Memorandum

U.S. Department
of Transportation

**Research and
Innovative Technology
Administration**

Subject: East End Coordinated Rail-Bus Network

Date: April 9, 2009

From: Sean Peirce, Volpe National Transportation Systems Center

Reply to Attn. of:

To: Tom Neely, Town of Southampton, and
Members of the Technical Advisory Group

This memo is an updated version of the analysis produced for the December 2008 meetings of the Technical Advisory Group. It is intended to provide a summary of the Volpe Center's initial feasibility analysis for the proposed coordinated rail-bus network, covering the following topics:

1. Service concept and assumptions
2. Rail service scenario, infrastructure and vehicle investments, operating costs
3. Bus service scenario, infrastructure and vehicle investments, operating costs
4. System-wide service characteristics
5. Ridership estimates
6. Overall summary

Information in this memo on infrastructure needs, vehicles, costs and ridership are initial, order-of-magnitude estimates produced by the Volpe Center's modeling work. Though a number of revisions have been made since December in response to feedback received and recent developments, these estimates should not be regarded as definitive. They are intended to support further planning and stakeholder discussion.

1. Service Concept and Assumptions

For the purposes of this analysis, the coordinated rail-bus network was assumed to include the following elements, based on the consensus of the TAG. The service parameters were listed in our memo of October 16, 2008, and are briefly summarized here:

- The existing public transit (rail and local bus) services in the five towns of the East End would largely be replaced by a coordinated rail-bus network. Some high-volume trains such as the Cannonball would continue, as would certain SCT bus routes running from Riverhead into western Suffolk County. Rail shuttle service would operate on the Ronkonkoma-Greenport and Speonk-Montauk lines, with onward connections to existing LIRR service. Bus services would be used to link the two rail lines, to provide service to areas beyond the rail network, and to provide "feeder" service from neighborhoods and major destinations into the closest rail stations. Bus lines would include a mixture of conventional fixed-route service, "flex" (route deviation) services, and/or flexible station shuttles.

- Bus and rail schedules would be structured to allow relatively short connections between services, ideally less than 10 minutes between each bus arrival/departure and rail arrival/departure, subject to the constraints of the overall bus service levels and scheduling.

- Service would run 7 days per week throughout the year. Bus and rail services would run every 60 minutes during off-peak hours and every 30 minutes during the peak hours of roughly 6-10 AM and 3-7 PM. The span of service would be 18 hours per day for about half the days of the year and 14 hours per day the rest of the year.

- Neither expanded park-and-ride facilities nor waterborne transportation would be part of the concept.

- Standard base fare would be $2.50 per trip, including free transfers between vehicles. A more detailed analysis of fare policies and options for fare media and collection will come later in the project.

2. Rail Service Scenario

Background

The rail component of the proposed rail-bus network includes a number of new (or re-opened) stations, and service every 30 to 60 minutes, for 14-18 hours per day, on both the Ronkonkoma-Greenport and Speonk-Montauk rail lines. As a first step in modeling this proposed service, the Volpe Center gathered data from the LIRR, including wayside layout diagrams showing the location and condition of tracks, stations, sidings, and other infrastructure.

Both the proposed service parameters and the LIRR infrastructure information were entered into Railroad Traffic Planner, a software package jointly developed by the Volpe Center and MIT for the Federal Railroad Administration. Railroad Traffic Planner allows service scenarios to be modeled and evaluated. Outputs from the software are intended for planning purposes only, not for implementation, but are sufficient for this initial modeling effort.

One of the main infrastructure limitations of the existing rail lines is that they are single track, so trains traveling in opposite directions can pass each other only at sidings. As more train service is added, this problem becomes more complex. The limited number of sidings must be used more intensively, creating delays in service as trains spend time waiting to pass rather than moving between stations.

Signaling, Communications, and Dispatch

These sections of track also lack the sort of signaling system that is necessary to ensure safety when multiple trains are operating in proximity to each other in both directions. At present, these rail lines have only a Manual Block System in place, with no active signaling. The current arrangements were not designed or intended to handle the dense two-way traffic that is envisioned for the rail-bus network, particularly the way single-tracked segments would be used for bi-directional operations.

There are several options for communications and train dispatching. In our view, Centralized Traffic Control (CTC) would be the most cost-effective options for safely controlling the trains. CTC uses a centralized train dispatcher’s office that controls railroad switches and the signals that the operators must obey. The dispatcher has a map that identifies where all the trains are located in real-time. The system used for dispatching may contain some or all of the following attributes: track bulletins, track warrants, archive of information, playback and simulation capabilities, train describer, timetable generation, train management and cab signaling, track data management, real-time and optimizing movements, interlocking and tower control.

The Volpe Center team spoke with staff members from the Utah Transit Agency (UTA), where a form of CTC is being used for a new commuter rail line that shares some characteristics with the Montauk and Greenport lines (single track with sidings, 30-minute peak service). CTC has worked well in this environment. CTC allows signals to be "interlocked," which is a means of ensuring that opposing trains cannot make unsafe movements. Another advantage of CTC is that it can readily be adapted to include Positive Train Control (PTC), a system that enhances safety through the use of onboard equipment that prevents unauthorized train movements. The federal Rail Safety Improvement Act of 2008 mandated the use of PTC on most U.S. railroads by 2015, though there are some exceptions and further analysis would be needed on specific requirements along the East End rail corridors.

Based on discussions with a vendor of CTC systems (GE Transportation), costs for installation of a CTC-based wayside signal system would be on the order of $100,000 per track mile for equipment and $75,000 per track mile for installation. This is equivalent to a total of $15.8 million for the two East End rail lines. This estimate includes the accompanying hardware and software for that would be needed for dispatch.

Electrification

LIRR electric service ends at Ronkonkoma and Babylon. Extending electrification eastward to Greenport and Montauk would potentially create a number of service advantages and long-term cost savings. Electric-powered vehicles have better acceleration properties and thus can make service runs more quickly; they do not need to stop for refueling; they are generally quieter and (depending on the source of the electricity) produce fewer emissions; and their operational costs tend to be lower over the long term. However, electrification is an expensive undertaking and initial modeling did not show a net cost savings compared to diesel operation over a 20-year payback period. The consensus of the TAG was also that planning for the rail component of the rail-bus network should assume diesel operation.

Additional Modeling Assumptions

The Volpe Center's model is based on the speeds and acceleration/deceleration characteristics of a typical passenger train. Modeling also assumed end-of-the-line turnaround times of at least 20 minutes and (to be conservative) dwell times of 2 minutes per station, though 60-90 seconds would typically be sufficient. Refueling stops were not built into the service schedule, because the rail vehicle that was chosen for modeling (see below) has a 600-gallon tank, which would ordinarily be sufficient for a day's operations. Therefore refueling was assumed to take place before or after the hours of revenue service.

Modeling Results

Software modeling results indicated that the current single-track rail configuration has sufficient capacity to handle the proposed level of service, provided that: (1) a total of seven sidings are added: at Medford, Quogue, Southampton College, Water Mill, and Wainscott stations, plus intermediate sidings between Yaphank and Calverton and in the Jamesport area; (2) rail services are carefully timetabled to allow trains to pass at the sidings, in some cases waiting longer than normal at stations so that the opposing train can clear, (3) CTC/PTC is used to manage overall traffic flow; (4) the sidings are upgraded with signal control and interlocking as discussed above; (5) freight movements are scheduled at off-peak times.

Additional sidings beyond those noted above would provide a greater safety margin and would increase operational flexibility, for example in allowing rail services to get back on schedule after a disruption. Otherwise, even small disruptions in service can create ripple effects throughout the day, as trains must wait at sidings for others to pass. When trains break down along sections of single track, major disruptions ensue that require cancelling service altogether and/or using buses to provide substitute transportation to the nearest unaffected station.

The model results also show that, given the travel and turnaround times involved, 6 trainsets would be needed on the Montauk line, and 9 on the Greenport line, in order to provide the intended level of rail service. The primary constraint driving the vehicle requirements is the need to provide 30-minute service during peak hours, and the greater requirement on the Greenport line reflects differences in the spacing of stations and the track speed restrictions in place.

Travel times would be comparable to existing LIRR service, except that some runs are slightly longer because of the way timetables need to be adjusted to prevent trains from meeting at places other than sidings. The modeled schedules are reproduced in Figure 1 for reference, though these should not be regarded as anything other than conceptual at this point. Times can be adjusted based on input from the TAG, though some changes would require an extra train on the line.

Rail Vehicle Options

Light rail vehicles are often considered when rail services are marked by frequent departures and modest passenger volumes. However, light rail cannot be used in this case due to federal railroad safety rules that prohibit light rail vehicles from sharing tracks with heavy rail – namely, the LIRR service and freight trains that would continue to use the lines east of Speonk and Ronkonkoma. (Although it is possible to obtain waivers from the Federal Railroad Administration, that appears unlikely in this case due to the high rail traffic volumes and single track.) Light rail is also more typically associated with electric power, though there are some examples of diesel-powered systems.

Diesel multiple units (DMUs), also known as railcars, are self-propelled rail vehicles that do not require a separate locomotive. DMUs are in service in Portland, Oregon's Westside Express line and the South Florida Tri-Rail system, and have been under consideration by other rail agencies. DMUs were identified as a vehicle option by the TAG, and in our opinion, they are a logical choice for the East End rail service given the mileage and expected passenger volumes. DMUs allow flexible configurations and typically have lower costs on a per-seat basis than conventional trainsets that use a locomotive to pull coaches. Operating at about one mile per gallon, DMUs are roughly twice as fuel-efficient as conventional locomotive operation.

