Appendix L – Rapid Transit for North Essex – from Vision to Plan

Rapid Transit System For North Essex

From vision to plan

1 July 2019

Essex County Council

RINGWAY JACOBS integrated expertise

Essex Highways

Essex Highways

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The analysis and forecasts contained in this report make use of information and input assumptions made available to Jacobs at a point in time. As conditions change the analysis and forecasts would be expected to change. Hence the findings set out in this report should be understood as relevant to that point in time when the information and assumptions were made.

Executive summary

Introduction

The Garden Communities Charter states that 'garden communities will be planned around a step change in integrated and sustainable transport system for the North Essex area, which will put walking, cycling and public transit systems at the heart of the development, and be delivered in a timely way to support the communities as they grow.'

The charter explains that this means:

- an integrated approach between land use and transport planning;
- seeking a modern and rapid forms of public transport;
- introducing sustainable transport early within the development of garden communities; and
- providing a green infrastructure including safe, convenient and attractive walking and cycling routes.

This report provides a strategic plan detailing what such a rapid transit system for North Essex could look like, and how it can be delivered and afforded. There is a firm belief that the vision is achievable and will contribute significantly to wider policy objectives related to climate change and air pollution, providing healthy and active choices, and sustainable economic growth.

Technological revolution

The UK is at the cusp of a revolution in technological solutions and personal transport choices[1] within which there is key role for rapid transit in successful towns. The fundamental challenge is to create the space to enable public transit to be rapid and reliable. If this is achieved, then transit solutions can evolve in response to innovation as and when it becomes practical to do so.

For North Essex, it is proposed that rapid transit aims towards introducing a system akin to a trackless tram. This combines the advantages of light rail with the practicality and flexibility of bus rapid transit. The system can be built up incrementally, growing alongside the garden communities. It adapts readily to early adoption of autonomous vehicle technology and, in time, the main

[1] http://www.demand.ac.uk/commission-on-travel-demand/

trackless trams would co-ordinate with automated pods to take passengers to final destinations.

Examples of rapid transit solutions and the desired level of segregation
Sources: CRRC TEC, railexpress.com.au/Sydney Inner West Council

