally contain between 600 and 3,000 people. (www.census.gov)

[6]United States Council on Environmental Quality, Climate and Economic Justice Screening Tool, 2022, https://screeningtool.geoplatform.gov/en/#10.43/41.4314/-72.0108

[7]Distressed Municipalities. 2022. Retrieved June 2023 from https://portal.ct.gov/DECD/Content/About_DECD/Research-and-Publications/02_Review_Publications/Distressed-Municipalities

[8]US Census Bureau, 2019 American Community Study.

Norwich, Groton, and New London are also home to several of the region's major employers, defined in this study as having over one thousand employees. The William W. Backus Hospital in Norwich has 1,895 employees[9]; in Groton, the U.S. Navy Submarine Base has 10,750 employees, Electric Boat has around 11,000 employees (of which around 4,000 are based in New London)[10] , and Pfizer has 4,853 employees[11] ; and the Lawrence Memorial Hospital in New London has 2,553 employees[12] . Though the science, technology, and manufacturing jobs present in these urban areas offer the highest paying wages, the hospitality sector accounts for a high proportion of relatively low-wage jobs. Mohegan Sun Casino and Resort in Montville and Foxwoods Resort Casino in Ledyard are two key employers in this sector and provide over 5,000[13] and 6,800[14] jobs respectively.

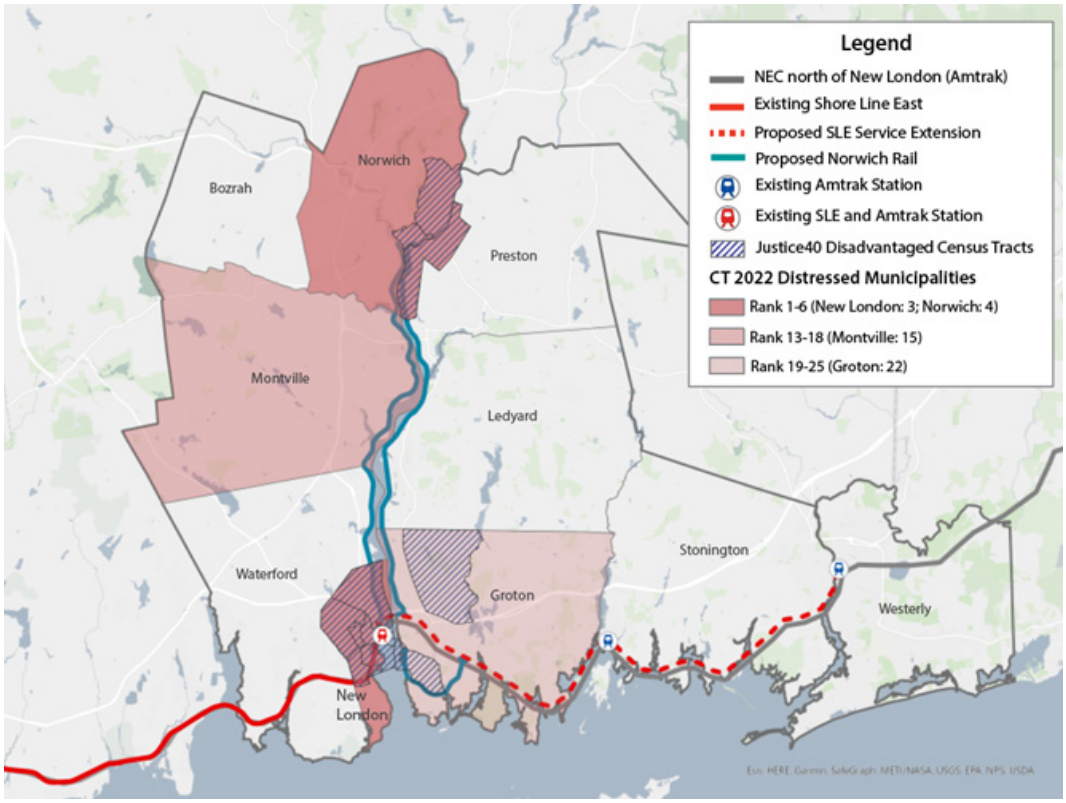

Figure 3
Justice40 Disadvantaged Census Tracts and CT 2022 Distressed Municipalities in the Study Area

As shown in Figure 4, since 2001, the study area has struggled with a structurally slower pace of job creation relative to established benchmarks (State of Connecticut and the NEC). The New London-Norwich Corridor in particular has experienced a widening gap in terms of job creation compared to the New London-Westerly Corridor, Connecticut, and NEC. While employment growth across the New London-Westerly Corridor employment since 2001 has been slightly better, compound annual growth rate (CAGR) in jobs since 2001 for the larger study area remains negative (-0.45%) relative to the Northeast Megaregion (0.38%) and NEC (0.41%).

The reduced regional economic performance is a function of an economic base anchored by industry sectors which are either "medium-term/short-term" or "under-developed/long-term", with significantly fewer sectors seen as positioned for "super sector" or "mature". More importantly, analyses reveal that the study area's economic base is significantly less diversified compared to the larger NEC, where growth in industry sectors such as professional services since 1995 tended to correlate with parallel growth in demand for regional and commuter rail service[15].

[9] City of Norwich, Annual Comprehensive Financial Report, 2022, https://www.norwichct.org/ArchiveCenter/ViewFile/Item/1250.
[10] Interview with General Dynamics Electric Boat. AECOM. June 2023.
[11] City of New London, Annual Comprehensive Financial Report, 2022, https://cms9files.revize.com/grotonct/document_center/Departments/Finance/Reports/2022%20 Annual%2Comprehensive%20Financial%20Report%20(FYE%20June%2030,%202022).pdf.
[12] Yale New Haven Health. Lawrence + Memorial Hospital | Westerly Hospital Year in Review. 2022. https://www.westerlyhospital.org/-/media/Files/LM/PDF/annual-report/20415_LM_WH_FY2022_ AnnualReport_FINAL.ashx

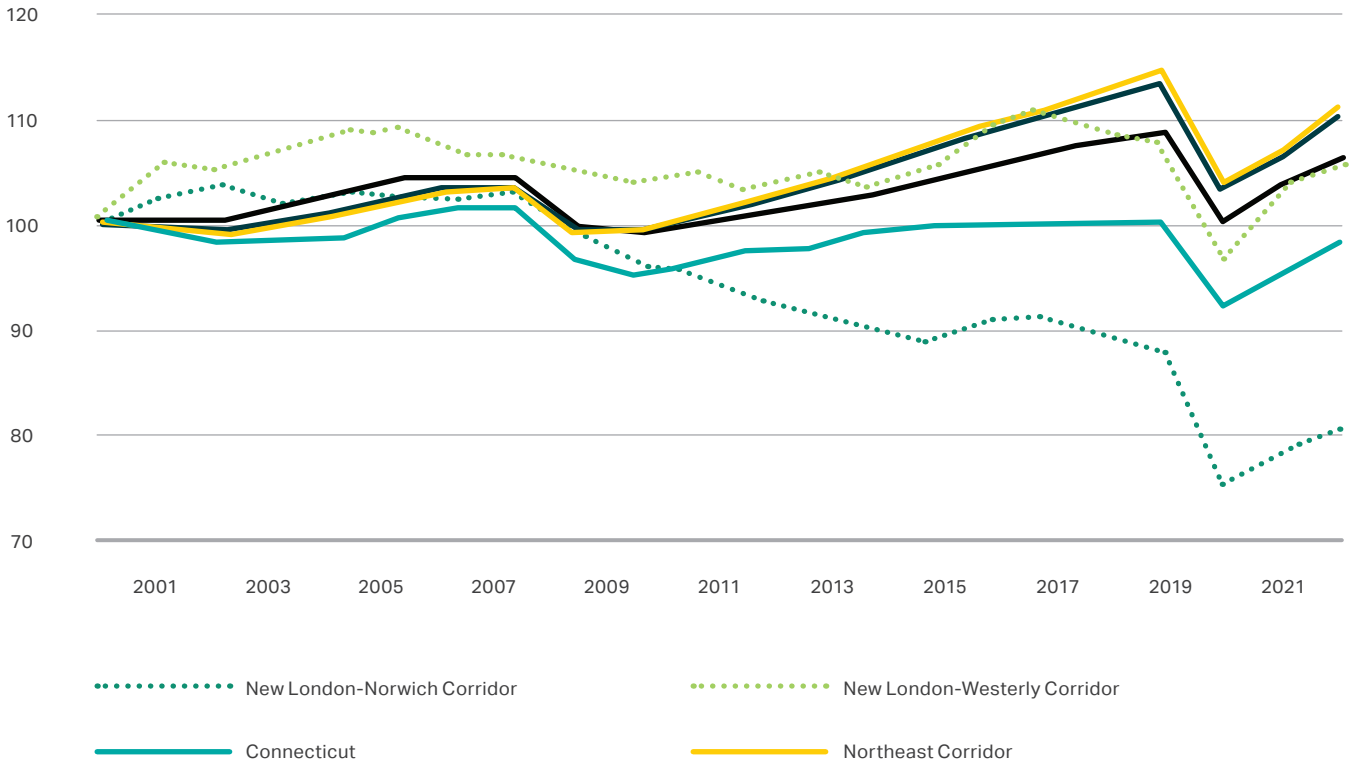

Figure 4
Regional Employment Growth Index (2001=100%)[16]

Region	Compound Annual Growth Rate 2001 - 2022
New London-Norwich Corridor	-0.89%
New London-Westerly Corridor	0.22%
Connecticut	-0.10%
Northeast Corridor	0.41%
Northeast Megaregion	0.38%

2.2. Existing Rail Service

On a regional scale, Amtrak provides intercity passenger rail on its Acela and Northeast Regional trains and serves the NEC from Boston, to New York City, and further south to Washington, D.C. and Virginia. Additional connections to transit are possible along Amtrak's service corridor, such as CTrail service on the Hartford Line from New Haven to Hartford and Springfield, Massachusetts. While the scope of this study is contained between the New London to Westerly stations on the NEC, further connections may be pursued in the future to bolster rail service between New Haven and Providence[17].

[13]Mohegan Sun, interview. AECOM. April 2023.
[14]Foxwoods Casino, interview. AECOM. March 2023.
[15]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix L: Economic Market Analysis. August 2023.
[16]Economic Modeling Specialist International (EMSI), Labor Market Data, 2022.
[17]Amtrak's 2023 New Haven to Providence Market Study details the travel behavior and demand for intercity rail between the two locations.

CTrail provides SLE commuter rail service from New Haven to New London seven days a week from 5am to midnight, with approximately 12 trips in each direction on weekdays and 8 trips on weekends[18] . Effective December 18, 2023, SLE service will be provided on 8 daily roundtrips to match ridership and demands[19].

Within the ECRTS area limits, passenger rail service is provided along the Amtrak-owned two-track segment of the NEC. Intermediate Amtrak stops in the study area include New London, Mystic, and Westerly. Monday through Friday, Amtrak's Northeast Regional Train and Acela Express offer approximately 10 trips in each direction; on Saturday and Sunday, a minimum of 8 trips are offered in each direction[20] .

Through its subsidiary New England Central Railroad, GWI owns and operates limited unscheduled freight service on the Palmer Line and the Norwich Line -- between one and two trains per day to meet market demand. The Palmer line runs along the west side of the Thames River, passing through New London, Waterford, Montville, and Norwich within the study area, and traveling up towards Palmer, Massachusetts. To the east of the Thames, the Norwich Branch travels from New London to Worcester, MA, passing through Groton, Ledyard, Preston, and Norwich within the study area[21].

2.3. Existing Transit Service

There are several different public transit services available within the study area including local bus, intercity bus, and ferry options (Figure 5). Southeast Area Transit District (SEAT), the largest local transit provider in the study area, provides fixed route, microtransit, and complementary ADA paratransit services six days a week (Table 1)[22]. Improvements to SEAT services are budgeted for FY24 and are anticipated to include the re-introduction of Sunday service, improvements to frequency and span of service, and introduction of new services. Additional transit services within the study area include regional bus service operated by Windham Region Transit District and 9-Town Transit, Mashantucket Pequot Tribal Transportation, and location-specific services for the region's casinos. In Westerly, the Rhode Island Public Transit Authority (RIPTA) offers limited flex zone and fixed route service. Those wishing to travel beyond the region can utilize the ferries serving several communities in Long Island Sound, Greyhound intercity bus, SLE commuter rail, or Amtrak intercity passenger rail.

[18]"Schedules." Shore Line East CTrail. 2023. https://shorelineeast.com/schedules
[19]Connecticut's Governor Lamont signed the FY24-25 Biennial State Budget Bill in June 2023, which reduces SLE funding from 66% of pre-pandemic ridership service to 44%.
[20]"Schedule Results." Amtrak, 2023. https://www.amtrak.com/tickets/schedule-results.html
[21]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix E: Corridor Capacity Analysis and Service Framework. February 2023.
[22]Connecticut Department of Transportation. ECRTS Transit Service Plan. June 2023.

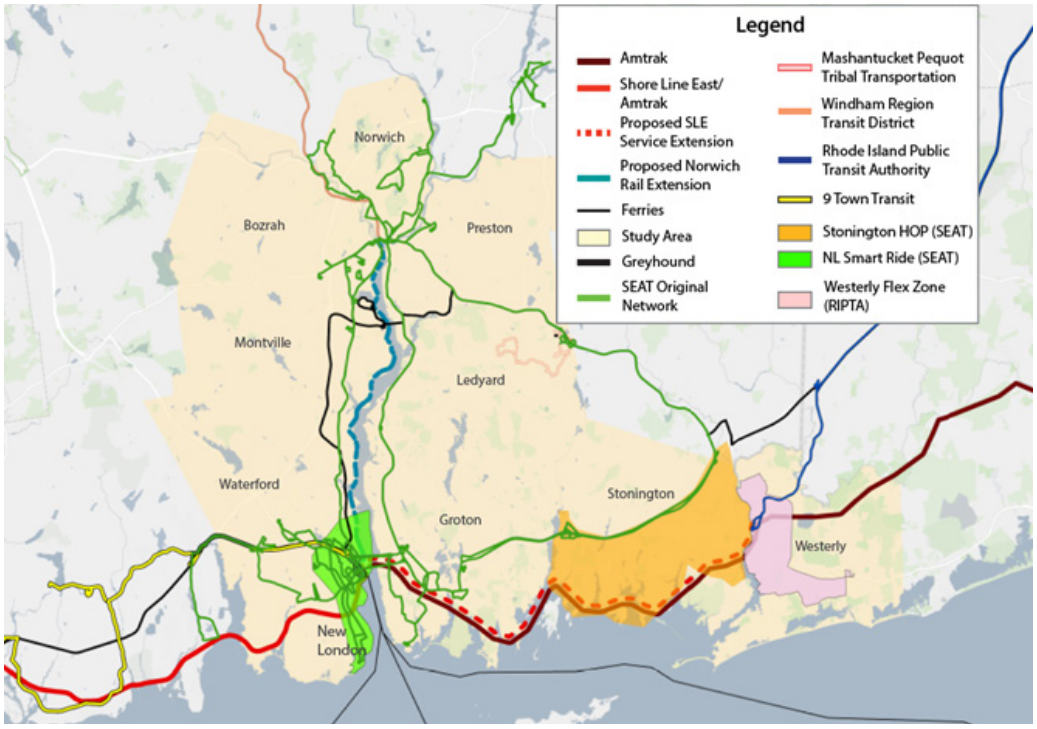

Figure 5
Existing Transit Service Map

Table 1
SEAT Local Transit Service

Type of Service	Routes	Service Span and Frequency	Service Area
Fixed route	16 routes	M-F, start time range: 6-8am; end time range: 7-11pm Service every hour except on Routes 2, 3, 108 (2 hrs)	Range of routes operating in and between New London, Montville, Norwich, Preston, Ledyard, Groton, and Stonington
		Sat (all except Route 3), start time range: 6-9am; end time range: 5-11pm Service every hour except on Routes 1, 2, 108 (2 hrs)	
Demand response	SEAT Connect (Complementary ADA paratransit)	M-Sat, 6am-11pm	Trip requests at least a day in advance, all trips begin/end within ¾ mile of a SEAT fixed route
	New London Smart Ride	M-Sat, 8am-8pm	Microtransit trips beginning and ending within New London
	Stonington HOP	M-F, 6am-6pm	Microtransit trips beginning and ending within Stonington

3

Preliminary Feasibility Assessment


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3.Preliminary Feasibility Assessment

The region-wide and corridor-specific findings from the existing conditions analysis and engagement efforts are discussed below. Together, the baseline conditions and market analysis informed the results of the Preliminary Feasibility Assessment (Appendix H), which identified specific corridors and station/stop sites for further analysis and assessment in this study.