DMUs can operate on their own or pull multiple passenger coaches, though acceleration can suffer when more than one coach is added. DMUs and coaches both come in single- and bi-level versions; however, most bi-level cars are too high for some of the highway bridges on the East End rail lines. Typical seating capacities are 94 passengers for a single-level DMU and 102 for a single-level coach. At the outset of service, the recommended trainset configuration is a single DMU for low-volume runs and a consist of one DMU pulling one coach on higher-volume runs. (Additional coaches could be added over time if needed to accommodate ridership.)

Selection of a particular vehicle model or vendor is beyond the scope of the current analysis, but there are a number of relevant factors and recent developments to consider even at this initial phase. Until recently, Colorado Railcar Manufacturing LLC was the only manufacturer of DMUs that are FRA-compliant, that is, that meet crashworthiness guidelines allowing them to share track with conventional heavy rail vehicles. This company halted business operations in late December 2008, creating significant uncertainties about the availability of DMUs. Since a number of transit systems around the country are seeking DMUs for planned system expansions, there is some expectation in the passenger rail community that another manufacturer may step in with an FRA-compliant design. Indeed, some manufacturers are already at work on this, though it may be several years before any such vehicles are available.

The TAG has noted that another option that could be explored is refurbished Budd cars (RDCs). These are self-propelled diesel railcars that were commonly used in the 1950s and 1960s for regional rail service. They are still in use on a handful of services in North America, including the Trinity Railway Express (TRE) commuter rail line in Dallas-Ft. Worth, where they are typically used for lower-volume mid-day trains. Fully refurbished cars are taken down to the steel shell and fitted with new engines, transmissions, electrical systems, climate control, and interiors. These refurbished vehicles have seating capacities comparable to the single-level Colorado Railcar DMU, are FRA-compliant, and should have service lifetimes that are comparable to other rail vehicles. While not originally designed with the Americans with Disabilities Act (ADA) in mind, it is possible to refurbish the cars with an accessible design. In some cases this may require other modifications, such as to station platforms. For example, the TRE provides wheelchair access to its Budd cars using a metal bridgeplate that is manually lowered to cover the gap between the train and a section of raised platform.

Based on the schedule modeling results above, it is assumed that 6 railcars would be needed on the South Fork line and 9 on the North Fork line, plus two spares that can be used during periods of repair, for a total of 17. Six additional coaches are assumed for the purpose of accommodating passengers during high-demand periods. For rough cost estimation, we used Colorado Railcar's list prices as of December 2008: $6.5 million per DMU and $3.5 million per coach. For the Budd car option, we used a figure of $2.0 million per refurbished vehicle, based on prior published estimates[1], which were consistent with an informal cost estimate received by the TAG from a prospective vendor.[2] These figures yield total rail vehicle acquisition costs in the range of $46.0 million to $114.5 million. Both figures should be used with some caution given the lead times associated with acquiring either type of rail vehicle and the potential uncertainties about availability and unit costs. It is worth noting that a conventional locomotive-plus-coach arrangement could also be used, and that often rail vehicles can be leased rather than purchased if that better aligns with the transit agency's institutional and financial framework.

Operational Costs

Operational costs include fuel and maintenance and the labor costs associated with operating and dispatching vehicles and collecting fares. According to the National Transit Database, the average cost of operating commuter rail is $424 per vehicle-hour of revenue service. (For the LIRR, the average is $490.) Since the proposed rail service is equal to approximately 45,000 annual vehicle-hours of service, an initial rough estimate of operational costs is $19.0 million per year, using the lower national average figure. In light of the fuel-efficiency of DMUs, actual costs could be slightly lower than the national average, though this would also tend to be offset by the relatively high labor costs in the New York metropolitan area.

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[1] See, e.g., the *Marin County Commuter Rail Implementation Plan* (http://www.co.marin.ca.us/depts/pw/main/rail/rail.cfm), 2004. These estimates, in turn, were based on an approximate cost of $1.8 million per vehicle for refurbished Budd cars acquired in 1995 by the Trinity Railway Express (TRE) system in Dallas-Ft. Worth.

[2] To be clear, this vendor is not the only potential source of refurbished Budd cars. One complicating factor is that several of the firms in this business, including the one contacted by the TAG and the one used in 1995 by TRE, are located in Canada. The Buy America Act requires that transit rolling stock, if acquired using any federal funding, must have 60 percent U.S. content and must have final assembly in the U.S.

Based on the mileage of the proposed service, the fuel economy of the DMUs, and the current price of diesel, the fuel component would only be about one-fourth of the total cost, or around $4.5 million per year, and most of the rest would be labor for operations, maintenance, dispatching, and fare collection. As recent experience has shown, fuel costs are also subject to substantial fluctuation based on the price of diesel. Conventional locomotive-drawn service would typically have slightly higher fuel costs.

Rail Investment and Costs
As discussed above, a total of seven passing sidings would be required to maintain safe bi-directional operation. Relatively short sidings will suffice due to the small size of the trainsets and the limited freight movements. Each siding would be approximately one-quarter mile in length and cost about $500,000. This is based on Utah Transit Authority's recent costs of roughly $350 per foot of track, though UTA notes that recent increases in the price of steel might translate into higher prices.

Each existing and new siding would also require an electronic switch (rather than manual) to ensure safety and compatibility with the CTC operating environment. Costs are estimated at $75,000 per switch (again based on discussions with a vendor, GE Transportation) for each of 20 sidings, for a total of $1.5 million.

The rail vehicles would also require arrangements for storage, maintenance, and repair work and a means (fixed or mobile) of refueling. Depending on the institutional arrangements for the service, it may be possible to use existing LIRR facilities for these functions, though their distance from the East End would mean a longer time out of service, and the railcars (whether Colorado Railcar or Budd) represent a different vehicle type from all existing LIRR rolling stock. The LIRR has also noted that storage space at Ronkonkoma and Speonk is fully subscribed. One potential alternative, at least in the near term, would be to store vehicles overnight at the passing sidings on each line, and to use a "mobile rail shop" (a truck equipped to conduct repairs on rail vehicles) for maintenance. The current practice of mobile fueling could also be continued.

Over the longer term, at least one dedicated storage and maintenance facility (and possibly two, one for each line) would likely be required, with the costs dependent on the size and mix of functions. Based on recent Volpe Center experience with rail projects for the U.S. Army, construction costs for a rail maintenance facility would be on the order of $15 million. However, other TAG members cited figures closer to $35 million for recent LIRR facilities of similar scope. The $35 million figure will be used for cost estimation purposes here in order to conservatively reflect the potentially high land, labor, and materials costs that prevail in the New York area (as well as the possible need for a second facility). Further precision will require additional analysis and consultation with the LIRR.

New and Re-Opened Stations
This initial analysis assumes that infrastructure investments will be made to (re-)open the following stations: Calverton, Quogue, Southampton College, Water Mill, and Wainscott. This work would include, at a minimum, the construction of ADA-compliant boarding platforms and space for passenger waiting and/or ticket vending machines. Based on similar projects at other commuter rail agencies, typical costs for new stations range from $250,000 for a very basic platform to $2 million or more for a station with a covered waiting area, lighting, and other amenities. (Recently opened stations along the UTA line were in the range of $1.5 million, though this included 10-car platforms, canopies, and a snowmelt system.) Additional costs would be incurred for parking lot resurfacing or other site improvements, and the actual cost could vary substantially based on current site conditions. For modeling purposes, fairly basic stations at $1,000,000 each are assumed. This represents a modest investment for

accessible platforms and shelters. It excludes costs for the construction or renovation of a station building and any land acquisition costs. Land ownership around former and existing LIRR stations is divided among numerous public and private entities, and it is possible that some land purchases could be required for expanded rail service and/or connecting bus operations.

Issues Identified in Modeling

The effects of running the Cannonball service (and other high-volume seasonal trains) on the South Fork have not yet been specifically modeled in the Railroad Traffic Planner software. However, since these seasonal trains can carry in excess of 1,000 passengers, it is clear that the smaller-capacity railcars envisioned in this scenario would be insufficient for the passenger volumes, making a transfer at Speonk impractical. Indeed, on a busy summer Friday, as many as seven eastbound trains arrive on the South Fork carrying more than 500 passengers each. To allow the Cannonball and other high-volume trains to continue past Speonk on the single track, several of the proposed local train runs would need to be cancelled during these periods (Thursdays, Fridays, and Sundays roughly from May to September).

The Cannonball would presumably still be available for local travel between South Fork hamlets, and/or substitute bus service could be implemented as necessary. Further analysis of this issue can be pursued in the next phase if desired. Freight train movements, though limited, would also need to be scheduled at off-peak times to ensure separation from passenger trains. Further modeling would also be needed to assess the impacts of the expanded passenger service on grade crossings and noise.

Rail Cost Summary

Item	Unit Cost	Quantity	Total
Rail Vehicles			
DMU Railcar Single-level	$ 6,500,000	17	$ 93.5 million
DMU Coach Single-level	$ 3,500,000	6	$ 21.0 million
-- OR --			
Rebuilt Budd RDC	$2,000,000	23	$46.0 million
Infrastructure			
Railroad siding (1/4 mile)	$ 500,000	7	$ 3.5 million
CTC	$ 175,000	90	$ 15.75 million
Switches	$ 75,000	20	$ 1.5 million
Maintenance / repair facility	$15 – $35 million	1-2	$35.0 million
ADA retrofit -- New / reopened stations	$ 1,000,000	5	$ 5.0 million
Total Rail Capital Costs			**$106.75 million to $175.25 million**
Annual Operating Costs	$ 424 per vehicle-hour	45,000	**$ 19.0 million**

3. Bus Service Scenario

Background
Compared to current SCT bus services, the bus component of the rail-bus network represents a change in approach: many of the proposed bus routes are designed to feed into the rail system (with coordinated transfers) rather than provide end-to-end transportation. Several of the proposed routes have also been assumed to incorporate elements of demand-response or "flex" service.