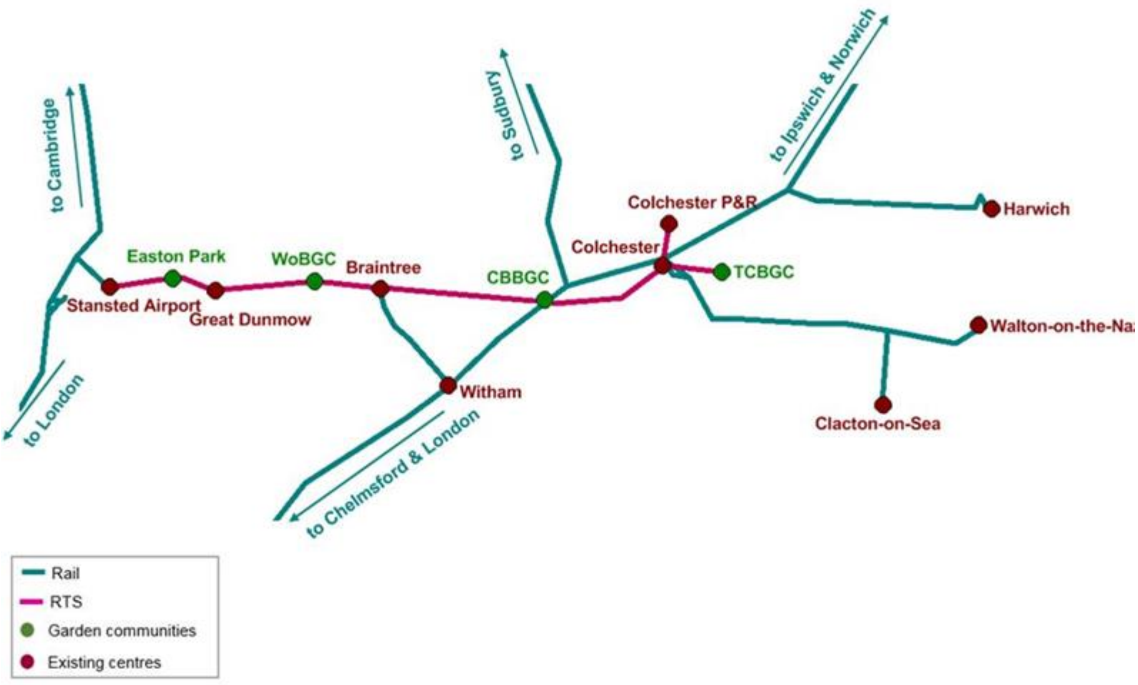
Routes

Trackless trams are a recent development which have been used in Zhuzhou, China. The aim will be to create a route network connecting key destinations across North Essex, which can be used by rapid transit vehicles and trackless trams, or equivalent technological solutions, once such systems are readily available. A key advantage of the strategy to develop a rapid transit route network is its adaptability to different technologies.

The dedicated routes, oftentimes alongside cycle lanes, will either be segregated or provide high levels of priority for rapid transit over other traffic. The latter arrangement would be used at locations where, for example, local access is needed. It is forecast that rapid transit will, over time, provide a genuinely practicable and attractive transport choice for many key destinations across North Essex and contribute to a virtuous circle of increasing sustainable travel. Prior to 2033 it is not expected that rapid transit vehicles will be driverless; it is only post 2033 that fully autonomous vehicles are expected to become a possibility.

This report identifies how the first four RTS routes can be incrementally created to deliver the space, priority and segregation required. It is expected that after the first four routes are established the network of destinations served would expand.

- **Route 1** connects Tendring Colchester Borders Garden Community, a potential eastern park and ride site, the university, the main rail station, the hospital and the existing Colchester northern park and ride site;
- **Route 2** connects Colchester Braintree Borders Garden Community, a potential western park and ride site, the town centre and the rail station;
- **Route 3** is being planning jointly with Uttlesford District Council and connects Stansted with Braintree via the West of Braintree Garden Community; and
- **Route 4** connects Braintree and the Colchester Braintree Borders Garden Community, and in doing so connects the two subsystems that would have been created.



Rapid Transit Network

Integration with transport and planning policy

To ensure success and the step change in public transport use implied by the vision, however, the report also identifies the principles for the image, quality and service standards which will guide design and operations. Furthermore, those complementary measures and policies with which it is necessary for rapid transit to be co-ordinated are discussed, including:

- access to stops to maximise the catchment of potential users;
- road space reallocation to public transport and active modes;
- parking supply and demand changes including park and ride;
- interchanges and secondary services;
- ticketing and information; and
- following best practice for accessible and inclusive design.

Viability

Given the routes, stop configurations and expectation of complementary measures, a transport model has been used to estimate the likely patronage on a rapid transit system at different stages of its development. The estimates have been adjusted to reflect pessimistic and optimistic futures, for example on the success of complementary measures.

The report shows that the capital cost is related to the amount of contribution that can be expected from garden communities in North Essex. Although contributions from central government sources are being sought in order to accelerate implementation and maximise benefits for all. Furthermore, reflecting the appeal of route choices that have been made, the rapid transit system is shown to be operationally viable from 2033, able to cover both maintenance and operational revenue costs.

Conclusion

While there is much detailed work still to follow, it is hoped that this report provides a clear strategic plan to create a world class rapid transit system for North Essex - reimagining public transport affordably, swiftly and practicably - and so exceeding the aspirations embedded in the vision for garden communities in North Essex.

1 Introduction and vision

1.1 Context

As outlined in the draft Local Plan, North Essex has seen significant population growth in recent years, due to its strong economic base, proximity to London and attractiveness as a place to live and work. In Braintree and Colchester, house building targets have regularly been exceeded. Amongst a range of challenges faced by the North Essex Authorities (NEAs) is ensuring that the infrastructure necessary to support continued housing and jobs growth is in place at the right time.

The draft Local Plan envisages the majority of housing development occurring in existing settlements, but crucially also identifies three intended garden communities, each with several thousand new homes along with employment, education and community facilities. The locations of these garden communities are shown in Figure 1-1.