From a bus perspective, there were several key findings that informed future service plans:

- The region's concentration of people and employers largely exists along the Thames River, with hubs in New London, Groton, and Norwich. Approximately 48 percent of all study area jobs and 44 percent of the study area population are within a mile of the corridor.
- Although not directly along the corridor, Foxwoods Casino has high job density as it is a regional entertainment destination.
- There is a need for transit investment to support local development and growth, as well as attract more people and jobs to the region. Robust transportation options should be implemented in anticipation of the projected increase in manufacturing and defense industry jobs.
- Two common job classifications within the region include service industry staff at casinos and employees at the submarine base. Many of these employees, especially those in the hospitality industry, would be more inclined to use transit – if frequent and convenient -- as it can be a more affordable option compared to car ownership. The convenience of transit could also support the mobility of sailors at the submarine base who do not have cars.
- The region's employment and population density levels are lower than those that traditionally support rail service, indicating that bus service connecting New London and Norwich could be a better alternative.
- Electric Boat offers shuttle services and promotes carpooling among employees, however additional transit service is needed in employment centers, like downtown Groton, where parking demand is projected to exceed capacity.

Three corridors were initially considered for commuter passenger rail service during the Preliminary Feasibility Assessment: NEC, Thames River, and Groton Secondary[23].

- **NEC.** This segment of the NEC has two tracks with Amtrak intercity passenger rail service that passes through areas of high population[24] and employment densities[25] in New London, Groton, and Westerly. With the Amtrak infrastructure and service already in place, possible extended SLE service could support connections between corridor-abutting communities, to the region's major employers (with over one thousand employees), and to major tourist destinations in New London and Mystic.
- **Thames River Corridor.** GWI currently operates minimal freight service along single tracks on the west banks (Palmer Line) and east banks (Norwich Branch) of the Thames River[26]. New passenger rail service along the Palmer Line could provide direct connection to Mohegan Sun Casino and Resort, which is responsible for the highest percentage of vehicle traffic in the region[27], in addition to other destinations such as Connecticut College and the US Coast Guard Academy. Alternatively, the Norwich Branch passes through the US Navy Submarine Base and the planned Preston Riverwalk Development.
- **Groton Secondary.** This segment consists of a single track that extends from Electric Boat through Pfizer's campus and connects with the NEC between Poquonnock and South Road in Groton. Currently there is no passenger or freight service operated on this segment. Passenger rail service along this corridor could potentially address gaps in local transit, which currently does not provide frequent service to two of the region's largest employers, Electric Boat and Pfizer.

[23] While stakeholders expressed interest in inter-city rail connections, that is beyond the scope of this study, which focuses on commuter rail feasibility. Amtrak's 2023 New Haven to Providence Market Study details the travel behavior and demand for intercity rail between the two locations.
[24] US Census Bureau 2019 American Community Survey
[25] US Census Bureau Longitudinal Employer-Household Dynamics (LEHD) Dataset
[26] Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix E: Corridor Capacity Analysis and Service Framework. February 2023.
[27] Streetlight Data, March-April, July-August, and September-October 2019 & 2021, combined destinations

As part of the station siting process, eighteen station locations were initially evaluated along the three corridors to document the opportunities and constraints associated with each – seven along the NEC, eight along the Thames River Corridor, and three along the Groton Secondary (Figure 6). Siting considerations assessed in the analysis include regulatory and physical site characteristics, such as existing parcel ownership, land use, zoning, presence of environmental justice communities, right-of-way constraints, topography, wetlands presence, and susceptibility to climate impacts, including flooding and extreme heat. The stations were also evaluated with regards to existing transit, cycling, and pedestrian accessibility, as well as market potential and operational feasibility.

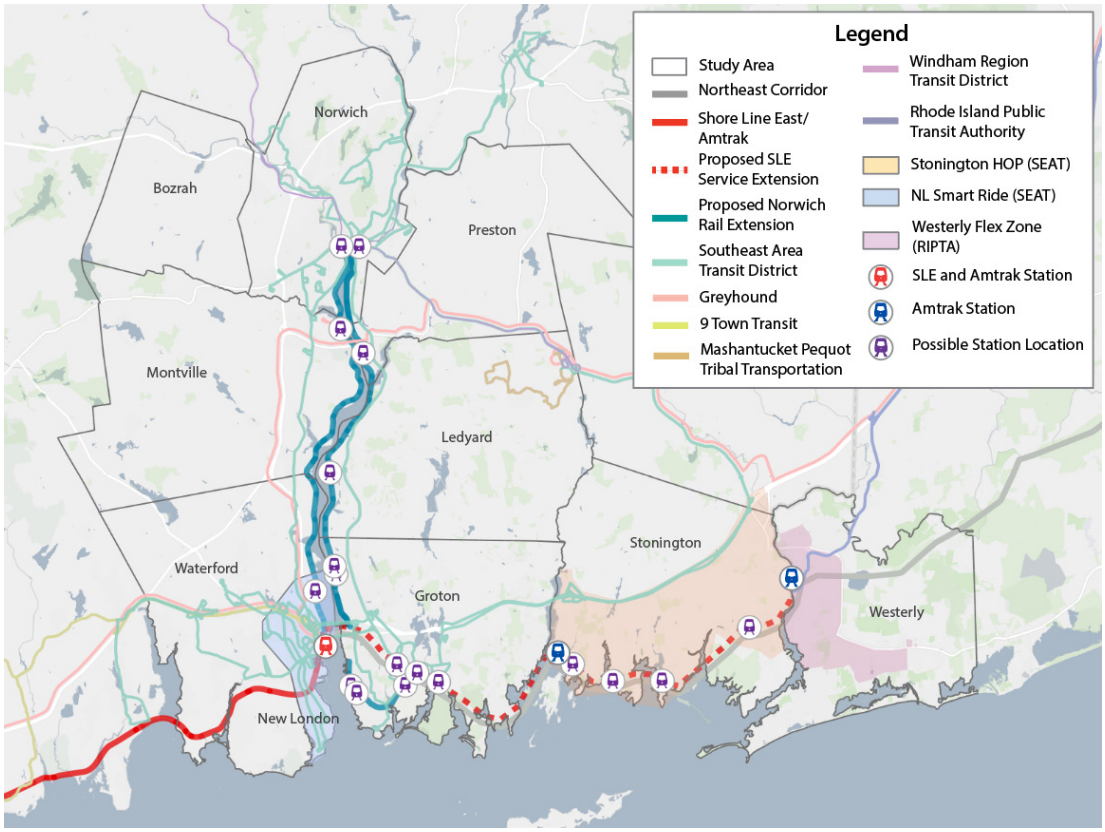

Figure 6
Study Area Possible Station Locations

3.1. Rail & Transit Market

Analysis of demographics, development, and travel trends and projections are key to understanding the anticipated transit market and the scope of transit service changes that could work towards meeting the needs of that market.

3.1.1. Population Changes

Future projections indicate slow overall population growth in the state and region; southeastern Connecticut population is projected to increase by 0.28 percent per year between 2023 and 2050[28] . Projected population change in specific locations may diverge from actual future changes depending on the land available for development, but Norwich and Montville are projected to see greater population increases relative to the rest of the region due to greater birth and in-migration rates. Additionally, there is a significant older population throughout the region — in part due to individuals not relocating post-retirement — resulting in about a third of the population being over the age of 65[29] . This aging population trend points to a potential future high demand for a variety of accessible and safe transportation options.

3.1.2. Employment Changes

The number of jobs declined in the pre-pandemic decade. The region relies heavily on the gaming and service industries for job opportunities, which have both been severely impacted since the recession in 2008 and more recently by the COVID-19 pandemic[30] . However, the COVID-19 pandemic made prior projections around the labor market less clear in their certainty — the unemployment rate continues to fall in the region, and the manufacturing industry is anticipated to grow rapidly in the next decade. General Dynamics Electric Boat hired thousands of new employees in 2022 and is expected to bring 2,500 new jobs to the region to meet the needs of new military contracts by 2029[31] .

3.1.3. Transit Oriented Development (TOD)

TOD is often associated with a host of potential benefits including increased and accelerated development, as well as a wide spectrum of economic, social, public health, and environmental benefits. The TOD Corridor Scan[32] analyzes the existing conditions specific to the communities surrounding the proposed rail extensions to identify areas that could benefit from improved rail and transit access, evaluate initial TOD opportunities, and highlight potential economic impacts of proposed rail alignments. It reveals relatively low population and job densities along the corridors, but greater population and job densities in urban cores[33] . These urban cores — particularly New London, Norwich, and Groton — could likely support the most transit ridership and could potentially sustain TOD[34] . Discussions with major employers and activity centers corroborate these findings, as current and anticipated employment base growth patterns could contribute to increased ridership. However, supportive land use policies and local infrastructure investments that promote densification, walkability, and multi-modal connectivity throughout corridor-abutting communities is critical to the viability and success of TOD. Ultimately, the market for TOD is established by advancing TOD-supportive policies and investments while taking into account the existing conditions and projected trends across areas.

[28]Southeastern Connecticut Council of Governments. Southeastern Connecticut Metropolitan Transportation Plan FY 2023-2050. March 2023. http://seccog.org/wp-content/uploads/2023/05/2023-2050SCCOGMTP-20230506revison.pdf

[29]Regional Plan of Conservation and Development – SCCOG. (2017). Retrieved from Seccog.org website: http://seccog.org/reg-plan

[30]Connecticut Department of Transportation. Eastern Connecticut Rail and Transit Feasibility Study Preliminary Feasibility Assessment Executive Summary. March 2023.

[31]Southeastern Connecticut Council of Governments. 2023.

[32]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix A: Existing Conditions Report. March 2023.

[33]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix B: Transit Oriented Development Corridor Scan. March 2023.

[34]Industry research suggests a density threshold of around 3,000 people per square mile for operating some level of infrequent local bus service. In addition to people, industry guidelines suggest that the housing density levels necessary to support transit are approximately 4,500 units per square mile for BRT and 2,500 units per square mile for regular local bus service. (CRCOG. Fact Sheet: Transit Oriented Development. 2016. https://crcog.org/wp-content/uploads/2016/07/Ch05_FactSheet_TOD.pdf; PSRC. Transit-Supportive Densities and Land Uses. February 2015. https://www.psrc.org/media/4958)

[35]Streetlight Data, March-April, July-August, and September-October 2019 & 2021.

[36]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix A: Existing Conditions Report. March 2023.

3.1.4. Travel Patterns

Travel patterns show Mohegan Sun Casino and Resort and Foxwoods Resort Casino drawing approximately 39% of the vehicle traffic for major destinations in the region (Table 2)[35] . Though the existing rail and transit network serves these major destinations, there are substantial opportunities to expand accessibility to and within southeastern Connecticut. Directness, speed, frequency, and span of rail and transit services are all areas of opportunity for improvement.

The current parking infrastructure providing connections to bus or rail service consist of park & ride lots, train station parking lots and garages, and municipal parking. Parking varies in the amount of spots available and cost, and the availability does not always align with the demonstrated parking need. In downtown Groton, for example, the projected increase in number of Electric Boat employees, which could bring more commuter traffic to the area, is anticipated to generate a deficit of 1,7 parking spaces. Groton also provides an example of a municipality where the local park & ride lot averages 100 percent capacity and does not provide connection to bus or rail services within ¼ mile[36]. Additional transit service, more aggressive Transportation Demand Management (TDM) policies, the construction of new parking lots in close proximity to transit, rail service, and in downtown areas, or a combination of these strategies could be needed to address demand.

Table 2
Major Destination Travel Patterns

Major Destination	Daily Traffic	Total Share	Highest Volume Travel Origins
Mohegan Sun Resort and Casino, Montville	13,320	21.0%	Montville (32.6% of trips) Norwich (14.8% of trips) Ledyard (5.4% of trips)
Foxwoods Resort Casino, Ledyard	11,135	17.6%	Ledyard (33.1% of trips) Norwich (9.5% of trips) Montville (5.9% of trips) Groton (5.5% of trips)
Westerly	9,453	14.9%	Westerly (62.4% of trips) Stonington (14.9% of trips)
Mystic	7,234	11.4%	Stonington (44.2% of trips) Groton (33.3% of trips)
US Navy Submarine Base, Groton	6,620	10.4%	Groton (64.3% of trips) Ledyard (9.5% of trips) New London (5.2% of trips)
New London Center	5,439	8.6%	New London (39.6% of trips) Groton (13.3% of trips) Waterford (12.5% of trips) Montville (5.9% of trips)
Electric Boat/Pfizer, Groton	4,469	7.1%	Groton (42.9% of trips) New London (6.3% of trips) Montville (5.2% of trips)
Norwich Center	3,544	5.6%	Norwich (57.4% of trips) Montville (7.4% of trips)
Downtown Stonington	2,163	3.4%	Stonington (61.9% of trips) Groton (11.9% of trips) Westerly (11.4% of trips)

3.1.5. Rail and Transit Need

Transit scores are calculated as a composite score based on demographic data for categories including senior population, minority population, poverty, employment, single car and zero car households, income, renter status, disability, and zone traffic[37] . Within the study area, Norwich, New London, and Groton have the highest concentration of census blocks with high transit scores. The map of transit scores by census block highlights areas with greater concentrations of population with demographics that may benefit most from improved connectivity and enhanced access to rail and bus transit (Figure 7). Improving transit connectivity in these areas also aligns with supporting improved transit access for disadvantaged communities, such as those identified in the Climate and Economic Justice Screening Tool developed under the Justice40 Federal program.

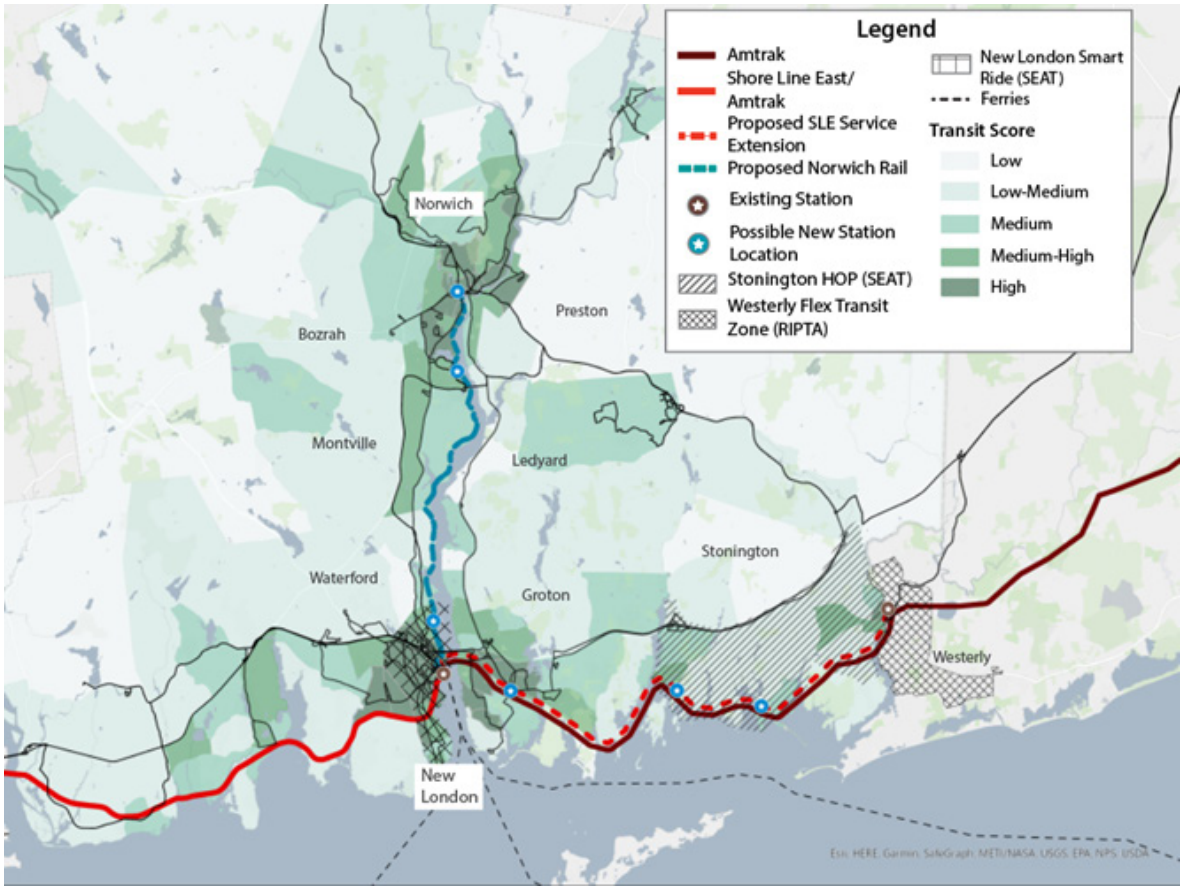

Figure 7
Study Area Transit Scores by Census Blocks

[37]To produce a data-driven market analysis, demographic data by category was broken into quantiles with each quantile being attributed a score between 1 and 4. The category-based scores were summed to determine a composite transit score for each census block – the highest possible score is 44 and scores ranged from 11 to 43.