Modeling Assumptions
The Volpe Center modeled the proposed bus routes using the service parameters noted above (hourly service for 14-18 hours per day, with half-hourly service during morning and afternoon peak periods). Travel times were estimated using existing SCT route travel times, where applicable, as well as posted roadway speeds. Additional recovery time of approximately 20 percent (a figure commonly used in bus transit planning) was built into the schedule to allow for variations in traffic congestion and the number of passengers boarding and alighting. Travel times and schedules will need to be updated based on actual travel conditions, and in some cases, it may be desirable to have the scheduled travel times vary by time of day or season based on ridership and traffic conditions.

Route Descriptions
The table below summarizes the modeling of the proposed bus routes, including travel characteristics, the recommended number of peak and off-peak vehicles, and the frequency of service that can be provided with those vehicles. (For fixed-route services, "average" wait time is one-half of the scheduled frequency, based on randomly timed arrivals at the bus stop; in practice many riders will time their trip based on the schedule so as to wait less.)

The Volpe team also made initial assumptions about whether each route should be structured as a conventional fixed-route service, a fixed route with an option for "flex" (deviation), or a demand-response service. These initial determinations were based on the characteristics of the service area, likely passenger origins and destinations, running times and mileage, and vehicle availability.

In general, bus services that are envisioned as “feeders” to rail stations were designed as flexible, demand-response shuttles that serve points within a 3-mile radius from the station on request. The 3-mile radius reflects the approximate area that a single bus can serve for both dropping passengers off and picking passengers up from the train station during periods of half-hourly train service. (These service areas can be expanded geographically by meeting a train in only one direction or by providing hourly service during off-peak periods.) This form of on-demand service was chosen for modeling because it aligns well with the fact that many trips will start or end at the train station but are otherwise geographically dispersed. Several transit agencies around the country have also found that introducing new services as demand-response helps to identify the areas of greatest demand, which can then be converted into a fixed route later.

Most of the other bus routes provide service to areas beyond the rail lines, such as to Orient Point, Sag Harbor, and Wading River, and generally have been modeled as conventional fixed-route services. The Shelter Island route is recommended for flex service during the off-peak periods, as the island’s layout allows broad coverage without additional vehicle requirements. Other routes, including those serving East Hampton, may be good candidates for flex service; however, this could increase waiting times for passengers who are connecting with the rail service. On the route map in Figure 2, fixed route service is shown as colored lines, with each color representing a different route. Demand-response shuttles are shown as circles around rail stations with approximate service radii. The shaded area on Shelter Island represents the approximate area for off-peak flex service.

The number of buses identified as necessary for each route is generally a function of the number required to provide service with wait times of no more than 30 minutes during peak periods and 60 minutes off-peak (except Hither Hills to Montauk, which is scheduled every 65 minutes in the off-peak). Schedules and vehicle requirements can be adjusted so as to minimize the wait time for passengers connecting between bus and rail. However, for most bus routes, establishing bus service with tight connections for boarding *and* alighting rail passengers, eastbound *and* westbound, would have required more than three times as many vehicles as listed in the table. The Volpe team therefore used its judgment in assigning vehicles to routes so as to strike a balance between rail-bus coordination and overall cost-effectiveness, typically selecting a number of vehicles that will allow good connections in the “peak” or predominant travel direction only. For example, the demand-response shuttles are modeled using only one vehicle; these would typically be timed to bring passengers to peak-direction trains in the morning and collect returning passengers from peak-direction trains in the afternoon. Travelers going in the off-peak direction would face longer wait times. Note also that extra vehicles have been assigned to the Riverhead-Hampton Bays route during peak periods to reduce waiting times on this important link between the two rail lines. In this case, tight timetabling with both the North and South Fork train connections was not feasible, so extra service was added so that bus wait times do not exceed 15 minutes.

Table 1. Bus Route Summary

Route	Round Trip/ Loop Distance *miles*	Time allowed for Round Trip *min.*	Off-Peak Buses	Off-Peak best frequency *min.*	Peak Buses	Peak best frequency *min.*	Service Notes (services are fixed-route unless noted)
Greenport RR - Orient Pt via Hospital	19.2	50	2	25	2	25	
Shelter Island	8.8	25	1	25	1	25	Flex during off-peak
Riverhead – Jamesport	12.8	50	1	50	2	25	
Riverhead RR -Wading River	24.0	65	2	33	3	22	
Riverhead RR - Hampton Bays RR	18.0	70	3	24	5	14	
Riverhead -Westhampton RR	17.5	55	1	55	2	28	
Riverhead Circulator A	11.6	60	1	60	2	30	Flex during off-peak
Riverhead Circulator B	8.4	45	1	45	2	23	Flex during off-peak
Bridgehampton RR - Sag Harbor - North Haven	16.2	50	1	50	2	25	
East Hampton - Sag Harbor - North Haven	22.2	60	1	60	2	30	
Noyak – Bridgehampton	25.8	85	2	43	3	29	
Southampton - North Sea	10.2	45	1	45	2	23	
East Hampton – Wainscott	8.8	25	1	25	1	25	
East Hampton - Cedar St, Stephen Hands Path, Springy Banks Rd	8.7	30	1	30	1	30	
East Hampton - Springs Fireplace Road, Three Mile Harbor Rd	12.6	40	1	40	2	20	
East Hampton - Accobonac Road	11.3	40	1	40	2	20	
Montauk RR to dock & village	10.0	55	1	55	2	28	
Amagansett - Napeague via Montauk Hwy (seas.)	12.6	40	1	40	2	20	
Hither Hills to Montauk light via village (seasonal)	21.2	65	1	65	3	22	
Southold shuttle A	6.0	20	1		1		Demand response
Southold shuttle B	6.0	20	1		1		Demand response
Mattituck shuttle A	6.0	20	1		1		Demand response
Mattituck shuttle B	6.0	20	1		1		Demand response
Speonk station-village shuttle	6.0	20	1		1		Demand response
Westhampton station-village shuttle	6.0	20	1		1		Demand response
Quogue station-village shuttle	6.0	20	1		1		Demand response
Southampton station-village shuttle	6.0	20	1		1		Demand response
Bridgehampton station-village shuttle	6.0	20	1		1		Demand response
Wainscott station-village shuttle	6.0	20	1		1		Demand response
Hampton Bays Shuttle	6.0	20	1		1		Demand response

The Greenport – Orient Point bus route provides a good example of the trade-offs involved in determining bus requirements and setting schedules. It is estimated that it will take a bus 20 minutes to travel between Greenport and Orient Point. On the schedule below, an extra 5 minutes has been added each way in order to provide some slack time in the schedule in case of traffic congestion or extra time needed to board passengers.

The Greenport-Orient Point route is unusual in that the bus has transfer points on both ends – the ferry terminal on the eastern end and the Greenport rail station on the western end. Connecting with a terminal rail station like Greenport is more straightforward than with an intermediate station, since all passengers will be alighting from the eastbound service and boarding the westbound trains. Ideally at a minimum of five minutes would be provided between the boarding and alighting of each leg of the trip, to allow even the slowest passengers to transfer without rushing. In some cases in the example below, however, only two minutes is scheduled between some eastbound trains and the bus' departure from Greenport due to the interactions between the train, bus, and ferry schedules.

This schedule provides half-hourly service through the off-peak midday hours. This is more than the service requirements laid out by the TAG. However, without the second bus, connections could be made in only one direction. In other words, if the second bus (shaded rows in the table) were removed, westbound passengers could not make either the ferry to bus connection or the bus to rail connection.   In this case, with a 50-minute round-trip travel requirement, the bus has an extra 10 minutes each trip in which it waits at the Greenport rail station. This extra time allows a single vehicle to drop off passengers for the westbound train and then wait for passengers alighting the eastbound train. Not all routes will be amenable to such coordination. Had the route required an extra five or ten minutes, an entirely different solution to the schedule would have to be developed, likely missing more connections or adding significantly more vehicles.