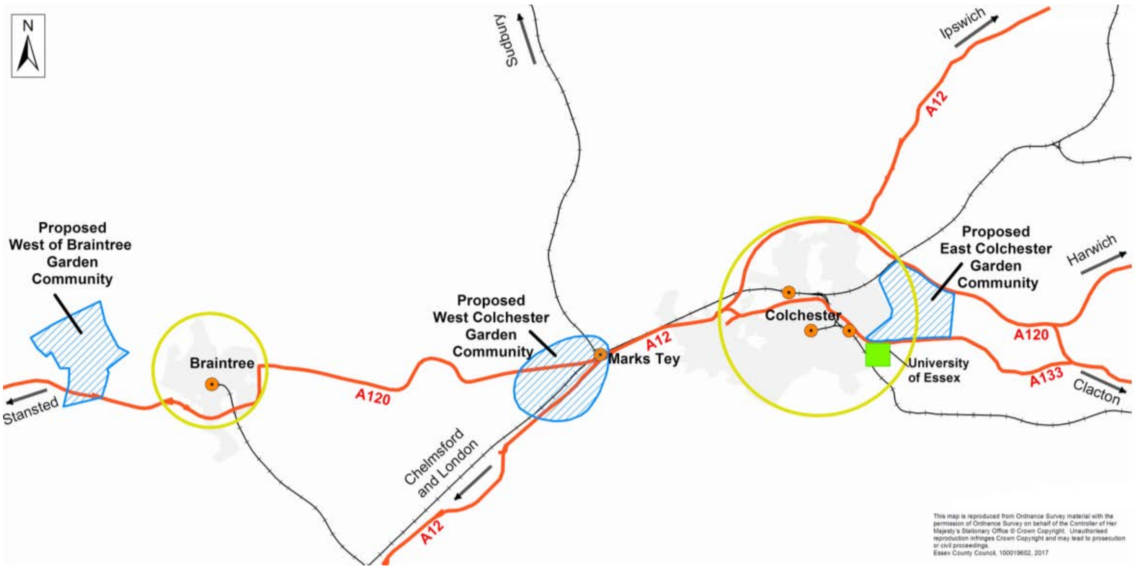


Figure 1-1: Locations of planned garden communities within North Essex
Source: NEGC

The garden communities will be designed to reduce the need for outward commuting. However, where commuting or other trips occur, it will be important to ensure that these can be undertaken using sustainable modes. The Garden Communities Movement and Access Study (Jacobs, 2017) suggested ambitious mode share targets for the garden communities, with just 30% of trips targeted to occur by car. The new garden communities have thus been located and are being designed to facilitate sustainable forms of transport. Figure 1-1 shows that the location of the planned garden communities and the existing settlements in North Essex will form a clear east-west corridor to support the potential of sustainable travel aims.

Outside the garden communities, it will also be necessary to increase the mode share of sustainable forms of transport. Thus, there are two principal challenges:

- achieving a high mode share for sustainable modes from the outset in the garden communities and other new developments, and “locking in” this benefit for the long term; and
- generating enduring modal shift towards sustainable modes in existing settlements.

Active modes – walking and cycling – will play a crucial part in achieving a sustainable mix of travel modes too, and the garden communities will be designed to encourage walking and cycling. For longer distance journeys, however, public transport provision will need to be of a high quality from the outset. Achieving these high shares for sustainable modes will be crucial in ensuring that growth in the housing supply occurs sustainably.

1.2 The vision

The NEAs are proposing the provision of a rapid transit system (RTS) serving the garden communities and existing towns, providing for intra-community travel and connecting new and existing settlements. Ultimately this will develop into an east-west rapid transit corridor across North Essex, from the Tendring Colchester Borders Garden Community (TCBGC) in the east to Stansted Airport in the west. The RTS would:

- enable sustainable growth in the housing supply across North Essex;
- connect households to jobs across North Essex;
- lock in a high share for sustainable modes in the garden communities from year one; and
- Increase the sustainable mode share in existing North Essex settlements.