3.2. Outcomes

While all the alignments analyzed during the Preliminary Feasibility Assessment were determined to be technically feasible, the remainder of the phases of the ECRTS focus detailed analysis on the most viable rail alignment in each corridor and congruent bus transit improvements to support greater regional connectivity. The Thames River Bridge – a moveable bridge operated by Amtrak that spans the river from New London to Groton – was determined to be a key constraint when screening the NEC, Thames River Corridor, and Groton Secondary. The Corridor Capacity Analysis determined that both the bridge's operational requirements and schedules associated with future Amtrak growth only allow the addition of one commuter train per hour in each direction[38] east of New London Station across the bridge. Potential operations along the Palmer Line are not tied to the Thames River Bridge, but service along the NEC, east side of the Thames River, and Groton Secondary each would require a train to traverse the bridge. Because of the scheduling constraints associated with the bridge and future Amtrak operations, providing service along the NEC would preclude service along the Thames River corridor via the Norwich Branch (east side) and service along the Groton Secondary.

Moving forward with passenger rail service via the SLE extension on the NEC and the Palmer Line (Figure 8) serves larger population nodes, vulnerable communities, employment centers, and recreational destinations. Serving these locations could encourage TOD buildout in areas that have the infrastructure, demand, and support for development. More details on each corridor are provided in the next two sections. The east side of the Thames River, including major employers and the future Preston River Walk development, could be served with improved transit options, discussed in Section 5, Bus Transit Service Plan.

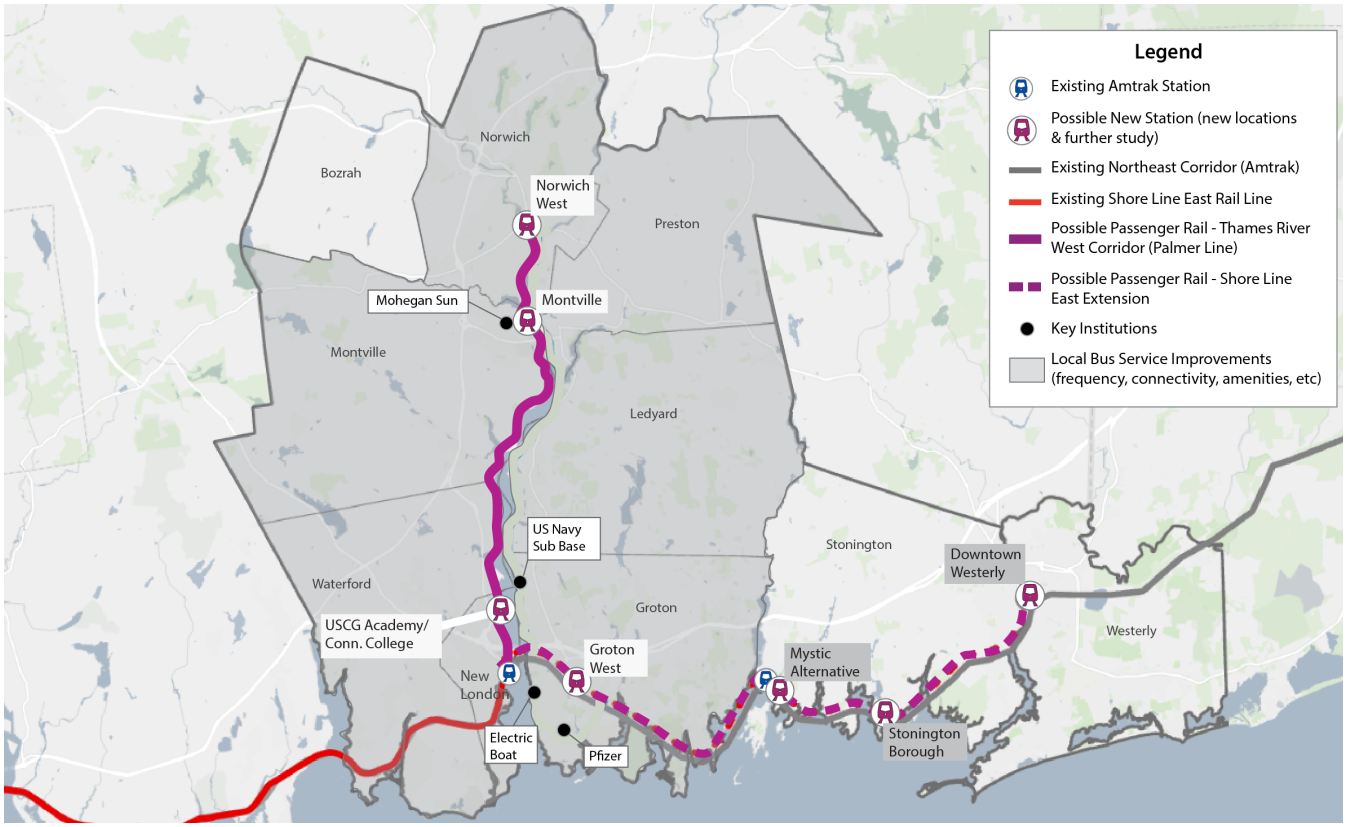

Figure 8
Proposed Rail Alignments and Station Locations

[38]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix E: Corridor Capacity Analysis and Service Framework. March 2023

3.2.1. NEC

The portion of the NEC between New London and Westerly is characterized by a considerable number of curves along the route, two movable bridges, and several grade crossings, all of which limit the speed of rail service[39]. There are significant service constraints involved in operating on movable bridges due to the time consumed when a bridge is closed to rail traffic. The alternative, however, of rebuilding a bridge to be at a height where river traffic could pass underneath is an expensive undertaking that could significantly add to the project's estimated capital costs and impacts to surrounding communities. Ensuring that additional service levels coordinate with movable bridge operations is, therefore, a more feasible option than rebuilding the Thames River Bridge. Factoring in Amtrak's planned service increase and associated traffic[40] , one commuter train per hour in each direction is feasible. Since the Thames River is a federally regulated and navigable channel, achieving a frequency of one commuter train per hour in each direction across the bridge would require extensive coordination with the US Coast Guard and Amtrak, as well as right of way (ROW) securement and permitting.

The analysis of potential station locations within each station area zone and input from Amtrak identified the following locations as most feasible[41]:

- **Groton West:** Unlike the Groton East and Groton Central sites, Groton West may not require track reconfiguration. Groton West also has higher relative ridership demand, requires less coordination with Amtrak service and the US Coast Guard.

- **Mystic Alternative:** The existing Mystic Station is not compatible with CTDOT's electric M8 equipment or the Americans with Disabilities Act (ADA), which require level-boarding at stations[42]. The curvature at the existing Mystic Station prevents the platform from being reconstructed to accommodate high-level boarding and be ADA compliant, thus requiring a new station to be sited. The Mystic Alternative site is located on a straighter section of track and can be built to include high-level boarding and be ADA accessible.

- **Stonington Borough:** This location demonstrates higher ridership demand and market potential than the other possible Stonington station sites. The Borough location is also walkable to Stonington's downtown area, thus supporting TOD and transit access to major trip generators.

Figure 9
Thames River Movable Bridge

[39]Connecticut Department of Transportation. Eastern Connecticut Rail and Transit Feasibility Study Preliminary Feasibility Assessment. March 2023.
[40]As shown in the ECRTS Preliminary Feasibility Assessment Appendix E: Corridor Capacity Analysis and Service Framework, Amtrak's operations are planned to increase from 10 Acela weekday roundtrips to 14, and from 9 Regional weekday roundtrips to 17.
[41]The ECRTS Preliminary Feasibility Assessment Appendix F: Potential Station Sites details this analysis.
[43]US DOT Federal Transit Administration. Oversight Procedure 35 – ADA Review (Level Boarding and Between-Car Barriers for Commuter Rail). June 2018. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/regulations-and-guidance/117586/op-35-ada-review-06-2018.pdf

3.2.2. Thames River Corridor

Each of the towns with potential stations along the Palmer Line – New London, Montville, and Norwich – have Plans of Conservation and Development (POCDs) that identify the importance of and plan to improve multimodal access. This includes enhancing and expanding bicycle and pedestrian infrastructure and improving the accessibility of expanded transit service[43] . Similarly, Montville, New London, and Norwich plan to increase infill development and have a large percentage of connected sewer service areas to support this expansion. Prioritizing passenger rail service along the Palmer Line is congruent with the SEAT Bus Study, Southeastern Connecticut Council of Governments (SCCOG) Long Range Metropolitan Transportation Plan, and the SCCOG POCD, which set the goal of express bus service or Bus Rapid Transit (BRT) "lite" from New London to Norwich to capitalize on travel patterns and improve regional connectivity.

Potential phasing of public transportation improvements along the Thames River Corridor could allow those traveling between regional economic nodes to experience greater mobility more immediately, while larger capital investments become operational over a longer time horizon. The short and long-term strategies identified in this report are initial suggestions for improving connectivity in the southeastern Connecticut region. While short-term strategies could be more readily adopted, given accompanying financial and operational support, long-term strategies would require further steps including coordination with other stakeholders such as regulatory authorities and utilities as well as a more detailed review of infrastructure components like bridge conditions and load ratings as well as grade crossing assessments. On the bus side, additional actions could include a Comprehensive Operational Analysis (COA) that updates the findings in the previous one, conducted approximately eight years ago. In both short- and long-term instances, additional funding would be needed.

The short-term strategies outlined in this study focus on increasing inter-municipal mobility, including expanding and enhancing the bus transit service on both sides of the Thames River. Improving regional bus service from New London to Norwich has been identified as a priority in numerous statewide, regional, and local plans. Improving the operating hours, increasing frequency, and adopting a single fare collection system could heighten the usability and convenience of service for travelers commuting between the two nodes and beyond. On the east side of the river, enhancing local bus service by establishing a frequent route between the US Navy Submarine Base and Electric Boat's Groton facilities could leverage existing roadways to provide expedient service between the two major employers.

The long-term strategies outlined in this study focus on improving regional connectivity and include upgrading the Palmer Line to establish commuter rail service between Norwich and New London, with stops at Norwich West, Montville (Mohegan Sun), and US Coast Guard Academy/ Connecticut College in New London.

4

Bus Transit Service Plan


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4. Bus Transit Service Plan

Transit improvements could be an effective solution that addresses regional mobility needs, independent of any potential other actions. The transit market analysis and associated public outreach conducted as part of this study demonstrates a current need for bus transit investment. Investments in transit could support local development and growth, attract more people and jobs to the region, and provide robust transportation options for the growing number of manufacturing and defense jobs. The region's concentration of people and employers largely exists along the Thames River, with hubs in New London, Groton, and Norwich. Approximately 48 percent of all study area jobs and 44 percent of the study area population is within a mile of the corridor[44]. The study area is expected to add an additional 2,000 residential units in the next 3 to 5 years[45]. Many of these multifamily units may be in transit-accessible locations like New London, Groton and Norwich. New London and Groton anticipate an influx of jobs due to growth in the local manufacturing and defense industries. Although not directly along the corridor, Foxwoods Resort Casino has high job density as a regional entertainment destination.

SEAT's 2015 Comprehensive Operational Analysis[46] (COA) examined three scenarios: two cost neutral and one that focused on system expansion. As a result of the proposed service modifications, SEAT increased frequency of service between Norwich and New London, partially extended service hours, discontinued some low ridership routes, and established a Norwich-Foxwoods Casino Connector. Despite these improvements, SEAT's current transit service does not include Sunday service, has limited evening service, and does not offer a connection between New London and Westerly.

Several factors contribute to the potential need for a near term transit solution along the Thames River and other population nodes, and are further detailed in the Transit Service Plan (Appendix I):

- Though public transit ridership dipped during the global COVID-19 pandemic, SEAT currently serves more riders than pre-pandemic levels[47]. This suggests an appetite for expansion of public transit.

- Job growth in areas like downtown Groton, where parking demand is projected to exceed capacity, creates conditions that could encourage higher non-single occupancy vehicles[48] mode share if transit is frequent, reliable, and serves destinations of interest.

- Among the most common types of employees in the region are service industry staff and employees at large regional employers like the US Navy Submarine Base, two groups that are open to transit as a mode of transportation to work, whether for financial reasons (reducing the cost burden of a personal vehicle) or for convenience (for sailors on base who do not have cars).

- Demographic indicators – presence of minority, low-income, and older adult populations – signal that demand for travel could exist along the coastline and the Thames River. Transit service oriented towards these higher-demand locations could be able to tap into latent demand.

- When surveyed as part of this study, 94% of respondents said that they would support passenger rail from Norwich to New London, with 59% reporting they would use the service occasionally to regularly. This underpins key findings from previous planning documents, calling for increased regional connectivity between existing population and employment centers whether by bus transit or rail[49].

[44]The corridor was measured by generating a 1-mile buffer around the existing Route 1 and Route 2 SEAT routes as they run parallel to the river.
[45]Costar, Goman + York Property Advisor.
[46]Southeast Area Transit District. SEAT Bus Study Final Report. October 2015.
[47]NTD SEAT fixed route ridership data
[48]Single Occupancy Vehicle
[49]Connecticut Department of Transportation. Preliminary Feasibility Assessment Appendix G: Public Survey Report. March 2023.

Water transportation, such as a shuttle or adding stops along ferry routes, could be another possibility for connecting New London with Groton and Montville with Ledyard/Preston across the Thames River. The shortest connection between each of these two community pairs is across the river, not through the roadway/bridge network. Additional study and coordination beyond the scope of this feasibility study is needed to understand the water transportation potential and costs in this region. This could include additional interviews with existing operators and identifying the necessary regulatory steps involved with creating a ferry service.

Because SEAT is the primary transit provider within the study area, the transit service plan focuses on short-term improvements that can be made to SEAT's existing level of service, infrastructure, and policy. However, timed connections to Windham Region Transit District, 9-Town Transit, RIPTA, SLE, Amtrak, and the ferry services are vitally important to regional connectivity, workforce development, and tapping into the economic potential of the region, and thus need to be coordinated regularly with each agency's timetables. For FY24, improvements to SEAT services are budgeted and are anticipated to include the re-introduction of Sunday service, improvements to frequency and span of service, and introduction of new services. As the implementation for these expansions is finalized, this document will be updated

4.1. Level of Service Strategies

Level of service improvement strategies are informed by the transit service and demand analysis, review of previous plans, and discussions with regional stakeholders. The strategies include fixed route realignments (Figure 10), extended demand response service (Figure 11), and schedule modifications that may overlap with planned FY24 enhancements. The below tables provide an overview of improvements to SEAT's fixed route and demand response services, including increased level of service, new routes and service, and eliminated and replaced routes. Implementation timeframe as well as the number of additional vehicles needed to address current gaps in service and align the transit network with emerging demand centers is also detailed in Table 3 and Table 4. Strategies to improve mobility within the study area are slated into two timeframes: (1) standalone bus strategies which could be implemented by 2028 and (2) bus with rail strategies, which could have the potential to be accomplished by 2035. These strategies are currently unfunded.