Table 2. Sample Schedule for Greenport – Orient Point Route

Train Arrives Green-port	Time to catch bus from train	Bus Departs Greenport	Bus Arrives Orient Point	Time to catch ferry from bus	Ferry Leaves Orient Point	Ferry Approx Arrival Orient Point	Time to catch bus from ferry	Bus Departs Orient Point	Bus Arrives Green-port	Time to catch train from bus	Train Departs Green-port
											4:00
											5:00
											5:28
		6:00	6:25				6:25	6:25	6:50	0:10	7:00
6:28	0:02	6:30	6:55	0:05	7:00			6:55	7:20	0:10	7:30
6:58	0:02	7:00	7:25				7:25	7:25	7:50	0:10	8:00
7:28	0:02	7:30	7:55	0:05	8:00			7:55	8:20	0:10	8:30
7:58	0:02	8:00	8:25			8:20	0:05	8:25	8:50	0:10	9:00
8:28	0:02	8:30	8:55	0:05	9:00	8:50	0:05	8:55	9:20	0:10	9:30
8:58	0:02	9:00	9:25	0:05	9:30	9:20	0:05	9:25	9:50	0:10	10:00
9:28	0:02	9:30	9:55	0:05	10:00			9:55	10:20	0:10	10:30
9:58	0:02	10:00	10:25			10:20	0:05	10:25	10:50	0:10	11:00
10:28	0:02	10:30	10:55	0:05	11:00			10:55	11:20		
		11:00	11:25			11:20	0:05	11:25	11:50	0:10	12:00
11:24	0:06	11:30	11:55	0:05	12:00			11:55	12:20		
		12:00	12:25			12:20	0:05	12:25	12:50	0:05	12:55
12:24	0:06	12:30	12:55	0:05	13:00	12:50	0:05	12:55	13:20		
		13:00	13:25	0:05	13:30	13:20	0:05	13:25	13:50	0:10	14:00
13:24	0:06	13:30	13:55	0:05	14:00			13:55	14:20		
		14:00	14:25			14:20	0:05	14:25	14:50	0:10	15:00
14:24	0:06	14:30	14:55	0:05	15:00			14:55	15:20		
		15:00	15:25			15:20	0:05	15:25	15:50	0:10	16:00
15:24	0:06	15:30	15:55	0:05	16:00			15:55	16:20		
		16:00	16:25			16:20	0:05	16:25	16:50	0:10	17:00
16:24	0:06	16:30	16:55	0:05	17:00			16:55	17:20	0:10	17:30
16:58	0:02	17:00	17:25	0:05	17:30	17:20	0:05	17:25	17:50	0:10	18:00
17:28	0:02	17:30	17:55	0:05	18:00			17:55	18:20	0:10	18:30
17:58	0:02	18:00	18:25			18:20	0:05	18:25	18:50	0:10	19:00
18:28	0:02	18:30	18:55	0:05	19:00			18:55	19:20	0:10	19:30
18:58	0:02	*19:00*	*19:25*			*19:20*	0:05	*19:25*	*19:50*	0:10	*20:00*
19:28	0:02	*19:30*	*19:55*	0:05	*20:00*			*19:55*	*20:20*	0:10	*20:30*
19:58	0:07	*20:05*	*20:30*	0:15	*20:45*	*20:20*	0:10	*20:30*	*20:55*	0:05	*21:00*
20:28	0:07	*20:35*	*21:00*	0:15	*21:15*	*21:20*	0:10	*21:30*	*21:55*		
20:58											
21:28	0:27	*21:55*	*22:20*					*22:20*	*22:45*		
22:28	0:17	*22:45*	*23:10*					*23:10*	*23:35*		
23:28											
Bus 1		*trips and connections in italics do not run on during the low-season.*									
Bus 2		**connections in bold are not met by bus**									

A second example of scheduling complexity can be seen in the services provided to North Haven via Sag Harbor from Bridgehampton and East Hampton. It is estimated that the round trip to North Haven will require 60 minutes from East Hampton but only 50 minutes from Bridgehampton. A schedule that used all vehicles as efficiently as possible would provide 30-minute service on the East Hampton route and 25-minute service on the Bridgehampton route. While this provides the best possible service to the train stations, it provides erratic service between North Haven and Sag Harbor, where waits could range from 5 to 25 minutes during the peak period and as long as 50 minutes mid-day. If instead, the Bridgehampton buses wait an extra 10 minutes at the Bridgehampton Station on each run, the timing of the two services would be harmonized, and could alternate evenly to provide much more regular service between North Haven and Sag Harbor.. This would reduce the number of trips provided on the Bridgehampton route by 5 trips per day, or 17%, but with only minor cost savings since the driver would still work the same number of hours.

Bus Investment and Costs

Modeling results indicate that 52 buses would be needed to provide the proposed service. This reflects a minimum of one bus per route plus additional vehicles as necessary to achieve the desired 30-minute headways during peak periods. Spare vehicles are also needed to allow for replacements while buses undergo repair or routine maintenance. Typical rules of thumb are that routine maintenance is needed every 5,000 miles and that 15 to 20 percent of vehicles should be kept as spares. Spare vehicles at SCT and MTA Long Island Bus are in the 18 to 19 percent range according to the National Transit Database. This analysis assumes that 10 buses would be kept as spares, for a total of 62 buses.

Compared to the current SCT bus service, buses on the rail-bus network would largely travel on shorter routes that are focused on the rail stations. As such, and given the relatively low expected passenger volumes per trip and the need to negotiate smaller streets in village centers and residential neighborhoods, the Volpe team recommends using smaller, “cutaway” vehicles that seat 20 to 30 passengers. These vehicles are generally built as bus frames mounted on a truck chassis, and are available from numerous manufacturers with many different configurations and options. Further analysis of specific vehicle options can be part of the next phase of research. At this stage, the vehicle used for cost-estimation purposes is a 28-passenger, medium-duty, ADA-compliant shuttle bus with a hybrid-electric motor. Using prices available through the federal General Services Administration, the vehicle cost including a standard array of options is approximately $300,000. Total bus purchase costs would thus be $18.6 million including spares.

The bus service would also require an operations center, including a call center to take reservations for the on-demand and flex services, a bus refueling center, and a bus storage yard. Based on cost figures from USDOT’s Intelligent Transportation Systems Cost Database, and recent experience with the Cape Cod RTA, a call center and refueling station is estimated at roughly $7 million, plus land acquisition costs (if applicable). The exact facility requirements would depend on the institutional arrangements used for providing the service. For example, a contractor might provide some of these services as part of the contract for service, in which case the capital costs would be lower but the costs would be included in the contract fee. For cost estimation purposes, this center can be assumed to double as the dispatching center for the rail operations and the home of the CTC hardware.

Upfront costs related to fare collection will also depend on institutional arrangements, the fare policy that is implemented, and the fare media used. For example, a self-service “proof of payment” system involves higher upfront costs for ticket vending machines, but can reduce the labor costs of enforcement. Regional integration (i.e., a single farecard that is valid both on the East End and in the New York City area) would be convenient for customers, but would likely require fare collection hardware and software that are compliant with the MTA's systems. At this stage, no specific costs for fare collection hardware are included, but this issue can be addressed in the next phase of research.

Turning to operational costs, SCT's average operating cost per vehicle-hour is $89.42, compared to an average of $122.70 for the nation's 50 largest transit agencies. Operating costs for the bus portion of the rail-bus network are estimated using the lower SCT figure and the number of vehicle-hours of proposed service: 247,372 vehicle-hours per year. This produces an estimated $22.1 million in bus operating costs.

The cost estimate also needs to include non-direct costs for contract administration and oversight, service planning, accounting, auditing, legal services, property management, public affairs, marketing, and related activities. These costs will vary depending on the institution that manages the service. As a point of comparison, the Transportation Division of the Suffolk County Department of Public Works, which oversees SCT bus service, has roughly 17 staff positions at an annual cost of around $1.5 million, plus $2 million for insurance and other items. Although SCT has a larger service area than just the East End, managing the rail-bus network could be more resource-intensive due to its multi-modal nature and the need for close coordination of timetables. As a rough estimate, $5 million per year has been assumed for the rail-bus network's administrative costs, including a small office staff, insurance, and other expenses. These costs would be higher if the service is provided directly rather than contracted out, because additional functions such as human resources would be required.

Other Issues Identified in Modeling

The need for buses to meet fixed railroad timetables means that additional time must be built into their schedules to allow for transfers, plus schedule-recovery time to ensure that traffic delays on the route do not result in a missed train connection. As a result, the bus fleet would be used less intensively than under a conventional bus system, and more vehicles are needed for a given level of service. In meeting a half-hour train service, each bus might spend 20 or even 30 minutes out of each service hour waiting at the train station for passengers going to and from the train.

Bus Cost Summary

Item	**Unit Cost**	**Quantity**	**Total**
Medium-Duty Bus	$ 300,000	62	$ 18.6 million
Call center / refueling station / rail control center	$ 7,000,000	1	$ 7.0 million
Total Bus Capital Costs			**$ 25.6 million**
Annual Operating Costs	$ 89.42 per vehicle-hour	247,372	**$ 22.1 million**

4. System-wide service characteristics

The proposed rail and bus services have been laid out on the map in Figure 2 to allow for a more holistic view of service in the region. Table 3 shows the differences in travel characteristics between the current and proposed systems for a number of sample itineraries within the East End. The map and table highlight some of the key ways in which the proposed rail-bus network differs from the existing public transportation system:

- **Most obviously, both the geographic extent of transit coverage and the frequency of service are greatly increased.** Overall service frequencies are similar to the existing S-92 bus route, with departures every 30 to 60 minutes, but with a longer window of peak service, peak service in both directions, and a greater overall daily span of service. Most transit trips in the region would be faster and more frequent. Each area of the East End with existing transit service would continue to have service (possibly under a different form, such as an on-demand station shuttle). For areas off the S-92 route, such as Montauk, Springs, Noyac, North Sea, and Westhampton, the level of transit access would be greatly increased – from as little as 4-5 buses per day (or none, in the case of Shelter Island) to service every 30-60 minutes.

- **It is expressly designed as a multi-modal system, with timed connections between services, rather than rail and bus modes operating more or less independently.** In addition to connectivity, the advantage to this approach is that it allows much of the trip mileage to take place by rail rather than by bus, which means more reliable travel times, particularly during peak congested periods. However, the hub-and-spoke orientation means that transfers are required for almost all longer trips other than hamlet-to-hamlet trips along the same rail line. A trip between Sag Harbor and Greenport is currently a two-hour but one-seat ride on the S-92; this trip would become much faster (45-minute) with the rail-bus network, but would require four vehicles: a bus to North Haven, the South Ferry, the Shelter Island bus, and the North Ferry. Even with well-coordinated connections between bus and rail services, some transfer time and waiting is inevitable, which means that some trips will take longer than with the current system. For example, a trip from the Mattituck area to Eastern Long Island Hospital, both of which are currently on the S-92, would require taking a train to Greenport and then connecting to a bus for the last mile of the trip, adding at least 5-10 minutes to the journey even if the rail-bus coordination is fairly precise. The emphasis on limited-stop rail service also means that major employment destinations that are located outside of hamlet centers may not be as accessible as with the current bus route structure.