To achieve these goals, the vision for the RTS is to:

- provide a rapid transit service from the opening of the GCs;
- design for tram-like levels of priority to ensure journey time reliability, with the RTS segregated from traffic along the majority of its route, and partially on roads with reduced traffic access;

- adopt a high profile and high-quality transport technology, providing a sense of permanence and aspiration that feels fundamentally different to existing bus services;
- be highly visible, serving the hearts of the garden communities;
- be constructed in the context of a well-designed public realm, with stops surrounded by mixed use development to ensure that they are seen as places in their own right;
- operate frequently and reliably (at least every 10 minutes and ultimately every 5 minutes) providing fast journey times and greater convenience than travelling by car;
- be operationally viable, and capable of being cost-effectively operated and maintained to a high standard, ensuring that its visibility and prestige do not fade over time;
- be integrated with other public transport services and walking and cycling networks via a series of mobility hubs, widening access and improving convenience;
- be flexible, in order to accommodate future technologies as well as the potential for shared use of the network; and
- follow principles of accessible and inclusive design.

Requirements to deliver the Vision

Frequency, speed, reliability and comfort

This element of the vision is highly dependent on the other aspects set out in more detail below. In order to attract and maintain mode share, the service needs to be:

- **frequent**, meaning it must ultimately be commercially viable to operate, such that a frequent peak and off-peak service can be sustained. This can be achieved by ensuring demand is high and the operating and maintenance costs are affordable;
- **fast,** meaning it cannot be impeded by traffic. This is achieved by segregating the route alignment to the greatest extent possible, and freeing it of congestion where not entirely segregated;
- **reliable,** meaning the journey times achieved must be consistent across the day, and across the year. Again, this is achieved by minimising interaction with traffic; and
- **comfortable**, meaning that the passenger experience is pleasurable and productive (e.g. provision of WiFi). This should include following best practice for accessible and inclusive design of vehicles and stops.

A dedicated alignment

To meet the goals described above, the RTS needs to have a fast, reliable journey time, and needs to be perceived as radically different from a bus service. Key to achieving this is designing for tram-like levels of priority, which means ensuring the system has a dedicated alignment for as much of its route as possible, minimising interaction with road traffic.

Securing a dedicated alignment is the most crucial aspect of the delivery of the RTS scheme. In greenfield areas and within the garden communities, provision of a dedicated, segregated alignment is simpler and will form a core principle of garden community masterplans. In existing urban areas such as Colchester, where road space is limited, providing a segregated alignment for RTS will require more difficult decisions concerning road space reallocation. It is recognised, however, that there are other constraints beyond just reallocation of road space such as listed buildings, environmental and design considerations and impact on residences.

Given the challenges for route selection, more than one route option has been provided in this report on some sections to ensure that the route strategy is flexible should a reason emerge for favouring one alignment over another.

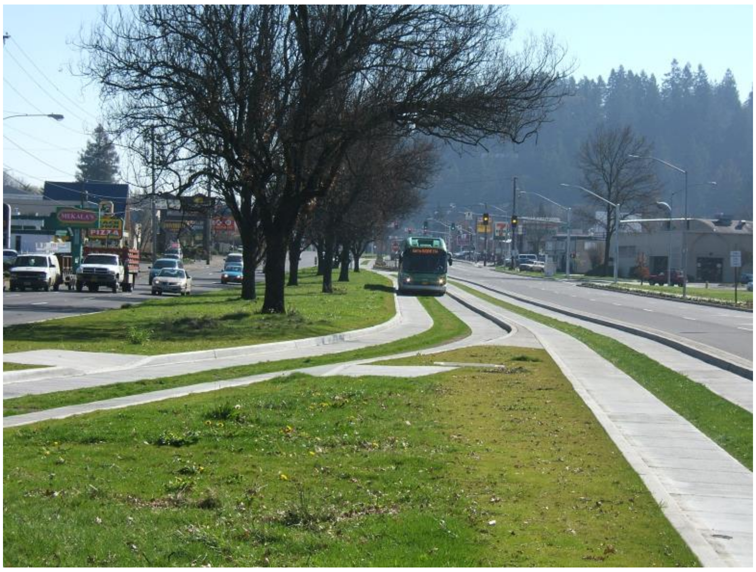


Figure 1-2: EmX BRT in Lane County, Oregon
Source: MovingAhead

However, all the options for routes provided have been studied, at a strategic level of detail, in order to establish that they are feasible to take forward, are able to provide the journey speed and reliability for RTS and are financially viable.