The primary goals of these improvement strategies are to:

- Implement express service on Connecticut Routes 12 and 32 and achieve faster travel times between regional destinations (SEAT Route 1E, Route 2, and Route 108);
- Provide strong transit connections to Electric Boat and Pfizer, including connections to Norwich and New London through one-seat rides or regional transit hubs (SEAT Route 85);
- Expand transit coverage in areas with high proportions of cost-burdened renters and transit-dependent households (SEAT Route 76 and demand response services like the proposed Grot-On-Demand);
- Serve tourist destinations seasonally, including increased service following the possible future implementation of passenger rail service (SEAT Route 32 and Stonington HOP);
- Increase accessibility to grocery stores, medical facilities, faith-based organizations, and other commercial activities on Sundays along routes that could serve a likely increased rider base (SEAT Routes 4, 6, 7, and 14, and ADA Paratransit, New London Smart Ride, and Grot-On-Demand)[50] ; and
- Improve regional connections beyond the study area to Hartford (CTtransit 914 Hartford Express).

To advance these improvement strategies, SEAT would need to secure sufficient funding to support the estimated increase in operational costs, as well as estimated capital costs related to a larger fleet and any infrastructure improvements.

[50]SEAT plans to offer Sunday service in 2023.

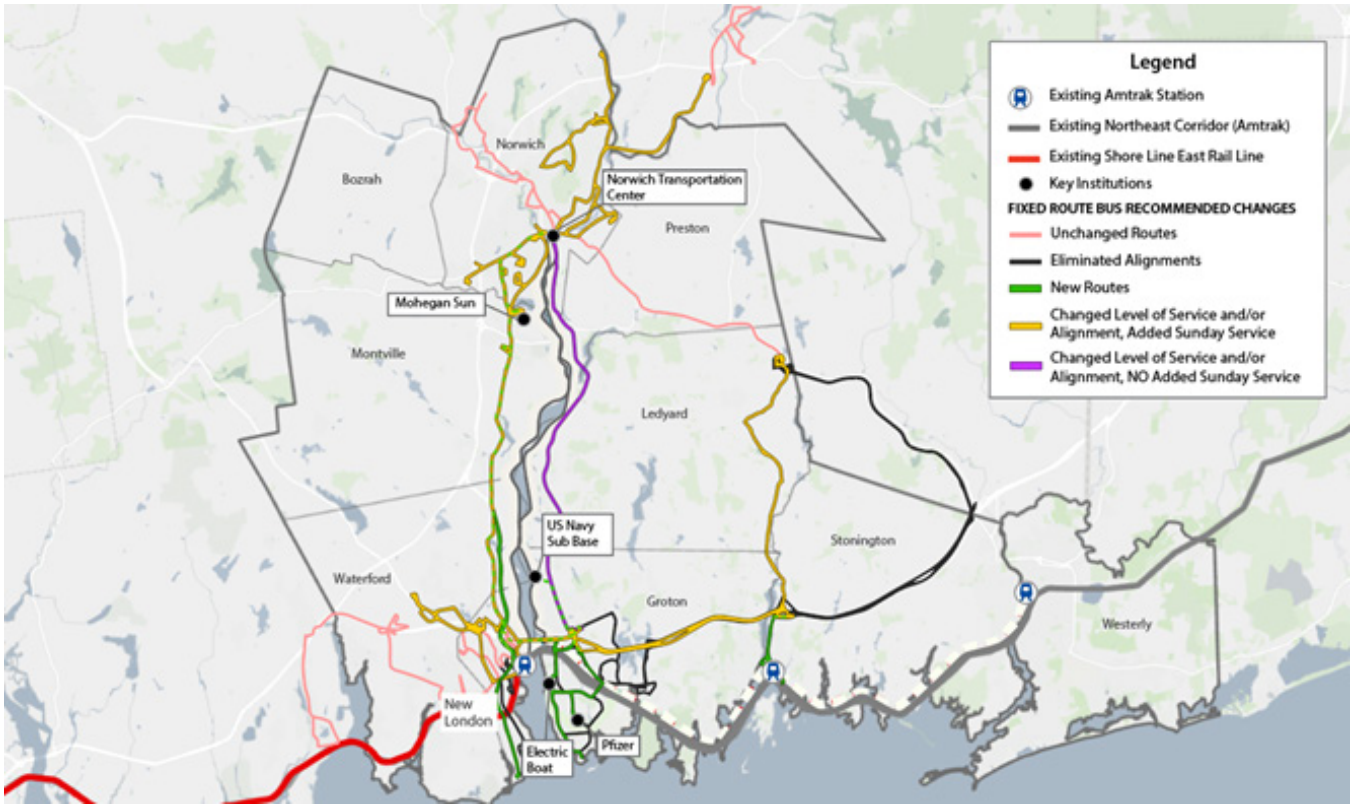

Figure 10
Proposed SEAT Fixed Route Service and Routing Modifications

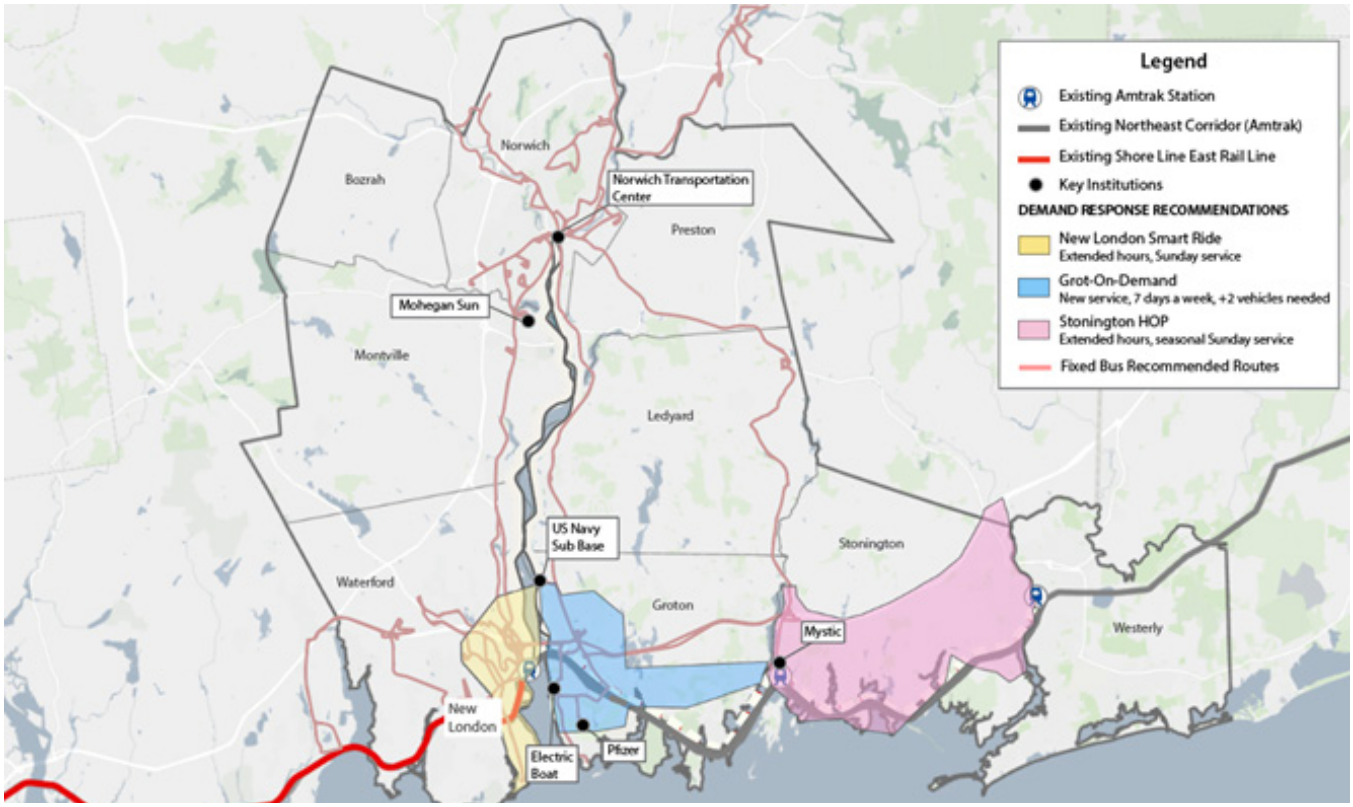

Figure 11
Proposed SEAT Demand Response Service Modifications

The below tables provide an overview of improvements to SEAT's fixed route and demand response services, including increased level of service, new routes and service, and eliminated and replaced routes. The potential implementation timeframe as well as the number of additional vehicles needed is also detailed.

Table 3
Level of Service (LOS) Improvements, SEAT Fixed Route

Change to Service	Route	Description	Standalone Bus	Bus with Rail	Net Vehicle Count
Increased LOS	Route 1	Sunday service, faster headways	✓		0
	Route 2	Faster headways, extended hours, alignment	✓		0
	Route 4	Sunday service		✓	0
	Route 6	Sunday service		✓	0
	Route 7	Sunday service		✓	0
	Route 14	Sunday service	✓	✓	0
	Route 108	Sunday service, faster headways, alignment			+1
New Route	Route 1E	Additional weekday express service	✓		2.0
	Route 32	Seasonal Mystic service	✓	✓	+1, +2
	Route 76	New London-Groton	✓	✓	+1, +1
	Route 85	Groton via. Electric Boat/Pfizer	✓	✓	+2, +2
	Route 123	New London via. Ocean Beach	✓	✓	+1, +1
No Service Change	Route 3 Route 5 Route 8 Route 9 Route 982	-		-	0
Route Eliminated	Route 11	See new Route 76 & 85 (above); See new Grot-On-Demand (below)		-	-1, -1
	Route 13	See new Route 123 (above)			-1, -1
	Route 15	See New London Smart Ride (below)			0
				Total Standalone Bus:	**+6**
				Total Bus with Rail:	**+5**

Table 4
Improving LOS, SEAT Demand Response

Change to Service	Program	Description	Potential Timeline	Net Vehicle Count
Increased LOS	ADA Paratransit	Sunday service	2028	0
	NL Smart Ride	Extended hours, Sunday service	2028	0
	Stonington HOP	Extended hours, seasonal Sunday service	2028	0
New Service	Grot-On-Demand	7 days a week	2028	+2
			Total:	**+2**

This set of strategies is intended to streamline service, enhance frequency, bolster transit connectivity between areas of interest, and extend the span of service hours. Transit could be an effective solution that addresses regional mobility needs, independent of any potential other actions. Most route-level service and alignment changes could be implemented independently of rail service, if additional funding is committed. In the longer term, several routes could be impacted by the potential future implementation of long-term rail service expansion along the Thames River and along the coastline from New London to Westerly. Where applicable, service changes are identified that would prevent service duplication and shift alignments to serve potential new stations. More details on transit strategies, including the reasoning behind modifications, specific routing and level of service updates, and bus schedules can be found in the Transit Service Plan (Appendix I).

4.2. Infrastructure and Policy Strategies

Beyond increasing bus service frequency and altering route alignments to better match ridership demand, infrastructure upgrades could increase travel speed and passenger experience. A complete description of infrastructure and policy strategies are included in the Transit Service Plan (Appendix I), but they are summarized here. Funding for implementing these strategies has not been committed.

4.2.1. Transit Signal Priority

To support new potential bus routes and improve travel times throughout the system, there are several infrastructure elements that could be implemented along bus routes. TSP enhances on-time performance by improving signaling for buses. Performing a TSP evaluation could identify opportunities to support the efficiency of new and existing bus routes. The results of a TSP evaluation could build on other roadway improvement projects; for instance, Connecticut Route 85 in Waterford is currently undergoing upgrades, including fiber optic interconnection for signals, which could also facilitate transit signal priority. Installing TSP in tandem with other upgrades could save money and reduce potential delays for riders. In addition to TSP, there could be other opportunities to improve the speed of transit service, such as installing queue jump lanes on roadways in high traffic areas like Mystic, Norwich, and New London and reconfiguring intersections.

4.2.2. Bus Stop Infrastructure

In addition to the intersection adjustments and queue jump opportunities highlighted above, improving bus stop infrastructure and amenities could enhance accessibility for riders. Currently, the majority of stops along SEAT's 16 fixed routes lack signage and amenities, even at stops with relatively higher levels of ridership (Table 5). The listed high ridership stops and any additional stops where multiple routes intersect should be studied further to determine infrastructure installation need. Strategies for improving infrastructure at these high ridership stops include meeting ADA compliance and installing signage, bus shelters and benches, sidewalks, and crosswalks where needed to improve safety and comfort for riders and pedestrians.

In addition to infrastructure upgrades at high ridership stops, every stop along fixed routes should at a minimum include bus stop signage with the service provider logo and contact information to support passenger wayfinding.

Table 5
High-Ridership Stop Current Amenities

Stop	Municipality	Daily Boardings	Signage	Shelter	Sidewalk	Crosswalk
Norwich Transportation Center	Norwich	331	✓	✓	✓	✓
New London Union Station	New London	292	✓	✓	✓	✓
Mohegan Sun	Montville	162		✓	✓	✓
Lisbon Landing - Walmart	Lisbon	72			✓	✓
Groton Square	Groton	67		✓	✓	✓
Wisconsin Ave & Hilltop Rd (NB)	Norwich	59				
Poquonnock Road[51]	Groton	48		✓	✓	
Walmart/Big Y	Norwich	35			✓	✓
Waterford Commons	Waterford	31			✓	✓
Bentley Ave & Ocean Ave (EB)	New London	33			✓	✓
Franklin St & Bath St (NB)	Norwich	46			✓	✓
Montville Commons	Montville	24			✓	✓
Crystal Mall	Waterford	20			✓	✓
Marcus Plaza	Norwich	22		✓	✓	✓
NSA Supermarket	New London	18			✓	✓
Quarto Rd & Davis Pl (EB)	Norwich	17			✓	

4.2.3. Policy

Realigning transit routes, improving intersections, and upgrading stop infrastructure are components of a multimodal strategy to improve transit access to employment, commerce, and recreation within southeastern Connecticut. In addition to the strategies above, consolidating stops and reviewing the flag policy have the potential to improve passenger travel times. Collaborating with other transit providers in the region to make fare collection seamless in a single system could also improve customer experience. With its newly released Customer Experience Action Plan, CTDOT is committing to enhancing user experience at each step of one's public transportation journey. Improved service, easier fare payment, and improved station and stop accessibility are among the identified customer priorities CTDOT aims to address through the Customer Experience Action Plan[52].

SEAT currently has a flag stop policy that allows individuals waiting along bus routes to "flag" down a bus and board at any point, even if there is no formal bus stop. While this service does increase flexibility for users, it also introduces safety challenges as individuals may wait for buses in poorly lit areas or in places that are unsafe to board. Understanding the need to balance safety with flexibility, SEAT should continue working with its member communities to review the flag policy and consider its revision. If the flagging policy is removed and new permanent bus stops are established, these stops must be constructed to comply with ADA guidelines, which include a firm stable surface, a compliant landing pad, cross slope restrictions, accessible connections, and a sidewalk width of at least three feet[53] . In the future, state funding could be available through the Bus Stop Enhancement Program to address a portion of these estimated capital costs[54] . Furthermore, any newly initiated CTDOT project on state roads must comply with the recently issued Complete Streets Controlling Design Criteria Directive requires the inclusion of transit provisions[55].

[51]Poquonnock Road is listed as Plaza Court as it is being removed and this will be the stop that replaces it.
[52]Connecticut Department of Transportation. Bus Stop Enhancement (BSE) Program Development. 2022. https://portal.ct.gov/-/media/OPM/NRZ/Meetings/2022/DOT-BSE_Program.pdf
[53]TCRP Report 19: Guidelines for the Location and Design of Bus Stops. Transit Research Board National Research Council. 1996. https://nacto.org/docs/usdg/tcrp_report_19.pdf
[54]Connecticut Department of Transportation. Bus Stop Enhancement (BSE) Program Development. 2022. https://portal.ct.gov/-/media/OPM/NRZ/Meetings/2022/DOT-BSE_Program.pdf
[55]Connecticut Department of Transportation. Complete Streets Controlling Design Criteria and Justification Process. 2023. ECD-2023-8_Complete_Streets_Controlling_Design_Criteria_ final_sah.pdf (ct.gov)

4.3. Ridership, VMT, and GHG Forecast

Prior to potentially establishing passenger rail on the Palmer Line or extending SLE service, the bus transit service plan outlines strategies to improving mobility, including the launch of five new routes, implementing one additional microtransit service, and adding Sunday service on ten routes and all demand response services. Were SEAT to secure funding to expand service by 2028, the increase in level of service combined with modest regional population growth[56] is forecasted to result in heightened ridership levels. This is forecasted to total approximately 303,000 additional trips per year across both fixed route and demand response service. The mode shift from personal automobile to transit could result in a reduction of up to 3.0 million vehicle miles traveled (VMT) annually, the equivalent of 120 trips around the globe.