- **The bus-rail network improves access to New York City and other areas beyond the East End, but does not address many of the existing LIRR schedule issues.** The network would provide frequent service to the LIRR stations at Speonk and Ronkonkoma, where onward connections could be made. This would also help ease the parking crunch at Ronkonkoma. However, significant gaps in the train schedules would continue, particularly at Speonk. Although East End trains may arrive in Speonk every 30-60 minutes, there could still be a space of several hours in the LIRR schedule for onward travel to New York. The situation is somewhat better at Ronkonkoma, but even here, the East End's schedule (regular 30-60 minute service) does not always align well with the LIRR service, which has many trains clustered tightly in the AM peak, but then larger schedule gaps during the rest of the day. As summarized in the table below, existing North Fork train commuters may find that the more frequent service to Ronkonkoma brings with it the trade-off of longer layovers there.

Summary of Ronkonkoma Connections – Weekday Mornings Westbound

Based on Draft Rail Schedules in Figure 1 and Current LIRR Schedule

East End Train Departs Greenport	East End Train Arrives Ronkonkoma	Layover to next LIRR	LIRR Departs Ronkonkoma
4:00	5:52	0:16	6:08
5:00	6:52	0:04	6:56
5:28	7:17	0:02	7:19
7:00	8:52	0:19	9:11
7:30	9:22	0:49	10:11
8:00	9:52	0:19	10:11
8:30	10:22	0:49	11:11
9:00	10:52	0:19	11:11
9:30	11:22	0:49	12:11
10:00	11:52	0:19	12:11

Table 3. Comparison of travel times and connections for selected East End trips.
All travel times are approximate and are based on current and proposed schedules and average connection times.

	Current Transit System				Proposed Rail-Bus Network			
Trip	Service/ Route	Service Level	Travel Time	Trans-fers	Service/ Route	Service Level	Travel Time	Trans-fers
Jamesport to South-ampton	S-92	17 trips/ day	0:55	none	bus to Riverhead, bus to Hampton Bays, train to South-ampton	Approx. 25 trips/ day	1:20	2
Hampton Bays to East Hampton	S-92 or LIRR	17 buses & 3-4 trains per day offpeak	39-55 min.	none	train	24 trips / day	39 min.	none
Sag Harbor to Greenport	S-92	Every 30-60 minutes	1:50 to 2:00	none	Bus to North Haven, South Ferry, Shelter Is. bus, North Ferry	Every 30-60 minutes	45 min.	3
Orient Point to downtown Riverhead	S-92	Every 30-60 minutes	1:05	none	bus to Greenport, train to Riverhead	Every 30-60 minutes	1:10	1
Noyac to Amagan-sett	10A to S-92 to 10C, or 10A to LIRR	5 buses/ day from Noyac	2 to 3+ hrs	1 - 2	bus to Bridge-hampton RR, train to Amagansett	Every 30-60 minutes	1 hour	1
Springs to S'hampton College	10B to S-92, or connect to 10A	8 buses/ day from Springs	1:10 to 1:40	1-2	bus to EH RR, train to College	Every 30-60 minutes	50-60 minutes	1
Montauk Village to Tanger Outlets	10C to S-92 to 8A	4 buses/ day on 10C btw Montauk & East Hampton	4 hours	2	Bus to Montauk RR, train to H. Bays, bus to Riverhead, bus to Tanger	Every 30-60 minutes	2:15 to 2:30	3

5. Ridership Estimation

Ridership for the proposed rail-bus network as a whole is estimated below using a combination of analytical methods. This is intended only as an initial rough estimate range that can be used to enable stakeholder evaluation of the system's potential usage and cost-effectiveness.

The primary estimation approach is based on the relationship between public transit ridership and service provision. As common sense would dictate, ridership generally increases as the level of transit service increases: more service means shorter average waiting times, and potentially a greater number of destinations served by the transit system, both of which make transit more attractive relative to driving or other alternatives (or forgoing the trip altogether). By comparing current ridership and current service levels to the level of transit service envisioned in the rail-bus network, an estimate of ridership for that proposed transit system is produced. As a check on this method, the results are compared against other sources of information, including findings from the South Fork Commuter Connection; Census journey-to-work data on transit mode share and travel patterns in the region; and estimates of potential transit ridership increases from the modeling effort pursued as part of the SEEDS process. Results from a telephone survey on transit sponsored Five Town Rural Transit (5TRT) are also discussed to provide further context.

Baseline: Current East End Transit Ridership

Current transit ridership in the East End is split across agencies and modes (SCT and LIRR), with different ridership counting procedures and little information about the number of passengers transferring between modes. For some services (e.g. westward bus routes from Riverhead), the ridership figures also include some non-East East travelers. A reasonable estimate of current ridership can nonetheless be generated by applying some basic assumptions to the reported ridership figures from SCT and the LIRR.

Ridership counts conducted by SCT in 2006 yielded estimates of annual ridership as follows:

Route(s)	Estimated Annual Ridership
S-92	403,296
S-94	535
8A	45,760
10A	11,114
10B	42,917
10C	44,149
10DE	3,797
S-90	19,303
S-62	141,691

In building an estimate of current East End Ridership, ridership figures on the S-90 and S-62 routes were adjusted for the fact that these buses go beyond the five East End towns and therefore transport passengers who have neither an origin nor a destination within the East End. As a simplifying assumption, 80 percent of the S-90 ridership and 20 percent S-62 ridership was considered local to the East End. Including the effects of this adjustment, SCT bus ridership within the East End is estimated at approximately **600,000** one-way trips per year. Fully two-thirds of this total comes from the S-92 route. (Note that these counts represent "unlinked" trips; in other words, someone who rode the 10C and then transferred to the S-92 would be counted on both routes. This is the most common way to measure transit ridership, but can present difficulties when trying to measure complete itineraries.)

Estimates of LIRR ridership are based on "station counts" conducted in 2006 of passengers boarding and alighting at each East End station. These counts were mostly conducted between April and June, and showed a total of 480 boardings and alightings per day, equivalent to 240 round-trip passengers. Translating these figures into annual totals requires a number of assumptions. First, the 240 passengers can be viewed as regular commuters who travel 245 days per year (i.e., 49 work-weeks). This yields an annual total of 464,600 one-way trips. (This could overstate ridership if these riders are not actually regular rail commuters, but it could also understate ridership since the station counts did not capture the July-August peak.)

The rail ridership total also needs to account for those East End residents who drive to Ronkonkoma to take advantage of the more frequent LIRR service available there. These travelers should be considered part of the current East End ridership base because Ronkonkoma, as the western terminus of the proposed rail shuttle system on the North Fork, would be part of the proposed rail-bus network. Station counts at Ronkonkoma show about 6900 daily travelers; anecdotally about a third of these travelers come from east of the station, but the exact share from the five East End towns is unknown. This analysis will assume that the figure is about 10 percent, and again that these travelers make the equivalent of 245 round trips per year.

All told, these assumptions produce an estimated annual total of around **460,000** one-way trips to or from the East End on the LIRR. When combined with the bus estimate, total local transit ridership is **1,050,000** rides per year. Although this estimate is based on a number of assumptions, it is within 10 percent of the estimate produced by the Five Town Rural Transit group in 2005 of total bus and rail ridership in the East End of **940,000** per year. Given that 5TRT's estimate is now a few years old and that ridership on the S-92 has been rising noticeably in recent years, the two figures should be considered roughly comparable. Moreover, extreme precision is not warranted on this point, since even the "hard data" points are actually the product of fairly limited samples and counts. As a rough estimate for modeling purposes, therefore, this section uses an estimated annual total of **1 million** one-way transit trips as the baseline.

Elasticity of Transit Demand with Respect to Service Provision

Transportation planners seeking to understand the demand for public transportation have studied the influence of a number of factors on ridership, including transit fares, the level of service provided, and the cost of driving. *Elasticity* is defined as the percentage change in transit ridership for a given percentage change in one of these factors. In this case, where a significant expansion of transit service on the East End is envisioned, the variable of interest is service provision, which is usually expressed in terms of the number of vehicle-hours or vehicle-miles of transit service. How much would ridership be expected to increase for each 1 percent increase in service?

A review of the literature by Litman (2007)[3] noted that the elasticity value is typically less than one. In other words, increases in service levels produce increases in ridership, but on a less than one-to-one basis. This reflects the fact that there are diminishing returns to additional transit service: many automobile commuters will continue to drive in spite of the extra service, while transit riders can only take so many extra trips per day to take advantage of it. However, there have been exceptions, where well-crafted transit services (such as new express transit lines) have achieved ridership increases that exceed the proportional increase in the amount of service. Overall, based on findings from prior research, Litman recommends using a range of 0.5 to 1.1. This means that for each 10% increase in transit service with the proposed rail-bus network over the current service, ridership would be expected to increase about 5% to

[3] Litman, Todd (2007). Transit Price Elasticities and Cross-Elasticities. Victoria Transport Policy Institute, Victoria, B.C., Canada.

11% over current levels. (The increase is usually greater in the long run, because commuters need time to adjust their travel choices to the new circumstances.)

It should be noted that these elasticities have been empirically derived from changes in transit service that are relatively small, such as reduced headways on existing routes or the introduction of a new route or set of routes. By contrast, the proposed rail-bus network would constitute a very large increase in the amount of service provided on the East End. As Section 4 describes, it would also represent a change in the *way the transit network is organized*. Many trips would be faster and some new destinations would be reachable, but transfers – which are perceived as an inconvenience and are known to be a drag on ridership – would be much more common.

Current and Proposed Service Levels

For this analysis, service provision was measured using the common metric of vehicle-hours. (One transit vehicle traveling for 10 hours, or 10 transit vehicles traveling for one hour apiece, would each be equal to 10 vehicle-hours.) Current run times, hours of service, and the number of departures were based on published LIRR and SCT schedules. Only periods in which vehicles were in revenue service were included; that is, the figures do not include layover or turnaround time or vehicles deadheading to storage yards. For rail service, "vehicle" refers to a trainset rather than the number of individual coaches.