Adopting a quality transport technology

The RTS should be perceived as radically different to existing bus services in North Essex. A key consideration in achieving this perception will be the technology, or mode, adopted. A range of technologies is available, each with pros and cons. An important consideration in choosing a technology is providing a sense of permanence to the route – i.e. ensuring that people make long term lifestyle decisions based on the availability of the RTS. Such decisions are unlikely to be made based on the availability of a traditional bus service, as this is less high profile and visible, and there is a sense that bus services can be withdrawn.

Existing transport technologies can be placed on a continuum of high cost to low cost. This is shown below.

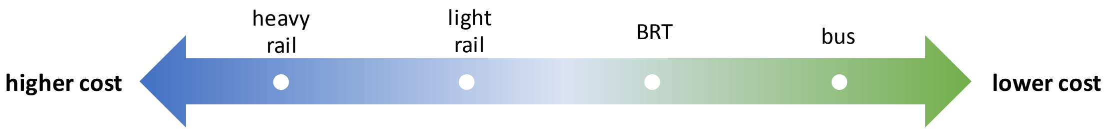


Figure 1-3: Continuum of cost by transport mode

These modes can also be associated with differing levels of segregation from other traffic, and with differing capacities – for example, we typically experience heavy rail as being entirely separate from traffic, and buses as interacting with traffic. However, the level of segregation is not necessarily dependent on the mode adopted – it is possible to have a railway line with many level crossings, or a bus route that runs on entirely dedicated, grade-separated roadway. Indeed, when adequately segregated, bus rapid transit can offer very high capacity – for example, the Metrobus system in Istanbul operates with 14 second headways along part of its route in the peak. Evidence from Nottingham shows that passengers are likely to take the first vehicle that arrives, be it tram or bus, indicating that the exact mode and level of segregation is of less importance to the end user than frequency and speed.

We have examined the suitability of each mode for use on the RTS.

- **Heavy rail** would preclude access to existing urban centres, without significant disruption and likely demolition of buildings. The cost would be impractical. The capacity provided would likely be excessive.

- **Light rail** allows access to existing urban centres and provides a sense of permanence. However, the capital cost associated with light rail schemes has typically been orders of magnitude higher than rubber-tyred solutions, and the disruption associated with track installation is significant.
- **Bus rapid transit (BRT) or guided bus rapid transit (GBRT)** can provide the same journey times, level of segregation and capacity as light rail, without the associated high capital cost.
- **Traditional bus** services running in bus lanes or mixed traffic are cheaper and more flexible, but do not deliver the modal shift of some of the options described above due in part to lack of priority and slow journey times.

Advances in technology mean that it is possible to add another category of technology to the above list. **Trackless trams** use optical sensors to autonomously follow markings on the road surface. An example of a trackless tram is shown in Figure 1-4.

Figure 1-4: "Trackless tram" in Zhuzhou, China. Self-driving vehicles, with rubber wheels, using sensor technology to follow markings painted on the streets
Source: CRRC TEC

This technology is currently being trialled in China. Relative to BRT, it has a number of benefits:

- higher capacity per vehicle;
- better ride quality (uses tram vehicle technology, such as bogeys);
- better 'look and feel'; and

- millimetre accuracy at stops, resulting in step-free boarding.

It also avoids the costs associated with utilities diversion and track laying for light rail. Although it is at the early stages of development, and further examination of cost and feasibility is required, along the cost & capacity continuum the trackless tram solution is likely to sit between BRT and light rail, with the level of cost being closer to BRT. As such, the adoption of this, or a similar technology presents a deliverable vision for the North Essex RTS.