CTDOT's goal of fleet electrification and SEAT's $20 million grant to electrify facilities are likely to influence SEAT's fleet composition in coming years, shifting from diesel to electric vehicles. If SEAT adopted the strategies outlined in the Transit Service Plan (Appendix I).

Service expansions alone are less impactful vis-à-vis a fifty to one hundred percent electric fleet, an additional 1,500 to 2,500 ton carbon dioxide reduction from tailpipe emissions could be realized from current conditions.

[56]Southeastern Connecticut population is projected to increase by 0.28 percent per year between the present (2023) and 2050. Source: Southeastern Connecticut Council of Governments. Southeastern Connecticut Metropolitan Transportation Plan FY 2023-2050. March 2023. http://seccog.org/wp-content/uploads/2023/05/2023-2050SCCOGMTP-20230506revison.pdf

4.4. Cost Estimates[57]

Moving forward with the bus transit service plan's strategies for improving mobility – including implementing new routes, improving the frequency on select routes, and increasing the span of service for SEAT operations -- would incur additional annual operations and maintenance expenses. Both operating and capital expenses would increase because of greater annual vehicle revenue hours and expanded fleet size, in addition to the initial capital costs associated with infrastructure and technology improvements. The detailed breakdown of estimated costs is included in the Transit Service Plan (Appendix I). Funding required to advance these strategies is currently not committed.

Generally, federal funding for transit is provided in two forms: federal apportionments and federal grants, which include loans and loan guarantees. The Federal Transit Administration (FTA) administers annual formula grants to transit agencies nationwide, as well as discretionary grants, which are awarded to recipients based on eligibility and merit. These funds support state and local public transportation systems.

Another federal funding mechanism, the Bipartisan Infrastructure Law, was signed into law by President Biden on November 15, 2021. By authorizing $1.2 trillion in total funding over 10 years (including $550 billion in new spending during FY 2021-FY 2025), it constitutes a substantial investment in intermodal transportation and other core infrastructure in the United States. Of the $550 billion in new spending, $284 billion is dedicated to improving the surface transportation network[58], including $103.5 billion dedicated to public transit projects[59] .

SEAT also receives state subsidy to support operating and capital costs, as well as local government contributions. Beyond these sources, SEAT generates revenue through fare collection and advertising.

4.4.1. Operation Cost Estimates

The identified changes in SEAT service can be modeled as a function of the additional vehicle revenue hours (VRH) associated with system expansion, as VRH is the most substantial factor influencing the cost of a transit system's operations. Implementing fixed route service at the level described by standalone bus strategies could incur an estimated total annual operating cost of $9.5 million (2023 Dollars) by 2028. Implementing the bus with rail strategies could incur a total estimated annual operating cost of $8.9 million (2023 Dollars) annually starting in 2035 (Table 6). Implementing corresponding demand response service at the standalone bus and bus-with-rail levels identified could incur approximately $2.6 million (2023 Dollars) in estimated operating costs annually starting in 2028 (Table 7). Because this is a feasibility study and has not reached the programming stage of project development, cost fluctuation could be expected to exceed 30%[60] .

Table 6
Estimated Operating Costs, SEAT Fixed Routes[61]

	Current	Level of Service: Standalone Bus (2028)	Level of Service: Bus with Rail (2035)
Annual VRH	67,000	92,000	86.000
Estimated Operational Cost (2023$)	$6,949,000	$9,538,000	$8,921,000
Estimated Operational Cost Increase (2023$)	--	$2,589,000 (+37%)	$1,972,000 (+28%)

[57]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account current market conditions.
[58]McKinsey and Company. 2021. "The US Bipartisan Infrastructure Law: Breaking it down." November 12, 2021. https://www.mckinsey.com/industries/public-sector/our-insights/the-us-bipartisan-infrastructure-law-breaking-it-down
[59]FTA. U.S. Department of Transportation Announces Key Priorities, Funding for Public Transportation Under the Bipartisan Infrastructure Law. 2021. U.S. Department of Transportation Announces Key Priorities, Funding for Public Transportation Under the Bipartisan Infrastructure Law | FTA (dot.gov)
[60]CTDOT 2022 Estimating Guidelines. 2022. CTDOT_Est_Guide_2022_v3.pdf.
[61]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account future market conditions.

Table 7
Estimated Operating Costs, SEAT Demand Response[62]

	Current	Level of Service: 2028 and beyond
Annual VRH	16,188 ADA – 5,067 Microtransit – 11,121	35,698 ADA – 5,899 Microtransit – 29,799
Estimated Operational Cost (2023$)	$1,251,000 ADA -- $384,000 Microtransit - $867,000	$2,769,000 ADA – $447,000 Microtransit – $2,322,000
Estimated Operational Cost Increase (2023$)	--	$1,518,000 (+121%)

In total, the implementation of expanded fixed route and demand response service could result in an additional estimated $4.1 million annually in operating expenses for standalone bus strategies, and an estimated $3.5 million annually following potential passenger rail implementation.

4.4.2. Capital Cost Estimates

In addition to estimated increase in operational costs associated with implementing the identified short- and long-term mobility strategies, SEAT would also face an estimated increase in capital costs in the form of bus procurement and infrastructure improvements to adopt the outlined service strategies (Table 8). For fixed route service prior to passenger rail implementation, SEAT would likely need 24 vehicles to operate maximum service and five spare vehicles – a total of 29 vehicles –; 23 vehicles operated in maximum service would likely be needed after expanded commuter rail implementation. SEAT's additional fixed route bus procurement needs would therefore likely consist of five 35-foot vehicles, which is estimated to cost approximately $5.5 million (2023 Dollars)[63] . The implementation of the Grot-On-Demand program may also require the purchase of additional vehicles. SEAT currently operates five microtransit vehicles in maximum service, three for New London Smart Ride and two for Stonington HOP. SEAT may require 3 vehicles to operate the Grot-On-Demand service and two additional vehicles to serve as spares, to achieve a 20% spare ratio.

The capital costs associated with implementing signaling and intersection improvements – TSP treatments for up to 78 intersections and 28 vehicles, queue jumps, and roadway reconfiguration – are estimated at approximately $1.7 to $2.7 million. Further study is needed to identify where specific TSP treatments and infrastructure improvements should be implemented. The estimated capital costs associated with implementing the minimum level of signage, bus shelters, sidewalks, and crosswalks at the 16 identified high ridership stops is approximately $850,000 (2023 Dollars). For all signaling, intersection, and bus stop infrastructure improvements, a comprehensive inventory of existing infrastructure should be studied in further detail, in tandem with investigations into the feasibility of TSP implementation and efforts to consolidate stops/change the flag stop policy. These cost estimates are preliminary figures and could fluctuate over time, increasing by up to 30%.

Table 8
Transit Strategies Capital Cost Estimates[64]

Capital Item	Estimated Cost (per unit)	Units	Total Approximate Cost
35' Electric Bus	$1,100,000	5	$5,500,000
Ford Transit Cutaway	$200,000	5	$1,000,000
TSP – Intersection [65]	$11,500 to $23,500	Up to 78	$897,000 to $1,833,000
TSP – Vehicle [66]	$5,250	Up to 28	$147,000
Queue Jump[67]	$12,500 to $17,500	Up to 10	$125,000 to $175,000
Roadway Reconfiguration (1)[68]	$500,000		$500,000
Signage [69]	$300	14	$4,200
Bus Shelter & Bench [70]	$8,500	9	$76,500
Pedestrian Improvements[71]	$250,000	3	$750,000
Total Estimated Cost (not incl. contingency):			**$9,000,000 to $10,000,000**

[62]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account current market conditions.
[63]In 2020, the cost of a New Flyer of America was approximately $930,000. In 2023 dollars, this equates to $1.1M.
[64]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account future market conditions.
[65]Alameda County Transportation Commission, Transit Technology Implementation Guidance, 2020, https://www.alamedactc.org/wp-content/uploads/2021/02/Appendix-D_Transit_Technology_Implementation_Guidance_20200824.pdf. Adjusted for inflation.
[66]City of Durham, Transit Signal Priority Summary, 2022. https://meadhunt.com/client/GoDurham/PlansAndStudies/TSPPlanReport.pdf. Adjusted for inflation.
[67]Alameda County Transportation Commission, Transit Technology Implementation Guidance, 2020, https://www.alamedactc.org/wp-content/uploads/2021/02/Appendix-D_Transit_Technology_Implementation_Guidance_20200824.pdf. Adjusted for inflation.
[68]Lump sum cost assigned for intersection improvements at John Street/Poquonnock Rd.
[69]AECOM Standard Cost Estimates, 2023.
[70]AECOM Standard Cost Estimates, 2023.
[71]Lump sum to install sidewalks in one location and crosswalks in 3 locations.

Rail Service Plan

5

5.Rail Service Plan

Like its bus transit counterpart, the Rail Service Plan (Appendix B) builds off the outcomes from the Preliminary Feasibility Assessment (Appendix H), which identified the SLE extension along the NEC and Palmer Line as the most suitable options for commuter passenger rail service in the region. This includes the siting of six new stations: Groton West, Mystic Alternative, and Stonington Borough along the NEC and Connecticut College/US Coast Guard Academy, Montville (Mohegan Sun), and Norwich West along the Palmer Line. The stations and strategies for achieving passenger rail service outlined in the rail service plan are unfunded.

5.1. Infrastructure Assessment

The New Haven Line (NHL) Capacity and Speed Analysis, conducted between 2017 and 2021, is a detailed assessment of the infrastructure, service, and fleet needs of the NHL as well as an overview of the branch lines (New Canaan, Danbury and Waterbury). Some of the reported findings inform the ECRTS including:

- Capacity and speed are constrained by legacy infrastructure;
- Track geometry and slow orders contribute to reduced speeds;
- State of good repair and normal replacement standards impact speed;
- Selected rolling stock technology can limit capacity; and
- Service and infrastructure can be optimized to improve trip times.

Building on the findings of the NHL Capacity and Speed Analysis, a visual field inspection was conducted for the ECRTS to assess the existing conditions of infrastructure in both corridors. This section presents a summary of the field inspection results that can be found in the Thames River Corridor Assessment, Appendix D to the ECRTS Preliminary Feasibility Assessment[72] . The results are broken up by asset category and further summarized by corridor (NEC/SLE Extension and Palmer Line), below.

5.1.1. Track Infrastructure

Track is defined as the composition of all the components that support longitudinal movement of rail vehicles. The three main components of a track are the steel rails, the ties, and the ballast/subbase. This assessment also includes interlockings[73] and sidings[74] .

NEC/SLE Extension

The SLE extension would be on the NEC, a two-track system between New London and Westerly, the limits of the study area. While the track infrastructure along the NEC is in good condition and generally meets Federal Railroad Administration (FRA) Class 8 standards[75] , the section under assessment is among the slowest along the entire Boston to Washington corridor, due to the many curves restricting maximum speeds to 90mph. Specifically, the infrastructure consists of:

- A 27.5 kilovolts (kv) alternating current (AC) constant tension catenary system with independent catenary[76] support poles;
- A bidirectional, multi-code cab signal system[77] optimized to support high speed service; and
- Amtrak's Advanced Civil Speed Enforcement System (ACSES) for complete positive train control (PTC)[78] compliance.

A third NEC track (Track 4) located in Groton between milepost (MP) 124 and MP 128 would need a complete upgrade, including electrification. This upgrade is required

[72]Connecticut Department of Transportation. ECRTS Preliminary Feasibility Assessment Appendix B: Thames River Corridor Assessment. March 2023.
[73]An arrangement of interconnected signals and signal appliances for which interlocking rules are in effect. Signals and movement of signal appliances must succeed each other in proper sequence to move trains between tracks.
[74]An auxiliary track to move trains off the main track for meeting or passing trains
[75]Railroad track quality is categorized by the FRA's Track Class standards, ranging from Class 1 to Class 9. Each class of track determines construction specifications, which dictate speed limits (increasing with Class level) and the ability to operate passenger trains. Source: US Track Classification Quick Reference: US Track Class Regulations per 49 CFR § 213, 49 CFR § 213. http://www.jgmes.com/webstart/library/table_fra_track.htm

to host eastbound trains making a stop at the Groton West station as there is insufficient room to construct a platform adjacent to the normal eastbound track (Track 2). The upgrade would include connecting switches at either end.

Palmer Line

The Palmer Line spans 13.6 miles of track between New London and Norwich. Spot checks during visual inspection found track infrastructure to consist of:

- Steel rail of 100/115RE pound (lb)[79] supported by wooden ties at all locations – most locations are served by wooden ties with severe longitudinal cracking, severe rotting, or buried units, which shows signs of poor drainage (Figure 12).
- Manual throw switches for sidings at two locations, with more likely throughout the rest of the corridor.

The ECRTS assumes the rail infrastructure would require a range of infrastructure improvements as part of the implementation of passenger rail on the Palmer Line to meet FRA Class 4 standards. These improvements, which are accounted for in the cost estimates provided in this study, include an upgrade of the current rail to a minimum of 132/133 lb steel rail, a new signal system with controlled passing sidings, electric locked industrial sidings, PTC compliance, and a complete replacement of damaged ties. A complete replacement of ties with concrete ties and an upgrade to the drainage system would be optimal.

Figure 12
Wooden Ties with Severe Rotting

[76]A system that uses overhead wire to supply electricity to rail vehicles.

[77]Cab signaling is a railway safety system that communicates track status and condition information to the cab, crew compartment or driver's compartment of a locomotive, railcar or multiple unit. The information is continually updated giving an easy-to-read display to the train driver or engine driver.

[78]Positive Train Control (PTC) systems are designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zones, and movements of trains through switches left in the wrong position.

[79]Rail sections in the United States are generally referred to by their weight per yard (lb). Larger rail designs were developed to better accommodate higher speeds and heavier trains.

5.1.2. Structures Study

Structures are classified into two main asset classes. An Undergrade Structure (UG bridge) is any feature the railroad bed crosses over, and an Overhead Structure (OH bridge) is any structure that passes over the railroad ROW.

NEC/SLE Extension

The most restrictive constraint along the NEC is the moveable bridge over the Thames River, and there is a second moveable bridge on the corridor that spans the Mystic River, ten miles east of New London. The opening and closing of the bridges to rail traffic can create significant impediments to both rail and marine traffic.

Palmer Line

Visual inspection of the Palmer Line found twenty-two UG structures, including seven timber trestle bridges. These seven bridges should be replaced, because the flammability, susceptibility to rotting and termite damage, and speed restrictions are not well suited for passenger service. OH structures were not found to have clearance or condition issues, with the exception of an abandoned bridge at Riverside Park that necessitates removal (Figure 13).

Figure 13
Abandoned Bridge at Riverside Park

5.1.3. Grade Crossings

It is assumed that CTDOT would undertake its customary diagnostics analysis of each grade crossing and based on the analysis, specify the crossing technology to be installed. Grade crossings for passenger rail should generally be fully signalized with bells, uni-directional traffic flow gates, and flashers. It is reasonable to assume all crossings would be, at the minimum, equipped with these active warning devices and receive upgraded running surfaces — the study's capital cost estimates for rail upgrades take these assumptions into account.

NEC/SLE Extension

Grade crossing technology on the NEC in Mystic and Stonington, approximately ten miles east of New London, is governed by specific federal statute unique to the NEC, including quad gates, intrusion detection, and pedestrian management systems. There are two grade crossings that contribute to restricted speeds in this area to conform with the statutory requirements.

Palmer Line

Visual inspection of the Palmer Line revealed twenty-four grade crossings of various materials. The Palmer Line's grade crossings are mostly in poor condition, with numerous crossing surfaces having severe issues. Additionally, twenty-one grade crossings lack active warning devices, and as a result, nearly all grade crossings would have to be upgraded.

5.2. Long-Term Mobility Improvement Strategy: New or Expanded Passenger Rail Service

The ECRTS investigates the development of future potential passenger rail service along the NEC and Palmer Line to determine whether scheduling along these two corridors would be compatible with existing operations. As such, existing and future rail operations on both the NEC (Amtrak passenger rail service) and Palmer Line (freight operations) are a key consideration in the development of new rail service schedules for each corridor. The proposed rail service plans for ECRTS are designed to avoid impacting existing passenger rail and freight service schedules. Funding for implementing these strategies has not been committed.