As described in the Existing Conditions report, the frequency of LIRR service to and from the East End varies by day, season, and line. In calculating current service levels, a composite figure (approximate weighted average across days and seasons) was used for each line. SCT service in the East End, with a few exceptions, does not vary by season. Service also does not vary by day, except that there is no Sunday service. For SCT routes that leave the East End, hours of service were based on the approximate portion of the running time that was within the East End, based on the printed timetable. In all, the East End's current transit network produces approximately 8,000 vehicle-hours of rail service and 48,000 hours of bus service annually, for a total of 56,000 vehicle-hours.

The proposed rail-bus network would have service 18 hours per day during half the days of the year, and 14 hours per day during the other half of the year. The two shuttle-train lines and most of the 30 bus routes would run on roughly hourly schedules, with half-hour service during the morning and afternoon peak periods. Based on these assumptions and the estimated running times associated with each route, the rail-bus network would offer approximately 45,000 vehicle-hours of rail service and 247,000 hours of bus service per year, for a total of 292,0000 vehicle-hours of transit service. This is an increase of 420 percent over the current transit system.

The lower end of the elasticity range appears to be most appropriate here because of the very large increase in the amount of service and the principle of diminishing returns. Thus, with an assumed elasticity of 0.5, the rail-bus network would be estimated to have 3.1 million total riders per year. (The number of boardings would be somewhat higher, since the rail-bus network has a hub-and-spoke orientation that requires transfers.)

This estimate is substantially lower than the 4.7 to 5.7 million annual riders that 5TRT estimated based on the telephone survey that it commissioned. However, the survey appears to reflect a well-known tendency for survey respondents to overstate their propensity to take transit. One source of error is "social desirability bias" – respondents know that using public transportation instead of driving is viewed favorably by others, and are thus more likely to respond in a way that conforms to that view. Simple optimism and good intentions also play a role, especially since the survey did not describe the routes, stops, and timetables of the proposed transit service in enough detail for respondents to make informed judgments. The survey results should thus receive very little weight in developing a ridership estimate, though they might be viewed as a "best case scenario."

Evidence from the South Fork Commuter Connection (SFCC)

From late October 2007 to late June 2008, the SFCC operated as a congestion mitigation measure during reconstruction of County Road 39. The SFCC included six additional local trains on the South Fork on weekdays – three in each direction. There were also shuttle bus services to connect the rail stations with villages, schools, and major workplaces, as well as two bus-in-lieu-of-rail services (the "school teachers' special" and "last chance" buses, both one-way westbound) that filled in gaps in the afternoon rail schedule.

Though the SFCC included some unique circumstances, it is also a useful "natural experiment" in assessing the response of East End residents to expanded transit service. Put another way, experience gained from the SFCC provides insight into how well the elasticity figures reported in the literature might apply to the East End.

The SFCC attracted about 8,000 one-way trips per month in November 2007, which is equivalent to about 200 round-trip riders per day. An intercept survey of riders showed that only 1 percent were existing LIRR commuters and 3 percent had been bus commuters, so the SFCC counts do reflect new transit ridership rather than existing transit commuters who simply switched departure times or modes. SFCC ridership remained relatively strong through the winter, but fell off sharply in May 2008 after CR 39 was fully re-opened. May ridership was about 3,200 one-way trips, or roughly 76 round-trip riders per day.

SFCC's three additional round-trip trains represented an increase in weekday LIRR service on the East End of approximately 54 percent, compared to the post-Columbus Day autumn schedule. The service increase was about 71 percent when the two bus-in-lieu-of-rail services are included as if they were rail.

The ridership-to-service level elasticity range mentioned above (0.5 to 1.1), when applied to the service increases associated with SFCC, would suggest that SFCC's new ridership would be in the range of 73 to 161 daily riders. This is indeed very close to the actual ridership numbers, though SFCC's peak was a bit higher. This provides some confirmation that the East End's population is likely to respond to additional transit service provision in a way that is roughly consistent with the elasticities derived from service expansions elsewhere as reported in the literature.

However, SFCC's relatively robust ridership results must be considered in conjunction with the fact that unusual conditions prevailed: the service was heavily promoted and marketed, connecting bus service was provided (particularly in the Town of Southampton), and construction delays on a major east-west artery created an environment that strongly discouraged travel by private automobile. SFCC's ridership levels after the re-opening of CR 39, which reflect an elasticity of about 0.5 – the same parameter used above – are probably a better reflection of the likely response to expanded public transportation. This would be particularly true in the absence of any supporting policies that would strongly discourage automobile travel (such as road-user charging, parking taxation, or mandatory trip-reduction targets for employers) and/or create clusters of higher-density housing and employment.

Journey-to-Work Mode Shares

The plausibility of the ridership estimates above can also be assessed by viewing them in light of the East End's existing mode choices for commute trips. As described in Section 4.1 of the Volpe Center's Existing Conditions report, data from the 2000 Census can be used to identify the Town-to-Town commuting patterns of East End residents and non-resident workers, as well as the share of commuters who use public transportation. According to this data, 55 percent of East End residents work in the Town of their residence, with many of the rest working in another East End Town, while the non-resident workforce comes primarily from the western part of Suffolk County. Just over 3 percent of the East End's resident commuters use transit as their primary means of travel for the journey to work, although this varies by Town, from a low of 1.4 percent on Shelter Island to 3.7 percent for residents of Southampton.

The proposed rail-bus network would offer more service to more East End residents (and in-commuters) and would make transit more attractive relative to driving or other modes. At the margin, some commuters would be expected to switch to transit. The effects would not necessarily be uniform across the East End towns[4] or between work and non-work trips. However, because trips to and from work constitute a large share of transit ridership, increases in ridership from the rail-bus network would translate into increased transit mode share. As a first approximation, the above-noted estimate of 3.1 million annual transit trips on the rail-bus network would be roughly equivalent to a transit mode share of around 9.5 percent for the East End. This is comparable to the levels that prevail in the westernmost Towns of Suffolk County (Huntington, at 10.6 percent, and Babylon, and 9.6 percent), which are much more densely populated and are home to many Manhattan-bound commuters.

Thus, this level of mode share might be considered potentially achievable, but in the near- to medium-term is probably unrealistically high for an area that is still largely rural. Indeed, areas that share some characteristics to the East End, such as Cape Cod (Barnstable County, Mass.) have transit mode shares in the 1-3 percent range, though their transit services are not as expansive as the proposed rail-bus network.

SEEDS Transit Ridership Forecast

Another point of comparison on ridership forecasts is the 2006 SEEDS (Sustainable East End Development Strategies) report. The proposed-rail bus network is similar to Transportation Scenario 3 from SEEDS, in that both are based on an intermodal network of expanded rail service and inter-hamlet bus connections, running at approximately 30-minute headways during peak periods. The SEEDS scenario is not an exact match, as there are a number of differences in the specific routes and service frequencies. Moreover, SEEDS also included Peconic Bay ferry service, which is not part of the current rail-bus concept, and assumed an accompanying set of land-use policy changes, not all of which have been implemented in the five Towns.

The SEEDS results are nonetheless useful because they are based on a more fine-grained and sophisticated model of mode choice and travel demand, using small Traffic Analysis Zones and the conventional four-step modeling process used by metropolitan planning organizations. The SEEDS modeling process yielded an estimated increase of 5 to 47 percent in the number of transit trips under Transportation Scenario 3, depending on the nature of the accompanying land-use changes (i.e., the overall change in development buildout and the change in density within hamlet centers). The 47 percent figure was associated with an increase in densities in hamlet centers; without such density changes, the increase in transit trips was estimated at 32 percent. Very roughly, these estimates imply an annual

[4] For example, Shelter Island currently has no scheduled local transit service, but with the rail-bus network it would have frequent transit for on-island trips with onward connections to both the North and South Forks.

ridership total of between 1.3 million and 1.5 million trips, again depending on the nature of any accompanying land-use policies.

Summary

Initial system-level estimates of ridership for the proposed rail-bus network range from 1.3 to 3.1 million one-way trips per year. The estimates derived from SEEDS, which are at the lower end of this range, are arguably the most realistic, inasmuch as they are based on an well-established travel demand model, using small geographic units and established models of mode choice. At the same time, the measured ridership response to the South Fork Commuter Connection provides some support for the idea that East End travelers may respond to expanded transit service in a more robust way, particularly if the service is accompanied by supportive policies. Given the uncertainty, the range of 1.3 to 3.1 million one-way trips can be used for modeling purposes as the lower and upper bounds of the ridership estimate. Based on the outcomes from the TAG's deliberations on the current concept, a more refined estimate can be produced as the analysis proceeds using the NYMTC model and/or boarding and alighting data from SCT.

It is important to keep in mind that ridership on the transit system would also be influenced by the effectiveness of any transit marketing campaigns promoting the new service, as well as by certain "intangible" elements related to the customer experience. Attributes such as clean and comfortable vehicles, friendly drivers, and fareboxes that accept credit cards (or, at least, ones that do not require exact change) are believed to be important in building a loyal ridership base, particularly among "choice" riders – those who have a private vehicle available but prefer public transportation for some trips.

Transit demand is also responsive to changes in fare. The TAG has proposed a flat fare of $2.50, including all transfers. This is more than the current SCT fares ($1.50 plus $0.25 for a transfer), while LIRR fares range from $2.25 to $6.50 depending on the distance. In other words, the proposed fare is generally higher for current bus riders, and either around the same level or somewhat less expensive for local rail riders. A direct apples-to-apples comparison is difficult because of the way in which the proposed rail-bus network reorganizes service into a multimodal system. Still, the difference in fares could be significant for lower-income bus riders, and if necessary, further analysis of the likely ridership response to a new fare level could be conducted. At this stage, however, the focus is on creating an initial ridership estimate, and no fine-tuning has been done for fare effects.