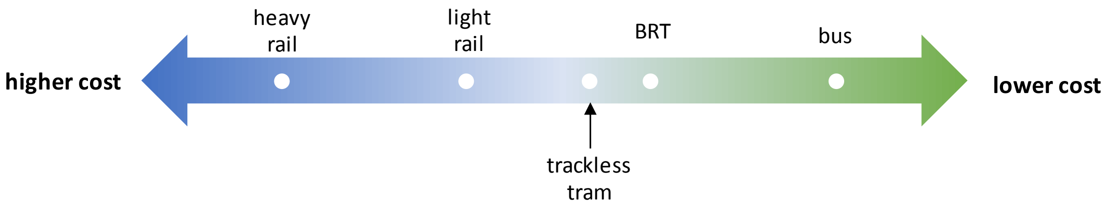


Figure 1-5: Potential position of the trackless tram along the cost continuum

The vision presented in this report is a long-term one. The most vital prerequisite to delivering a rapid transit corridor across North Essex is securing a dedicated alignment on which it can run and ensuring that new development is focused along this alignment. The mode that is eventually chosen is of less importance than this. We are currently in the midst of a period of rapid technological change, and the field of transport is no exception, as evidenced by the emerging technology described above. There is also the advent of autonomous vehicles and “mobility as a service”, which may ultimately change the types of rapid transit vehicles used and how the network is accessed. What will not change however, is the requirement to alleviate congestion by providing sustainable and high capacity alternatives to car travel. This means dedicated space for sustainable modes, and this in turn means providing a dedicated, segregated alignment across North Essex, to the greatest extent possible.

For modelling purposes, it has been assumed throughout the rest of this report that the North Essex RTS scheme will be delivered using bus rapid transit (BRT) technology that is capable of being upgraded to trackless tram in the near future. BRT and trackless trams have many benefits:

- they can deliver the same journey time, capacity and mode share benefits as other rapid transit modes;
- because it is well proven and the costs well understood, BRT provides demonstrable value for money and operational viability; and

- they are scalable, allowing the network to grow as demand from new development grows.

The assumption of BRT in the shorter term in this report does not preclude the revision of the scheme to adopt another mode or technology – indeed, it has been chosen because it is easily adaptable over time. The ability to upgrade to guided technology such as trackless tram should be examined in more detail, with the intention of adopting this mode for RTS in the near term.

Operational viability

While the development of the garden communities, along with other development within North Essex, presents the opportunity to secure capital funding, it is less likely that ongoing operational support will result from developments, aside from initial ‘pump priming’ funding and farebox revenue. It is therefore important that the service is operationally viable – ultimately capable of operating with little or no subsidy.

Crucially, the route, vehicles and frequency must be well maintained to retain any modal shift generated, and to continue to increase demand. Operating surplus can be invested to expand the network or provide additional capacity, thereby further encouraging further modal shift and growing demand. Key to achieving this ‘virtuous circle’ effect is adopting a technology that will eventually enable an operating surplus (albeit that initial ‘pump priming’ would be necessary with any technology).

Placemaking and visibility

Transit Oriented Development is a form of mixed-use development, whereby the development is centred around public transport, and the use of that public transport is encouraged while car use is discouraged. Transit Oriented Development (TOD) can be distinguished from Transit Adjacent Development (TAD). In the latter public transport is provided adjacent to or through a development but is not well promoted and does not necessarily achieve high mode share, typically due to poor design.

Figure 1-6: Madison BRT concept[2]

In order for a development to be truly considered TOD, the following elements are necessary:

- transit stops at the core of the new communities, surrounded by mixed-use development, including retail. This ensures that the locations of the stops are seen as places in their own right, where people want to spend time, rather than just transport nodes to be accessed as part of a journey;
- good walking and cycling routes to the transit stops – in particular, walking and cycling routes should be designed with personal security in mind (i.e. by being routed through busy areas with good lighting), and should be direct rather than meandering. The construction of cul-de-sacs can be detrimental to this aim. Secure cycle parking should be provided at stops; and
- in addition to proximity to mixed use and retail, transit stops can form part of wider placemaking goals by being placed on or adjacent to public squares or other amenities.

Additionally, the development will seek to discourage car use by limiting provision of car parking, or siting car parking away from homes, thus minimising the discrepancy in any walking penalty between public transport and car.

As discussed above, the provision of a dedicated alignment through the core of the communities (both new and old) is vital to the success of the RTS, regardless of the form the RTS service eventually takes. Ensuring that this

[2] https://www.seattlebikeblog.com/2015/05/08/madison-brt-project-could-also-build-better-union-st-bike-lanes/

alignment serves the mixed-use core of the communities, and that good quality public access to stops is provided, is crucial.