5.2.1. NEC/SLE Extension

The Preliminary Feasibility Assessment (Appendix H) concluded that the NEC could accommodate one train per hour in each direction for the SLE extension across all times of the day. To accommodate this service, the following assumptions were made:

- Sufficient off-main track, turn-around, and storage facilities could be provided;
- Running time could be 25 to 29 minutes;
- All trains could stop at all the station locations (local service);
- Any additional trains could impact the movable bridge opening time requirements and Amtrak, Metro-North, and MBTA scheduling as both Amtrak and MBTA operate in Rhode Island; and
- Coordination with US Coast Guard and Amtrak to secure ROW and requisite permits.

The diagram in Figure 14 shows the NEC Territory for the SLE extension and includes relevant features that must be considered in the service plan. To determine which rail service schedule could be the best for this corridor, the analysis considered two options (Table 9).
Option 1 is an extension of the current SLE schedule and trainset(s) from New Haven through New London to Westerly (with one through train from Stamford in each direction, a restoration of a former operating pattern).
Option 2 is a shuttle that could run only between New London and Westerly.

The Rail Service Plan (Appendix J) includes a hypothetical weekday public schedule format for all trains stopping in the study area.

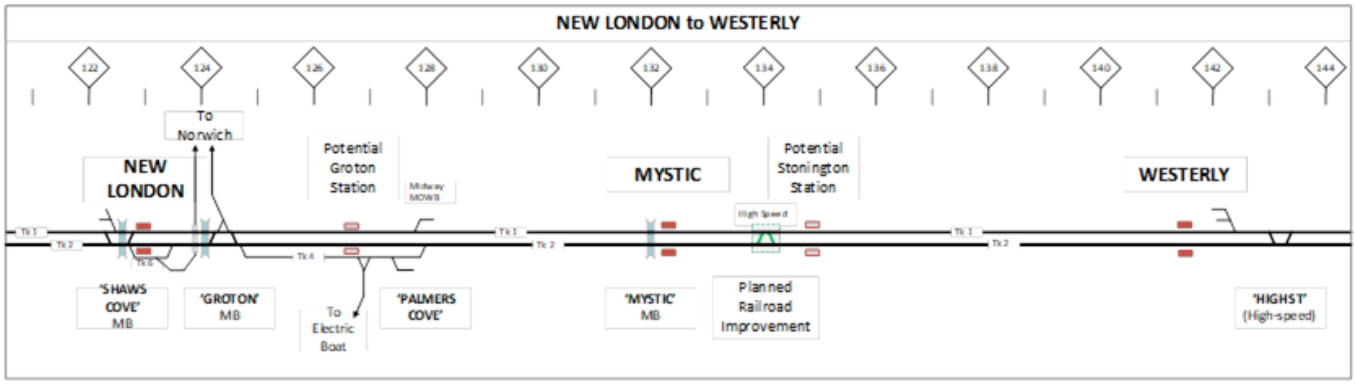

Figure 14
NEC Territory for SLE Extension

Table 9
SLE Extension to Westerly Service Options

Alternative	Frequency	Trip Time	Operational changes
1.SLE Extension	12 roundtrips/day (M-F)	NB: 24 mins SB: 22 mins	New operating plan with new schedule timings between New London and New Haven; 1 morning and 1 evening extension to Stamford restored
2. SLE Shuttle	7 NB and 8 SB trips/day (M-F)	22 mins (NB and SB)	Minimum 90-min required cycle time (roundtrip travel time plus time to "turn the train" at either end precludes hourly service)

5.2.2. Palmer Line

The Palmer Line follows the shape of the edge of the Thames River, which impacts the amount of straight track and limits the speeds achievable within this corridor; proportionally, more of the track is located on a curve than on straight track. An analysis of the maximum allowable speeds relative to rail line curvature and curve radius revealed the one-way trip time between New London and Norwich to be 42 minutes. However, the substantial proposed track improvements outlined above allow for increased speeds, which would reduce the travel time along the corridor to 28 minutes.

To determine which rail service schedule would be the best for this corridor, the analysis considered three options (Table 10), numbered consecutively following the NEC options.
Option 3 is an extension of the current SLE service from New Haven through New London to Norwich.
Option 4 is a shuttle that would run only to New London and Norwich.
Option 5 is a hybrid service plan taking service components from Option 3 and Option 4.

The study team chose to advance Options 3 and 5 because the plans for these options and the infrastructure elements needed to implement them are better aligned with the existing conditions within the larger NEC corridor. Additionally, existing freight operations on the Palmer Line are minimal, operational frequency stands at one or two trains per day, and the unfixed schedule prevents operations exceeding demand. Thus, the impact of freight operations on potential new Palmer Line passenger service is expected to be limited. Option 4 was eliminated as the required infrastructure and scheduling choices were cost prohibitive; additionally, Option 4 could not provide hourly frequency. Rail Service Plan (Appendix J) includes the weekday public schedule format for all trains stopping in the study area.

Table 10
Palmer Line Service Options

Option	Frequency	Trip Time	Operations
3.SLE Extension to Norwich	12 roundtrips/day (M-F)	27 mins (NB and SB)	New operating plan with new schedule timings between New London and New Haven; 1 morning and 1 evening extension to Stamford restored
4.Palmer Line Shuttle	7 NB and 8 SB trips/day (M-F)	27 mins (NB and SB)	Limited travel options during both peak periods due to distance and infrastructure limitations; option eliminated from further consideration
5.Extension/ Shuttle Hybrid	8 NB and 10 SB trips/day (M-F)	27 mins (NB and SB)	15 trips are shuttles and 3 trips are SLE extension runs; 1 reverse-peak direction train in both the AM and PM must be cancelled to achieve hourly peak service

5.3. Ridership Forecast, VMT Reduction, and GHG Abatement

To further evaluate the rail service plan schedules, 2035 ridership projections were forecasted for the scheduling options on the NEC and the Palmer Line[80]. An interregional travel demand model was utilized for the projections. The model is an adapted version of the NEC FUTURE model. After the ridership projections were completed, the VMT were calculated. VMT reductions, resulting from mode shift from private vehicles to new or enhanced passenger rail service, can be used to estimate greenhouse gas emissions reductions (Table 11).

The ridership projection for Option 1: SLE Extension to Westerly results in 159,300 new annual riders starting in 2035 (the modeling horizon year). These new riders equate to a VMT reduction of 25,886,000 annually, equal to just over 1,000 trips around the world. By shifting modes from travel by auto to travel by train, these new riders could also reduce greenhouse gas emissions by 9,853 tons per year.

The ridership projection for Option 2: SLE Shuttle between New London and Westerly results in 127,900 new annual riders. The VMT reduction for Option 2 is 25,139,000, resulting in 9,569 tons of greenhouse gas abatement. Implementing new passenger rail service along the NEC may directly contribute to even greater mode shift because of the heavy automobile traffic on Interstate 95, Route 1, and Route 184, which run parallel to the NEC. By establishing commuter rail service in this area, a new mode of travel would be available.

The 2035 ridership projection for Option 3: SLE Extension to Norwich results in 162,800 new annual riders. This ridership reflects a reduction in VMT of 25,836,000 and a 9,834 ton greenhouse gas reduction.

For Option 5: Palmer Line Hybrid between New London and Norwich the ridership projection is 126,400 new annual riders with a VMT reduction of 25,019,400. The resulting greenhouse gas emission reduction is 9,523 tons. Like the NEC Corridor, the Palmer Line also parallels automobile arteries like Interstate 395 and Route 32. The Palmer Line extension introduces new markets to rail service.

Table 11
New Ridership and VMT/GHG Abatement (2035 Forecast)

Option	New Ridership	VMT Reduction	GHG Reduction (tons/yr)
1. SLE Extension to Westerly	159,300	25,886,000	9,853
2. SLE Shuttle between NL and Westerly	127,900	25,139,000	9,569
3. SLE Extension to Norwich	162,800	25,836,000	9,834
4. Palmer Line Extension/ Shuttle Hybrid	126,400	25,019,400	9,523

[80]This model did not include Option 4 as it was eliminated during the study process due to its infrastructure constraints and minimal service options.

5.4. Station Siting

Six potential station sites were evaluated to determine each location's viability, focusing on a half-mile or one-mile radius around each possible station site. The details of the station siting evaluation can be found in Conceptual Station Site Locations (Appendix C). The analysis included the following:

- Rail operations feasibility and physical constraints,
- Access to population and activity centers,
- Environmental constraints,
- Traffic access and impacts,
- Pedestrian and bicycle access and connectivity, and
- Transit connections.

The stations include the following (Figure 15):

- SLE extension from New London to Westerly stations
  - Groton West (new),
  - Mystic Alternative (new), and
  - Stonington Borough (new).
- Palmer Line stations
  - United States Coast Guard Academy / Connecticut College (new),
  - Montville/Mohegan Sun (new), and
  - Norwich West/Norwich Intermodal Center (new).

Westerly and New London were not included in the station siting process, as it is assumed the existing stations in these communities could provide service for any future rail service expansion, with the associated modifications such as platform upgrades, grade crossing improvements, and coordination with RIDOT (in the case of Westerly).

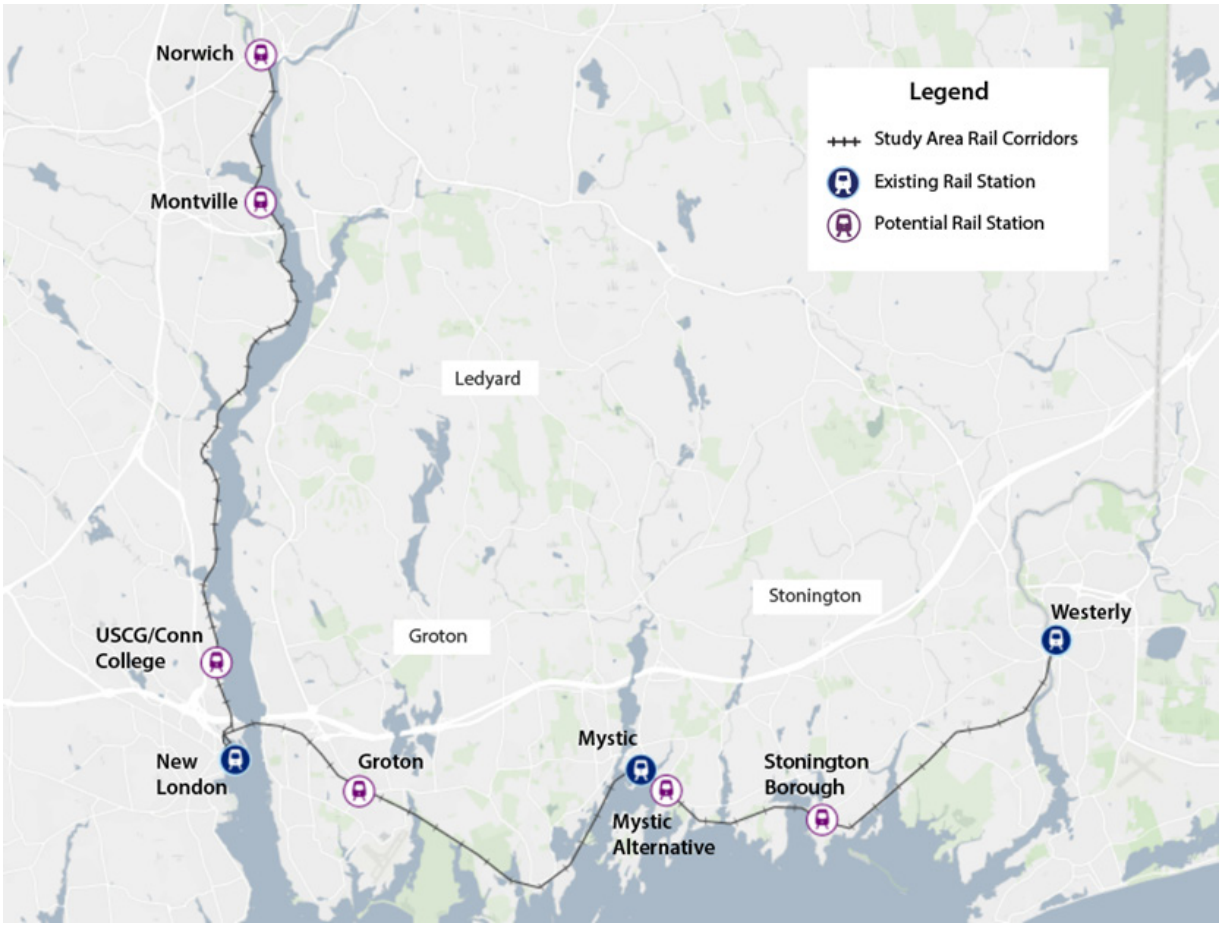

Figure 15
Proposed Station Locations

Table 12 summarizes the evaluation of the station sites, presenting a high-level breakdown of each location's constraints and opportunities based on the Conceptual Station Site Locations (Appendix C). Each station site was evaluated against the six criteria:

- **Rail Operations Feasibility and Physical Constraints** assessed the physical and geometric constraints of the potential station locations, including the need for tangent track of adequate length to accommodate a high-level, ADA-accessible rail platform; sufficient property available to provide ADA-accessible rail crossings; and station configuration to enable passenger safety and security.
- **Access to Population and Activity Centers** criteria evaluated the population and activity centers within one-half to one mile of the station sites.
- **Environmental Constraints** includes a review of several state and federal resources to determine any future risk or impacts associated with the implementation of a rail station at the identified locations including a natural and cultural resource screening process to assess proximate wetlands, buffer areas, areas of critical environmental concern, coastal habitats, and cultural and historic resources that could be subject to Section 106 review. Climate change impacts were evaluated including an analysis of potential flood risks from sea level rise and storm surge, extreme heat, and other impacts. The study team also conducted an analysis of proximate disadvantaged communities and equity indicators, including state designated Distressed Municipalities, Federal Justice40 census tracts, and various demographic indices.
- **Traffic Analysis and Impacts** evaluated both the existing traffic conditions as well as potential impacts that could be expected with the implementation of a potential station at each location including capacity for efficient traffic access for station pick-up and drop-off, as well as parking opportunities proximate to the station location.
- **Pedestrian and Bicycle Access and Connectivity** identified conditions within the existing roadway and sidewalk networks that affect bicycle and pedestrian modes of transportation. This evaluation focused on the existing street networks as it pertains to current bicycle (one mile radius) and pedestrian (half-mile radius) amenities that may support access to the six proposed station locations. Complementing the field investigations was the review of published data, reports, local regulations, and planning documents. The ADA accessibility, sense of community, regional initiatives and bicycle parking/storage were also taken into consideration.
- **Transit Connections** included improved opportunities for connecting or complementary service to potential passenger rail stations at the conceptual station locations, and also considered the opportunity or feasibility of each to function as a ground transportation hub. This analysis considered both existing bus and microtransit service as well as the proposed service modifications to determine level of connectivity that can be achieved through the conceptual station locations.

Table 12
Station Site Evaluation

	Station Site					
Evaluation Criteria	**Norwich West**	**Montville (Mohegan Sun)**	**USCGA/ Connecticut College**	**Groton West**	**Mystic Alternative**	**Stonington Borough**
Rail Operations Feasibility and Physical Constraints	Significantly Constrained	Constrained	Constrained	Constrained	Unconstrained	Constrained
Access to Population and Activity Centers	Excellent Access	Fair Access	Excellent Access	Fair Access	Fair Access	Limited Access
Environmental Constraints	Significantly Constrained	Significantly Constrained	Constrained	Constrained	Constrained	Constrained
Traffic Access and Impacts	Excellent Access	Excellent Access	Excellent Access	Excellent Access	Excellent Access	Excellent Access
Pedestrian and Bicycle Access and Connectivity	Fair Access Potential	Fair Access Potential	Limited Access	Fair Access Potential	Fair Access Potential	Fair Access Potential
Transit Connections	Excellent Potential Connections	Fair Potential Connections	Fair Potential Connections	Fair Potential Connections	Fair Potential Connections	Limited Potential Connections

No immediate fatal flaws were associated with these locations, although any future station design efforts must adequately address the constraints and challenges identified. Additionally, continued stakeholder coordination is of paramount importance for these sites.