The ultimate level of ridership over the longer term will also be strongly affected by region-wide and external variables that are not directly related to the transit service itself, notably:

- Population growth, demographic shifts, and employment levels
- Gas prices
- Land-use policies and real estate development
- Parking policies and TDM measures
- Traffic congestion.

6. Overall Summary

This memo has summarized the results of initial modeling and analysis for the proposed rail-bus network. While more detailed work will be needed to support specific deployment decisions, the current analysis did not reveal any issues that would make the rail-bus network technically or operationally infeasible, provided that certain infrastructure improvements are made. The intensive use of single-track rail does, however, make the system somewhat less robust and flexible, limiting its ability to adjust to vehicle breakdowns, service disruptions, and unusual travel patterns (e.g. from special events).

The proposed routes and services represent a very substantial increase in both the geographic spread of transit service on the East End and in their frequency and intermodal connectivity. Most residents would have access to frequent service, many transit trips would become faster and more reliable, and demand-response services would provide additional flexibility. East End transit ridership, which has been growing in recent years, would be expected to grow even further in response to the new service. At the same time, the reorganization of the transit network into something closer to a hub-and-spoke model, with one or more transfers required for most trips, would be viewed as an inconvenience for those accustomed to one-seat rides on the current routes, and could seriously hinder the ability of the service to draw patronage away from automobile commuters.

The other major drawback of the proposed transit system is its cost: roughly $130 to $200 million in upfront capital costs for infrastructure upgrades and vehicle purchases, plus costs (not yet estimated) for fare collection equipment; then approximately $46 million per year in direct operating costs. Depreciation, although a non-cash item, must also be considered: typical service lifetimes are 12 years for a transit bus and 20 years for a railcar, so the system will need funds for re-capitalization within a relatively short period.

Based on the estimated ridership range and an effective average fare of $2 (i.e., a base fare of $2.50, but with the usual discounts for multi-ride passes, seniors and students), this translates into a cost-per-ride of between $15 and $35, even when looking only at direct operating costs. The farebox recovery ratio – the share of operating expenses covered by fares – would be in the range of 6 to 13 percent. Although this recovery ratio is comparable to that for existing SCT bus routes with lower ridership, such as the S-90 and 8A, the sheer size and scale of the rail-bus network would mean that substantially higher transit subsidies would be required annually. The high per-rider costs would also make it difficult for the system to compete effectively for federal funds under programs such as Small Starts.

Overall Cost Summary

Capital Costs – Rail	$ 106.75 to $ 175.25 million
Capital Costs – Bus	$ 25.6 million
Total Capital	$ 132.35 million to $ 200.85 million
O&M – Rail	$ 19.0 million
O&M – Bus	$ 22.1 million
General & Admin Costs	$ 5.0 million
Total Direct Annual Costs	$ 46.1 million

Table 1. Modeling Outputs: Draft Rail Schedules

Proposed Rail-Bus Network
South Fork Rail – Eastbound

* extra trips during high season only

Speonk	5:00	5:30	6:00	6:30	7:03	7:33	8:05	8:39	9:09	10:00	11:00	12:00	13:00	14:00
Westhampton	5:05	5:35	6:05	6:35	7:09	7:39	8:10	8:44	9:14	10:05	11:05	12:05	13:05	14:05
Quoque	5:09	5:39	6:10	6:40	7:13	7:44	8:15	8:49	9:18	10:10	11:10	12:10	13:09	14:10
Hampton Bays	5:16	5:46	6:17	6:47	7:20	7:51	8:22	8:56	9:25	10:17	11:17	12:17	13:16	14:17
Southampton College	5:23	5:53	6:24	6:54	7:27	7:58	8:29	9:03	9:32	10:24	11:24	12:24	13:23	14:24
Southampton	5:28	5:58	6:30	7:00	7:32	8:04	8:35	9:09	9:37	10:30	11:30	12:30	13:28	14:30
Watermill	5:32	6:02	6:34	7:04	7:36	8:08	8:39	9:13	9:41	10:34	11:34	12:34	13:32	14:34
Bridgehampton	5:39	6:09	6:42	7:12	7:43	8:16	8:47	9:21	9:48	10:42	11:42	12:42	13:39	14:42
Wainscott	5:43	6:13	6:47	7:17	7:47	8:21	8:52	9:26	9:52	10:47	11:47	12:47	13:43	14:47
East Hampton	5:50	6:20	6:54	7:24	7:54	8:28	8:59	9:33	9:59	10:54	11:54	12:54	13:50	14:54
Amagansett	5:55	6:25	7:00	7:30	7:59	8:34	9:05	9:39	10:04	11:00	12:00	13:00	13:55	15:00
Montauk	6:13	6:43	7:18	7:48	8:17	8:52	9:23	9:57	10:22	11:19	12:18	13:18	14:13	15:18

										*	*	*	*
Speonk	15:20	15:50	16:19	16:49	17:18	17:48	18:22	18:52	19:22	20:00	21:00	22:00	23:10
Westhampton	15:25	15:55	16:25	16:55	17:24	17:54	18:27	18:57	19:27	20:05	21:05	22:05	23:15
Quoque	15:29	15:59	16:29	16:59	17:28	17:58	18:31	19:01	19:31	20:09	21:09	22:09	23:19
Hampton Bays	15:36	16:06	16:36	17:06	17:35	18:05	18:38	19:08	19:38	20:16	21:16	22:16	23:26
Southampton College	15:43	16:13	16:43	17:13	17:42	18:12	18:45	19:15	19:45	20:23	21:23	22:23	23:33
Southampton	15:48	16:18	16:48	17:18	17:47	18:17	18:50	19:20	19:50	20:28	21:28	22:28	23:38
Watermill	15:52	16:22	16:52	17:22	17:51	18:21	18:54	19:24	19:54	20:32	21:32	22:32	23:42
Bridgehampton	15:59	16:29	16:59	17:29	17:58	18:28	19:01	19:31	20:01	20:39	21:39	22:39	23:49
Wainscott	16:03	16:33	17:03	17:33	18:02	18:32	19:05	19:35	20:05	20:43	21:43	22:43	23:53
East Hampton	16:10	16:40	17:10	17:40	18:09	18:39	19:12	19:42	20:12	20:50	21:50	22:50	0:00
Amagansett	16:15	16:45	17:15	17:45	18:14	18:44	19:17	19:47	20:17	20:55	21:55	22:55	0:05
Montauk	16:33	17:03	17:33	18:03	18:32	19:02	19:35	20:05	20:35	21:13	22:13	23:13	0:23

These are conceptual timetables and are intended only to show the potential service levels of the rail-bus network, based on the modeling assumptions employed.

Proposed Rail-Bus Network
South Fork Rail - Westbound

* extra trips during high season only

Montauk	6:33	7:04	7:37	8:01	8:37	9:07	9:36	10:16	10:43	11:37	12:37	13:37	14:37	15:37
Amagansett	6:56	7:27	7:59	8:24	9:00	9:29	9:59	10:39	11:05	12:00	13:00	14:00	14:59	15:59
East Hampton	7:01	7:32	8:04	8:30	9:06	9:35	10:05	10:45	11:11	12:06	13:06	14:05	15:04	16:04
Wainscott	7:08	7:39	8:11	8:37	9:13	9:42	10:12	10:52	11:18	12:13	13:13	14:12	15:11	16:11
Bridgehampton	7:12	7:43	8:15	8:42	9:18	9:47	10:16	10:57	11:23	12:18	13:18	14:16	15:15	16:15
Watermill	7:19	7:50	8:22	8:51	9:27	9:56	10:26	11:06	11:32	12:27	13:27	14:23	15:22	16:22
Southampton	7:23	7:54	8:26	8:56	9:32	10:01	10:30	11:11	11:37	12:32	13:32	14:27	15:26	16:26
Southampton College	7:28	7:59	8:31	9:01	9:37	10:06	10:36	11:16	11:42	12:37	13:37	14:32	15:31	16:31
Hampton Bays	7:35	8:06	8:35	9:09	9:45	10:14	10:43	11:24	11:50	12:45	13:45	14:39	15:38	16:38
Quoque	7:42	8:13	8:42	9:17	9:53	10:22	10:51	11:32	11:58	12:53	13:53	14:46	15:45	16:45
Westhampton	7:46	8:17	8:46	9:22	9:58	10:27	10:57	11:37	12:03	12:58	13:58	14:50	15:49	16:49
Speonk	7:49	8:20	8:49	9:25	10:05	10:30	11:00	11:40	12:06	13:01	14:01	14:53	15:52	16:52

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Montauk	16:52	17:22	17:52	18:22	18:52	19:22	19:52	20:22	20:52	21:33	22:33
Amagansett	17:15	17:44	18:15	18:44	19:14	19:44	20:14	20:44	21:14	21:55	22:55
East Hampton	17:20	17:49	18:20	18:49	19:19	19:49	20:19	20:49	21:19	22:00	23:00
Wainscott	17:27	17:56	18:27	18:56	19:26	19:56	20:26	20:56	21:26	22:07	23:07
Bridgehampton	17:31	18:00	18:31	19:00	19:30	20:00	20:30	21:00	21:30	22:11	23:11
Watermill	17:38	18:07	18:38	19:07	19:37	20:07	20:37	21:07	21:37	22:18	23:18
Southampton	17:42	18:11	18:42	19:11	19:41	20:11	20:41	21:11	21:41	22:22	23:22
Southampton College	17:47	18:16	18:47	19:16	19:46	20:16	20:46	21:16	21:46	22:27	23:27
Hampton Bays	17:54	18:23	18:54	19:23	19:53	20:23	20:53	21:23	21:53	22:34	23:34
Quoque	18:01	18:30	19:01	19:30	20:00	20:30	21:00	21:30	22:00	22:41	23:41
Westhampton	18:05	18:34	19:05	19:34	20:04	20:34	21:04	21:34	22:04	22:45	23:45
Speonk	18:08	18:37	19:08	19:37	20:07	20:37	21:07	21:37	22:07	22:48	23:48

These are conceptual timetables and are intended only to show the potential service levels of the rail-bus network, based on the modeling assumptions employed.