Integration

The RTS should offer easy interchange with existing modes of public transport across North Essex, along with being well designed to facilitate walking and cycling. Figure 1-7 shows the RTS within the context of the rail network, demonstrating that it will be complementary and well-integrated. Additionally, as the garden communities increase in size, local feeder services should be introduced for parts of the journey that are not walkable and cyclable, and to ensure access to the RTS for the mobility impaired.

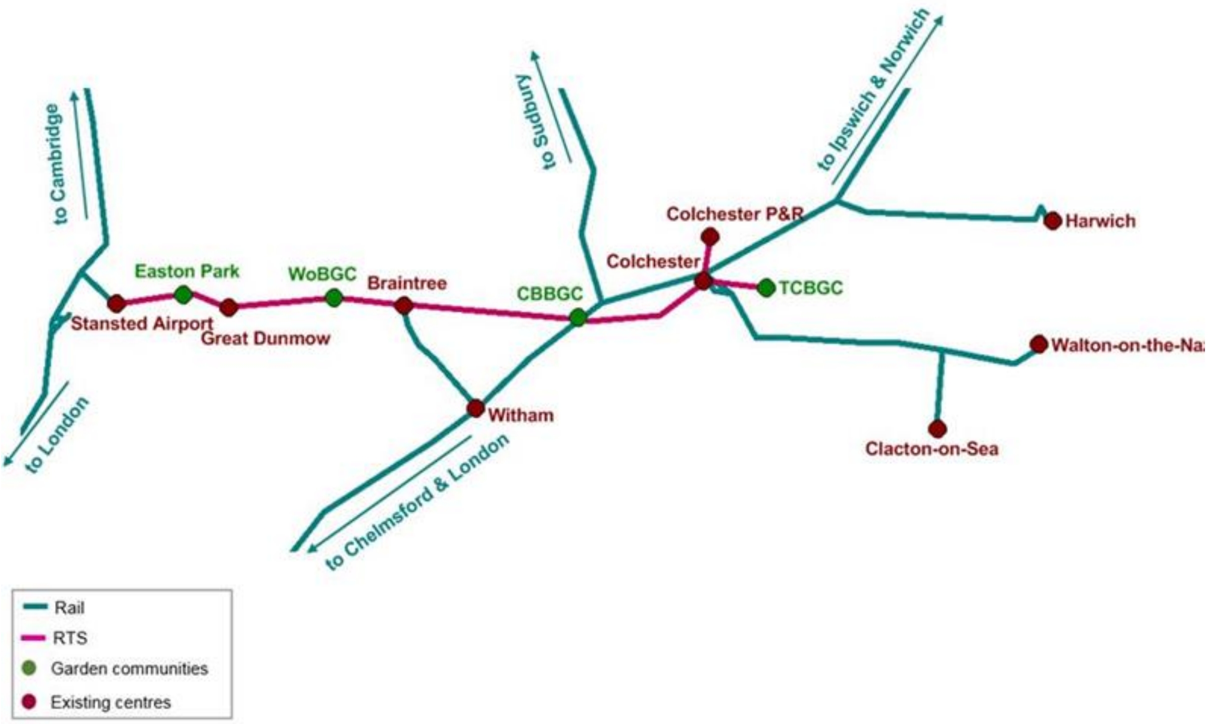


Figure 1-7: The RTS and its integration with the rail network

At core points on the RTS network, mobility hubs can be provided, allowing for easy connection to local / demand responsive buses, cycle hire, car club, taxi and cycle parking. These mobility hubs should be capable of evolving over time to reflect changes in technology – conceivably there could be interchange points between the RTS and autonomous pods. Regardless of the “last mile” mode chosen by the user, these hubs should facilitate a seamless experience in transferring from a “last mile” mode to the RTS high capacity trunk across North Essex.

In common with other areas in the country, the RTS will also need to be supported by policy and practical interventions around North Essex. There will need to be constraints on parking space availability, car park charging, cycling promotions, incentive schemes, travel planning and other measures.