5.5. Equipment and Service Support Needs

An assessment of equipment and system needs was performed using the proposed rail service timetables to determine the additional resources necessary for implementation of each schedule option. The assessment incorporated the following aspects of service support: compatible train equipment, deadheading, crew requirements, yard storage and layover space needs, maintenance facilities, and major system start-up requirements including written agreements, infrastructure upgrades, and coordination (Table 13).

In general, all options require one additional trainset and either two or four additional train crews from the current SLE schedule to meet the proposed weekday schedules. The crews are assumed to be based out of New Haven, except for a small, proposed crew base at New London to staff the shuttle options. The trainset and crew additions were considered reasonable increments to extend the services, although more detailed analysis beyond the scope of this study is required to fully establish the acceptability of the proposed crew assignments.

Regarding major system start up requirements, Options 1 and 2 primarily only require constructing a turning track at Westerly (High Street Interlocking), electrifying the Westerly layover track and Groton track segment, amending the current SLE operating agreements with Amtrak to use the NEC track between New London and Westerly, and entering into agreements with the Rhode Island Department of Transportation (RIDOT) for cost sharing. Beyond these initial requirements, extended service on the NEC could be implemented prior to construction of the proposed Stonington, Mystic, and Groton stations. Option 2 would also require a secondary yard space near New London to be built.

Options 3 and 5, however, require the completion of all the prescribed capital upgrades noted in the Rail Service Plan (Appendix J) to safely operate passenger rail. This includes all infrastructure upgrades, construction of new stations, and freight coordination. Crews could need to be fully qualified on GWI operating rules and all physical characteristics to operate on the territory. Implementing passenger rail service along the Palmer Line would also require ROW agreements with GWI.

Table 13
Equipment and System Needs Summary for Each Corridor Scheduling Option

	Option 1 (NEC)	Option 2 (NEC)	Option 3 (Palmer Line)	Option 5 (Palmer Line)
Equipment Compatibility	EMU or Push Pull 1 Additional Trainset	EMU or Push Pull 1 Additional Trainset	Push Pull Only 1 Additional Trainset	Push Pull Only 1 Additional Trainset
Additional Crew Needs	Yes 2 Additional Crews	Yes 4 Additional Crews	Yes 2 Additional Crews	Yes 4 Additional Crews
Layover Locations	Westerly / New Haven	Westerly / New London / New Haven	Norwich / New Haven	Norwich / New London / New Haven
Servicing/Inspections	New Haven	New Haven	New Haven	New Haven
Deadhead vs Yard Space	Deadhead	Yardspace	Deadhead	Either
Proposed Maintenance Facilities (MOE/MOW)	NHRY	NHRY	NHRY	NHRY
Major System Start Up Requirements	New / Relocated stations, Electrify Layover Track, Access Agreements (Amtrak/RIDOT), Crew / Supervisory Qualifications	New / Relocated stations, Electrify Layover Tracks, NLS Crew Base Facilities Access Agreements, (Amtrak/RIDOT), Crew / Supervisory Qualifications	Comprehensive Corridor Upgrades, Access Agreements (GWI), Crew / Supervisor Qualifications	Comprehensive Corridor Upgrades, NLS Crew Base Facilities Access Agreements (GWI), Crew / Supervisory Qualification of Territory

5.6. Preferred Passenger Rail Options

Through the detailed analysis of the rail service schedule options, preferred options for the NEC/SLE Line and the Palmer Line emerged. The options that perform best given the analysis findings are **Option 1: SLE Extension to Westerly, RI** and **Option 5: Palmer Line Hybrid between New London and Norwich** for a long-term commuter rail mobility improvement strategy serving southeastern Connecticut. To advance these options, additional funding, study, design, permitting, and agreements would be required.

5.6.1. Option 1: SLE Extension to Westerly

The SLE Extension to Westerly is a more suitable option because it reduces the issues of train congestion and train storage needs in New London, as compared to Option 2. While only one extension of the through SLE service (to Westerly or to Norwich) can be proposed, the extension to Westerly would provide the most benefit to the train passenger by maintaining the SLE frequency throughout the peak and non-peak hours. This extension would allow service to remain on the NEC and make a seamless extension to Westerly. To implement the full service, infrastructure updates would have to be completed at existing and future stations.

5.6.2. Option 5: Palmer Line Hybrid between New London and Norwich

With the SLE extension to Westerly, the hybrid service schedule between New London and Norwich is the preferred service option for the Palmer Line. The infrastructure needs and geometry of the corridor pose a significant challenge to implementing passenger rail along this corridor. Only Option 5 achieves hourly service between New London and Norwich in both peak periods.

5.7. Costs Estimates[81]

Implementing or expanding passenger rail service as a long-term mobility improvement strategy in the two corridors would incur estimated capital expenses due to infrastructure upgrades, equipment and system procurement needs, and greater estimated operating and maintenance costs to cover extended trips. The increase in both estimated capital and operating expenses would be incurred in phases, as laid out in the potential phased implementation plan. As of this report's writing, funding has not been allocated to advance these strategies.

[81]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account current market conditions.

Generally, federal funding for rail is provided in two forms: federal apportionments and federal grants, which include loans and loan guarantees. The Federal Transit Administration (FTA) and the administers annual formula grants to public transportation agencies nationwide. FTA and Federal Railroad Administration also administer discretionary grants, which are awarded to recipients based on eligibility and merit. These funds support regional, state and local public transportation systems.

CTrail receives funding through Connecticut's Special Transportation Fund (STF). The STF is a state-appropriated fund that finances most of the state capital and operating dollars that CTDOT receives each year. The predominant source of STF revenues comes from state motor fuel taxes, including gas tax, diesel tax, motor carrier tax, and the petroleum products gross earnings tax. Other STF revenues include general sales and use taxes, motor vehicle sales taxes and receipts, licenses, permits and fees, interest income, and other sources. The STF funds state transportation programs that receive revenues from transportation-related taxes, fees, and revenues, as well as from the proceeds of STO Bonds. The STF pays the debt service cost for state bonds issued as a means of providing funds for the state's share of transportation projects; supports a small program of Pay-As-You-Go activities; and finances the capital projects, operations, and services of CTDOT.

Another federal funding mechanism, the Bipartisan Infrastructure Law, was signed into law by President Biden on November 15, 2021. By authorizing $1.2 trillion in total funding over 10 years (including $550 billion in new spending during FY 2021-FY 2025), it constitutes a substantial investment in intermodal transportation and other core infrastructure in the United States. Of the $550 billion in new spending, $284 billion is dedicated to improving the surface transportation network[82].

5.7.1. Capital Cost Estimates[83]

Significant infrastructure improvements are required to support the service outlined in Options 1 and 5 (Table 14). The preliminary cost estimate for the capital investments in Option 1 is $243 million (2023 Dollars). The significant capital investments required to implement FRA Class 4 passenger rail service on the Palmer Line, following the Option 5 model, total an estimated $636 million (2023 Dollars). Because this is a feasibility study and has not reached the programming stage of project development, cost fluctuation could be expected to exceed 30%.

Table 14
Capital Cost Estimates for Passenger Rail Service on the NEC and Palmer Line

	Component	Description	Quantity	Unit	Unit Price (M)	Total Price (M)
NEC/SLE Extension (Option 1)	New Stations	Groton West, Mystic Alternative, Stonington Borough	3	EA	$52.0	$156.0
	High-Level Boarding Platforms	Westerly Station, Madison Station	2	EA	$16.0	$32.0
	Electrifying Storage Rail	Westerly Station – assumes poles are needed	1	EA	$2.8	$2.8
	Upgrading Track	Groton, MP124 to MP128, includes electrification	1	EA	$33.9	$33.9
	Turning Track	High St. Interlocking	1	EA	$0.4	$0.4
	M8 Trainset	4-Car	1	EA	$18.1	$18.1
	Total Cost:					**$243.2**

[82]McKinsey and Company. 2021. "The US Bipartisan Infrastructure Law: Breaking it down." November 12, 2021. https://www.mckinsey.com/industries/public-sector/our-insights/the-us-bipartisan-infrastructure-law-breaking-it-down

[83]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account future market conditions.

	Component	Description	Quantity	Unit	Unit Price (M)	Total Price (M)
Palmer Line (Option 5)	Corridor Improvements	Ballast, Structures, ROW, Track, Grade Crossings, PTC	1	EA	$388.7	$388.7
	New Stations	Connecticut College/ US Coast Guard Academy, Mohegan Sun, Norwich Intermodal Center	3	EA	$52.0	$156.0
	Yard Space	New London	1	EA	$75.0	$75.0
	Trainset	GP40 Diesel	1	EA	$16.0	$16.0
	Total Cost:					**$635.7**

5.7.2. Operating Cost Estimates[84]

Extending passenger rail service along the NEC and establishing passenger rail service on the Palmer Line incurs additional estimated operating costs beyond current SLE operations (Table 15). The operating expenses were estimated by identifying a cost per train mile and multiplying by the number of forecasted train miles per service day to determine an estimated operating cost per weekday. In regard to the Palmer Line, it was determined that the territory is most reflective of service provided along the Waterbury Branch operated by Metro-North Railroad, which is single-track territory utilizing diesel train equipment. The operating expense per train mile for the Waterbury Branch is currently about $124 per train mile. In Option 5, only a portion of the service would occur along the Palmer Line, and the remainder occurs along the NEC. Therefore, the estimated operating expense per day is a composite of the number of train miles along the NEC at $98 per mile, in addition to the number of train miles along the Palmer Line at $124 per mile.

The estimated operating cost increase for Option 1 over the baseline is $104,000 per weekday (2023 Dollars), nearly doubling the current operating expenses. In comparison, Option 5 results in more modest estimated operating cost increases – an additional $28,000 per weekday (2023 Dollars). These estimated costs are preliminary in nature and could be expected to increase by more than 30%.

Table 15
Estimated Operating Costs for Preferred Rail Options

Option	Description	Cost per Train Mile*	Train Miles Per Weekday	Cost per Weekday (2023 dollars)	Annualized Cost (2023 dollars)
Baseline	SLE Schedule (as of June 2023)	$98	1,114	$109,000	$26,200,000
Option 1	Extension to Westerly, RI	$98	2,176	$213,000	$51,200,000
Option 5	New London to Norwich Hybrid Service	$98/$124	1,074/260	$137,000	$33,000,000

**$98 per Train Mile along Shore Line East / $124 per Train Mile along Palmer Line*

[84]Costs listed in this section are static and tentative. If these strategies move forward updated cost estimates will be needed that take into account current market conditions.

Opportunities

6

6.Opportunities

Adopting the short- and long-term mobility improvement strategies outlined in the ECRTS has the potential to spur improvements in transit and rail access, regional mobility and connectivity, and regional economic productivity. The detailed, comprehensive economic analysis is included in the Economic Market Analysis (Appendix D).

6.1. Transit Oriented Development and the Market

By pairing transit and rail investment with policies that promote densification, walkability, and connectivity with other modes of transportation, the success and effectiveness of TOD could be amplified. From an economic and market standpoint, successful and effective TOD can provide lower-income residents with improved access to higher-paying jobs as well as attract investments that have the potential to create higher-paying employment opportunities on a regional scale, thus increasing the number of jobs, economic competitiveness, and regional economic productivity. From a public health and environmental standpoint, TOD can decrease negative impacts of automobile usage, including traffic congestion, GHG emissions, localized air pollution, traffic fatalities, and expensive wear-and-tear on road infrastructure. From a social standpoint, TOD results in denser and more affordable residential housing that is connected to station areas, which could increase the number of potential riders and reduce household costs associated with transportation and housing. Increasing potential household savings contributes to improving equitable access to resources and mobility.

Strategies to improve rail services may offer an avenue for poverty reduction and improved economic outcomes for the study area, which today remains at a structural competitive disadvantage relative to peer Connecticut cities (New Haven, Bridgeport, Stamford, and Hartford), which offer substantial regional and commuter rail service as well as local bus service. Study area transit accessibility is roughly 25% of the average of these Connecticut cities according to the Center for Neighborhood Technology (CNT) AllTransit Index[85] .

Over time, such consequential gaps in transit access have translated into reduced economic performance since 2001:

- **Increasing Poverty:** An increasing share of residents living below the poverty level relative to peer Connecticut cities, and statewide averages since 2010.
- **Housing Affordability:** 44% of study area households are currently rent burdened, and with about 25% of jobs in the study area paying less than $50,000 annually; homeownership is unattainable at current median home prices ($336,000 in Westerly and $200,000 in Norwich); limited new housing supply is also a factor.
- **Reduced Job Creation:** Reflective of a broader study area economy that is defined by mature industry sectors, long term job creation (-0.45%) has been well below averages for the NEC as a whole (0.41% annual employment growth) since 2001.

Beyond economic benefits linked to bringing study area's transit access toward peer Connecticut city averages, proposed transit infrastructure improvement strategies may encourage TOD across a considerable footprint of underutilized and vacant land from Norwich toward New London and Groton. The analysis identified considerable vacant acreage that could support future TOD investment, with corresponding benefits to property and sales taxes.

Beyond the long-term benefits associated with TOD, there are also several potential short-term economic benefits associated with the service extensions in this study, largely realized in the form of temporary construction jobs. Construction of proposed rail improvements could have potential to support about 4,500 jobs across construction and other sectors of the economy, generate an estimated $860 million in sales (2023 Dollars) and an estimated $340 million in earnings (2023 Dollars).

[85]Center for Neighborhood Technology. AllTransit Platform. https://alltransit.cnt.org/

6.2. Revenue Forecast[86]

Adopting the short- and long-term strategies associated with increasing the level of service on existing bus transit routes and implementing new or expanded passenger rail service along the NEC and Thames River Corridor could increase fare revenue for both SEAT and CTrail. Further detail is provided in Appendices I: Transit Service Plan and J: Rail Service Plan.

Table 16
Revenue Forecast for Transit and Rail Service Strategies

Mode	Service	Forecast Year	Additional Annual Ridership	Revenue Forecast (2023 Dollars)	Revenue Forecast (Date of Implementation Dollars)
Transit	Standalone Bus	2028	303,000	$370,000	$430,000
	Bus with Rail	2035	264,000	$335,000	$475,000
Rail	SLE Extension	2035	159,000	$1,195,000	$1,705,000
	Palmer Line	2035	126,000	$505,000	$720,000

Were the standalone bus transit enhancement strategies to be implemented in 2028, increasing service to the levels identified in the ECRTS bus transit service plan could result in an estimated $370,000 (2023 Dollars) of additional revenue per year for SEAT. This number falls if commuter rail service expansion is implemented, as the transit service plan envisions eliminating Route 1E to avoid a duplication of services -- Route 1E runs parallel to the proposed rail service on the Palmer Line. **Were the potential new commuter rail service implemented in 2035 to enhance regional mobility, SEAT's increase in annual fare revenue following this implementation is estimated at $335,000 (2023 Dollars).** The implementation fare revenue figures do not account for any fare increases that may happen in that time period. Accounting for inflation results in $430,000 additional annual fare revenue associated with transit service plan identified levels of service in 2028 and $475,000 additional annual fare revenue in 2035 following the potential implementation of passenger rail service.

The additional revenue associated with implementing the strategies outlined in Rail Service Plan (Appendix J) along the NEC and Palmer Line is estimated at $1,700,000 (2023 Dollars) annually. Passenger rail service along the NEC represents approximately 70% of the additional revenue increase, and service along the Palmer Line is responsible for the remaining 30%. This figure does not account for any fare increases beyond the SLE increase slated for Fall 2023. Inflating the annual revenue increase to 2035 dollars yields an estimated $2,425,000 between induced ridership increases on the NEC and Palmer Line.

[86]Revenues listed in this section are static and tentative. If these strategies move forward updated revenue forecasts will be needed that take into account current market conditions.