Proposed Rail-Bus Network
North Fork Rail - Eastbound

* extra trips during
high season only

Ronkonkoma	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	10:00	11:00	12:00	13:00	14:00	15:00
Medford	5:12	5:42	6:12	6:42	7:12	7:42	8:12	8:42	9:12	10:12	11:12	12:12	13:12	14:12	15:12
Yaphank	5:21	5:51	6:21	6:51	7:21	7:51	8:21	8:51	9:21	10:20	11:20	12:20	13:20	14:20	15:20
Calverton	5:38	6:08	6:38	7:08	7:38	8:08	8:38	9:08	9:38	10:37	11:37	12:37	13:37	14:37	15:37
Riverhead	5:48	6:18	6:48	7:18	7:48	8:18	8:48	9:18	9:48	10:46	11:46	12:46	13:46	14:46	15:46
Mattituck	6:05	6:35	7:05	7:35	8:05	8:35	9:05	9:35	10:05	11:02	12:02	13:02	14:02	15:02	16:02
Southold	6:19	6:49	7:19	7:49	8:19	8:49	9:19	9:49	10:19	11:15	12:15	13:15	14:15	15:15	16:15
Greenport	6:28	6:58	7:28	7:58	8:28	8:58	9:28	9:58	10:28	11:24	12:24	13:24	14:24	15:24	16:24

									*	*	*	*
Ronkonkoma	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00	21:00	22:00
Medford	15:42	16:12	16:42	17:12	17:42	18:12	18:42	19:12	19:42	20:12	21:12	22:12
Yaphank	15:51	16:21	16:51	17:21	17:51	18:21	18:51	19:21	19:51	20:21	21:21	22:21
Calverton	16:08	16:38	17:08	17:38	18:08	18:38	19:08	19:38	20:08	20:38	21:38	22:38
Riverhead	16:18	16:48	17:18	17:48	18:18	18:48	19:18	19:48	20:18	20:48	21:48	22:48
Mattituck	16:35	17:05	17:35	18:05	18:35	19:05	19:35	20:05	20:35	21:05	22:05	23:05
Southold	16:49	17:19	17:49	18:19	18:49	19:19	19:49	20:19	20:49	21:19	22:19	23:19
Greenport	16:58	17:28	17:58	18:28	18:58	19:28	19:58	20:28	20:58	21:28	22:28	23:28

These are conceptual timetables and are intended only to show the potential service levels of the rail-bus network, based on the modeling assumptions employed.

Proposed Rail-Bus Network
North Fork Rail - Westbound

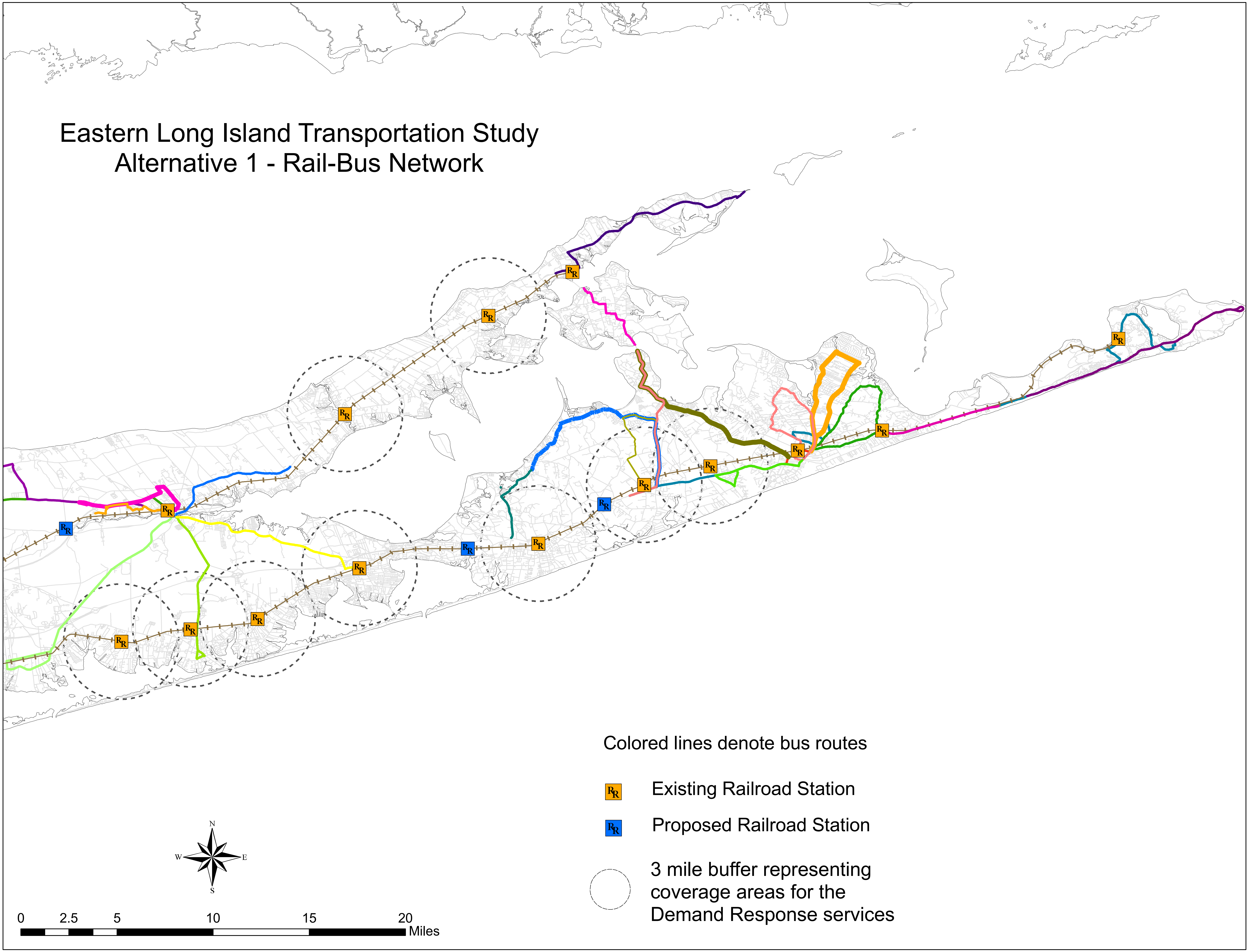
* extra trips during high season only

Greenport	4:00	5:00	5:28	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	12:00	13:00	14:00
Southold	4:19	5:19	5:47	7:19	7:49	8:19	8:49	9:19	9:49	10:19	10:49	11:19	12:15	13:15	14:15
Mattituck	4:33	5:33	6:01	7:33	8:03	8:33	9:03	9:33	10:03	10:33	11:03	11:33	12:29	13:29	14:29
Riverhead	4:49	5:49	6:18	7:49	8:19	8:49	9:19	9:49	10:19	10:49	11:19	11:49	12:45	13:45	14:45
Calverton	5:09	6:09	6:38	8:09	8:39	9:09	9:39	10:09	10:39	11:09	11:39	12:09	13:05	14:05	15:05
Yaphank	5:22	6:22	6:50	8:22	8:52	9:22	9:52	10:22	10:52	11:22	11:52	12:22	13:18	14:18	15:18
Medford	5:42	6:42	7:11	8:42	9:12	9:42	10:12	10:42	11:12	11:42	12:12	12:42	13:38	14:38	15:38
Ronkonkoma	5:52	6:52	7:17	8:52	9:22	9:52	10:22	10:52	11:22	11:52	12:22	12:52	13:48	14:48	15:48

								*	*	*	*
Greenport	15:00	16:00	17:00	17:30	18:00	18:30	19:00	19:30	20:00	20:30	21:00
Southold	15:15	16:15	17:15	17:45	18:15	18:45	19:15	19:45	20:15	20:45	21:15
Mattituck	15:29	16:33	17:33	18:03	18:33	19:03	19:33	20:03	20:33	21:03	21:33
Riverhead	15:45	16:49	17:49	18:19	18:49	19:19	19:49	20:19	20:49	21:19	21:49
Calverton	16:05	17:09	18:09	18:39	19:09	19:39	20:09	20:39	21:09	21:39	22:09
Yaphank	16:18	17:22	18:22	18:52	19:22	19:52	20:22	20:52	21:22	21:52	22:22
Medford	16:38	17:42	18:42	19:12	19:42	20:12	20:42	21:12	21:42	22:12	22:42
Ronkonkoma	16:48	17:52	18:52	19:22	19:52	20:22	20:52	21:22	21:52	22:22	22:52

These are conceptual timetables and are intended only to show the potential service levels of the rail-bus network, based on the modeling assumptions employed.

Figure 2. Route Map


Eastern Long Island Transportation Study
Alternative 1 - Rail-Bus Network
Colored lines denote bus routes
Existing Railroad Station
Proposed Railroad Station
3 mile buffer representing coverage areas for the Demand Response services
N
S
E
W
0
2.5
5
10
15
20
Miles