Outreach and Engagement

7

7.Outreach and Engagement

7.1. Engagement Logistics

The in-depth evaluation of existing conditions in the study area involved a series of engagement efforts to collect feedback from communities, stakeholders, and the public. Key feedback and guidance helped inform the general approach of the study, as well as the development of the technical documents and final report. Recognizing the possible expansion of passenger rail service and enhanced transit service could serve many jurisdictions and major destinations, the study team established a Steering Committee, Working Groups and conducted Public Information Meetings as well as a public survey (Table 17 and Figure 16). An overview of outreach and engagement efforts is provided in the **Engagement Summary (Appendix M).**

Figure 16
Public Meeting in Groton

Table 17
Stakeholder Engagement (2022-2023)

Outreach Group	Engagement	Topics
Steering Committee	Meetings: March 2022, September 2022, March 2023, August 2023	Identify study goals and contribute to the establishment of a framework for future decision-making
Customer Focused Working Group	Meeting: February 2023	Equity, unmet transportation needs, access and mobility needs, safety, amenities
Municipal Working Group; Municipal Leadership	Meetings: June 2022, December 2022, April 2023	Municipal planned projects, economic development, station siting
Major Employers/ Anchor Institutions	15-20 interviews	Demand for rail and transit services, employee benefit programs (TDM), parking availability and policies, future plans, employee travel patterns
Rail Working Group	Meetings: October 2022, February 2023	Data collection, alignment options, constraints and opportunities, confirmation of capital, operating & maintenance estimates, ridership/ revenue projections
Transit Working Group	Meetings: June 2022, April 2023	Unmet transportation needs, ground transportation options, equity, connectivity between systems
Public	Meetings: December 2022 in Norwich (in person), Groton (in person), and virtual	Introduce the study and gather input on proposed improvements, including extending rail service in southeastern CT and enhancing transit systems and connectivity between transit and rail
	Meetings: September 2023 in Norwich (in person, Groton (in person), and virtual	Summarize the results of the study and gather input on the study's findings and conclusion
Survey	Live from December 2022 to January 2023; 164 responses	Respondents indicated where they live, frequently travel, and the locations where they would like to see added or enhanced public transportation options

7.2. Public Feedback

Overall, during the final public information meetings and 45-day comment period, engagement efforts presented drew support for expanded rail and enhanced transit options in Southeast Connecticut. Of the 91 written comments received from the public, over 75 submissions communicated support for expanded rail and transit service in southeastern Connecticut, as well as connections beyond the region west to points in Connecticut and New York and east to points in Rhode Island.

7.2.1 Benefits

Positive feedback cited numerous benefits to the region in terms of increased economic development, tourism, and access to employment and housing. Public comments also noted that increased rail and transit service may reduce congestion and improve climate, public health, quality of life and equity outcomes.

7.2.2 Concerns

Critical feedback voiced concerns regarding the following aspects of the feasibility study results. Corresponding information is offered to provide more context and clarification.

Corridor Options

- **Feedback:** Some comments reflected concern about corridor options that were narrowed down due to key constraints surrounding operations across the Thames River Bridge. These comments expressed a desire for rail service particularly along the Groton Secondary corridor, which was not considered for further analysis following the Preliminary Feasibility Assessment.

- **Context:** The study team identified the Thames River Bridge as a key constraint that limited the corridor options for consideration, due to future expansions of Amtrak service that will utilize the bridge, as well as limitations in use due to US Coast Guard regulations regarding the opening and closing of the movable bridge. The study team also identified that frequent, reliable bus or shuttle service in the Groton Secondary area can likely provide more direct access based on the roadway network than the rail alignment. While all transportation options initially considered by the ECRTS may be technically feasible, the study team adopted a focus on strategies that are the ***most viable*** from a **cost** and **complexity** standpoint. A menu of short- and long-term options were identified for further study based on the most feasible overarching options.

Station Locations

- **Feedback:** Some comments reflected opposition to locating an alternative Mystic station to the east of the current station (further from downtown) and suggested a location to the west of the existing station should be considered. Comments also reflected mixed reactions to a potential station in Stonington Borough, with some comments pointing to the demographics of the area (e.g., affluent residents, high car ownership, and single-family housing) as not supportive of the need for commuter rail service, despite local officials' and other members of the public's receptivity to a potential station. Other comments reflected concern for noise as well as potential right of way impacts in Stonington Borough.

- **Context:** The existing Mystic Station is sited on a significant curve which precludes the platform from being reconstructed to accommodate high-level boarding, which is now required for Americans with Disabilities Act (ADA) compliance and is necessary to operate CTDOT's electric M8 equipment. The Mystic Alternative east of the existing station is located on a straighter section of track and can be built to include high-level platforms. The study team examined a potential location west of the current station and identified several constraints around environmental impacts and remediation. Regarding the potential station in Stonington Borough, since ECRTS is a preliminary feasibility study, there would need to be further study and preliminary engineering to determine an exact station site and any right of way impacts.

Cost Estimates

- **Feedback:** Several comments expressed concern for the large capital cost estimates, particularly for the rail strategies.
- **Context:** Cost estimates must adequately address constraints and reflect future needs and future market conditions, which can be difficult to project in the current environment given heightened inflation and construction costs and supply chain delays. The study team estimated capital costs for the strategies based on actual projects under construction or recently completed at the time of this study. The ECRTS is a feasibility study; an initial study step that would need to be followed by additional study and refined estimates if strategies are pursued further. While implementation of the rail strategies would require significant investment, the identified bus transit strategies offer a more cost-effective way to address mobility needs in the region.

Timeline

- **Feedback:** Several comments expressed concern for the length of the potential implementation timeframe, which was thought to be too long to meet the needs of the region.
- **Context:** The potential timeframes for implementation presented in this report reflect the project development process set forth by the Federal Railroad Administration (FRA) and Federal Transit Administration (FTA), which encompasses multiple components within the phases of planning, design, and construction. The potential implementation timeframes for the ECRTS strategies also reflect current conditions; none of the short- or long-term mobility strategies are funded. While implementation of the rail strategies would require significant time for planning, design, and construction of the capital improvements, the identified bus transit strategies offer a shorter-term way to address mobility needs in the region.

The public engagement effort provided the study team with valuable feedback on strategies for expanding passenger rail service and ground transportation options in the region. While there may be more expensive or more complex strategies to overcome some of the key constraints and address some concerns identified by the public, this study aimed to identify the most viable options from a cost and complexity standpoint while providing the region with the most realistic picture of future rail service.

It is possible that the bus transit strategies, such as increased frequency and span of service or more direct transit service to regional points of interest, have the potential to serve as both short- and long-term strategies to address unmet needs in region, as these solutions can be implemented quicker, are less complex, and are less expensive.

Summary and Conclusions


Old Saybrook Station
Wednesday, June 23
1:27 PM
AMTRAK
Location
B
Track 2
105

8

8. Summary and Conclusions

Bus transit improvements could be an effective solution that addresses regional mobility needs, independent of any potential other actions. To begin the process of addressing regional travel needs, bus strategies targeting level of service improvements could be implemented faster than rail strategies in part because they are less capital intensive. They are also flexible in addressing a range of needs. These strategies include bus route realignments, extended demand response service, and schedule modifications that address current gaps in service and align the transit network with emerging demand centers. Expanding access in this way will provide more and faster connections to regional employers, expand coverage in areas with high proportions of cost-burdened renters, and provide a competitive bus service to tourist markets in Mystic. Bus strategies targeting capital improvements could be phased in beyond the level of service improvements, as available resources and funding allow. Funding would be required to achieve these strategies.

Long-term strategies to enhance mobility could be achieved by extending SLE commuter rail service along the NEC and establishing new commuter rail service along the Palmer Line west of the Thames River. By offering an alternative mode of travel, the potential SLE extension to Westerly may encourage mode shift and capture existing demand because of the heavy automobile traffic on Interstate 95, Route 1, and Route 184, which run parallel to the NEC. In addition, a commuter rail service extension to Westerly could benefit the region as it is one of the last segments on the NEC without commuter rail service. It could establish an interstate commuter rail service between Connecticut and Rhode Island, building on intermodal connectivity between neighboring states, in addition to the existing intercity rail service. Extending service along the NEC could also benefit from the existing elements of rail infrastructure that currently handle passenger service.

To establish commuter rail along the Thames River Corridor, as presented in the feasibility study, the region would need to induce the demand for rail service between New London and Norwich. The demand could be realized if new and expansive economic and/or residential development occurs in the future along the corridor beyond what is factored in this study. Robust development resulting in increased congestion on the roadway network within the corridor may negatively impact both passenger vehicle and bus trip times, potentially influencing mode shift preferences. Based on current growth rates in the region for residential development and job growth, this change may not be realized for years, or even decades.

With the short- and long-term strategies identified as findings, further steps are needed to advance each project or strategy through the appropriate project lifecycle stages. FTA outlines a project lifecycle for transit projects that includes four steps:

1. Project Planning,
2. Project Development,
3. Engineering, and
4. Construction.

Each one of these project life cycle steps has several components that would need to be completed before moving to the next stage. Figure 17 shows a representative sample of what is included in each phase of a project as well as an average timeline for completion. At present, advancing transit solutions in accordance with the findings of the feasibility study is unfunded.


1711

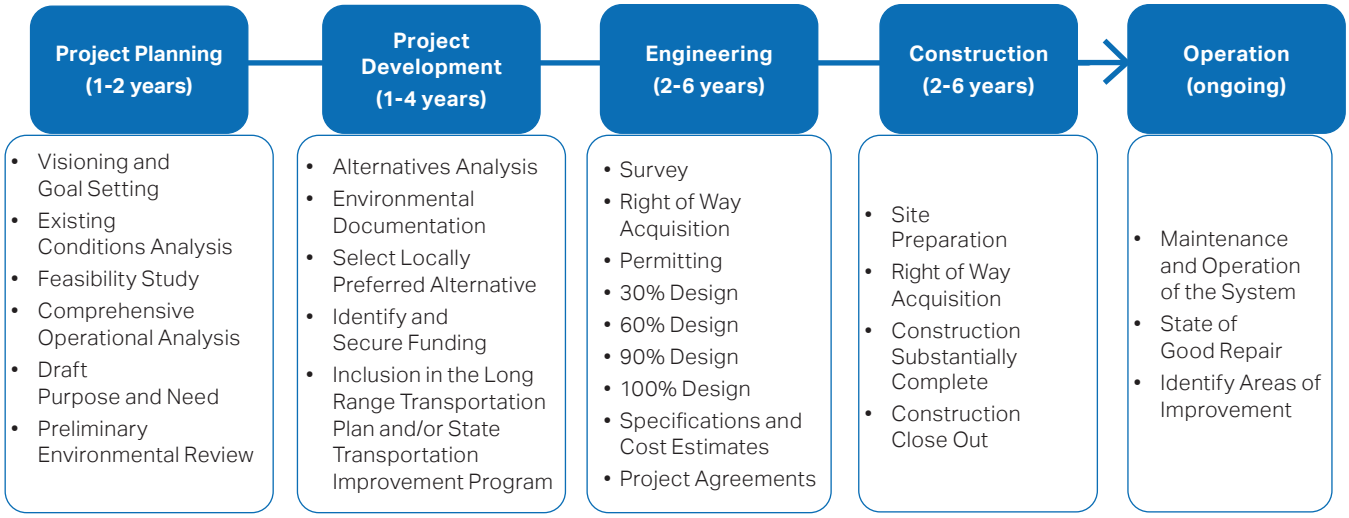

Figure 17
Bus Transit Project Lifecycle Stages

For the long-term rail strategies, the Federal Railroad Administration outlines a project lifecycle to include the following six steps:

1. Systems Planning,
2. Project Planning,
3. Project Development,
4. Final Design,
5. Construction, and
6. Operation.

Rail projects, which may include station and/or rail infrastructure, would also have several components that need to be completed before moving to the next project lifecycle stage. Figure 18 shows a representative sample of what is included in each phase of a project as well as an average timeline for completion. At present, advancing rail solutions in accordance with the findings of the feasibility study is unfunded.

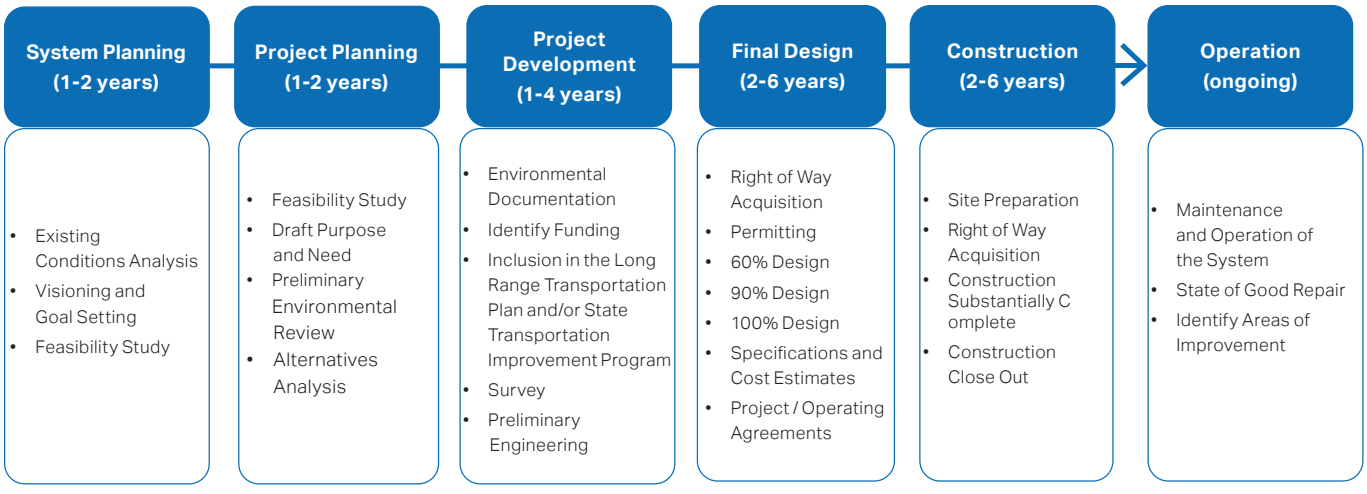

Figure 18
Rail Project Lifecycle Stages

The Hartford Line Rail Program (formally known as the New Haven Hartford Springfield Rail Program) serves as a recent example of an ongoing program developed to launch new rail service in Connecticut. The program advanced via a partnership among Connecticut, Massachusetts, Amtrak and FRA, following the project lifecycle stages above. The corresponding CTrail Hartford Line service, a regional passenger rail service between New Haven and Springfield along a 62-mile portion of the NEC, required funding from multiple state and federal sources with the ultimate goal of operating 25 daily round trips. This program is being implemented using a phased approach[87] for design, construction and operations. The program started with a feasibility study in 1994, additional study and design, Environmental Assessment in 2012, completion of the final design for the initial phases in 2014, start of construction for the initial phases in 2015 and began launching service in 2018.

The projects identified in this feasibility study are presented as a group of short-term and long-term strategies. Were one strategy or a combination of strategies to be identified as a viable option upon further study and/or funding, that strategy could move forward independently of the others and be incrementally phased in. A few representative examples are provided below:

Mode	Description	Further Study	Timeline	Considerations
Transit Strategy	Level of service improvements (extending service hours, increasing frequency along key routes, and implementing new routes)	Project Planning/ Comprehensive Operational Analysis	1-2 years	Development patterns, operator shortage/needs
Transit Strategy	Capital improvements (bus stop infrastructure, TSP, and queue jumps/road geometry changes)	Project Planning/ Development	1-4 years	Operating agreements (TSP and queue jumps), ROW considerations
Rail Strategy	Express service between New London and Westerly	Systems Planning / Project Planning	1-2 years	Operating agreements, storage track and interlockings, signal modifications, station upgrades, equipment and crew needs
Rail Strategy	Addition of local stops incrementally after the implementation of express service between New London and Westerly	Systems Planning / Project Planning	1-4 years	New and/or relocated stations (design, land acquisition), storage track and interlockings, signal modifications, equipment and crew needs, revised operating agreements
Rail Strategy	SLE extension to Groton instead of Westerly	Systems Planning / Project Planning	1-4 years	New station, location to turn trains around, which could mean new interlockings, turnouts, signal modifications, and new siding track

As demonstrated above, the short and long-term strategies presented have the potential to be implemented in phases. During the Project Development or Project Planning project lifecycle stage, an Alternatives Analysis could be completed as shown in Figures 17 and 18. During this analysis, phasing options could be developed and examined in detail. For example, an intermediate stop location or an infill station for rail could be determined as a logical intermediate step. Then a benefit-cost analysis that considers all aspects of the project would need to be completed. Should the incremental portion of a strategy be determined independently viable, that project component would still then need to go through all the project lifecycle phases shown in Figures 17 and 18 before it could be constructed. At present, advancing any strategies or solutions in accordance with the findings of the feasibility study is unfunded.

[87] New Haven - Hartford - Springfield Rail Program: Objectives & Scope (nhhsrail.com)