1.3 Report structure

This report is structured as follows:

- **Section 2** describes the **objectives and principles adopted** in developing the RTS scheme. These objectives and core principles underly all considerations in how the scheme is delivered;
- **Section 3** sets out the **route options** for each of the route sections, along with the associated **demand** and **mode share** at the garden communities;
- **Section 4** describes the key **complementary policy measures and infrastructure** that will be necessary to make the scheme a success, along with the potential for the RTS to **evolve with technology**;
- **Section 5** assess the **viability** of the scheme, based on its capital cost and forecast annual revenue and operating costs, and discusses sources of funding to deliver the scheme; and
- **Section 6** draws conclusions on the report.

There is also a technical appendix, detailing the demand modelling methodology used.

2 Scheme objectives and principles

2.1 Objectives

In this section, the objectives of the RTS scheme are developed (*what* the scheme aims to achieve) and the principles that will be adopted in its planning and delivery (*how* the scheme will achieve the objectives).

The full range of Local Plan objectives and garden community objectives as set out in the Garden Community Charter has been considered in developing objectives for rapid transit. For the RTS specifically, three high level objectives have been drawn up which reflect Local Plan aims:

- to enable housing growth;
- to offer high quality public transport as an attractive travel choice for new and existing residents, visitors, commuters and business travellers; and
- to contribute to wider sustainable development including health, environment, economy and community.

2.2 Principles for the design of RTS

2.2.1 Perception of quality and visibility

Currently, for local journeys in Colchester which is one of the most densely populated parts of North Essex, public transport accounts for 10% of journeys (based on journey to work data from the 2011 Census). Hence to achieve a significantly greater share of journeys, RTS will need to offer a significantly enhanced experience and be perceived as a radically different alternative to the bus. This will be driven by subjective factors such as look and feel, journey experience, ease of use and visibility. These can be influenced by inclusion of:

- measures supporting work and relaxation (e.g. tables, power sockets and refreshments for longer journeys);
- accurate and plentiful journey information;
- high-quality light rail-style stops providing level boarding, as part of a suite of measures to ensure the service is accessible for wheelchair users and those with prams;
- attractive vehicles and branding with interiors designed with a variety of passengers in mind following principles of inclusive design;
- ease of payment and off-vehicle ticket systems, along with multiple doors to ensure rapid boarding and alighting; and
- cycle parking at stops; and well-signed walking routes to/from stops.

Figure 2-1: BRT station in Curitiba, Brazil
Source: The Guardian

Figure 2-2: BRT stop in Brazil – the bus stop features glass and perforated plates as enclosures and uses efficient internal ventilation and lighting to create an easily maintained and pleasant space for commuters.
Source: Inhabitat

Figure 2-3: "Trackless trains" – self-driving vehicles, which have the rubber-wheels of a bus, use sensor technology to follow markings painted on the streets.
Source: Wikimedia Commons[3]

Figure 2-4: Cebu BRT concept
Source: Cebu City BRT

[3] *By N509FZ - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=69*

Figure 2-5: BRT station with cycling parking in Rio de Janeiro, Brazil
Source: ITDP Brasil

Recent examples of non-rail rapid transit schemes in the UK have shown the potential to significantly increase public transport usage. For example, this has been seen on the Crawley Fastway, which increased patronage on buses by 160% over ten years, and Belfast Sprint, which met its ten-year patronage targets at the end of its first year of operation.

When new residents move to the garden communities, it is a prime opportunity to change travel behaviour. In order for this to occur rapid transit needs to have a high level of presence and visibility. This will be assisted by clearly fitting rapid transit into the range of public transport options on offer. RTS will be routed through the cores of the garden communities, aiding visibility.

2.2.2 Level of service

Assuming the rapid transit system connects the key community and economic centres and is perceived as high quality, it still needs to meet a level of service in terms of frequency, journey time and capacity in order to be considered as a practicable alternative to the private car.

While these factors will evolve as a system is designed it is proposed that we consider aiming for:

- journey times faster than car between key destinations (and reliably so), facilitated by segregated running where possible;
- a frequent all-day “turn up and go” service, with a service running at least every 8 minutes, with a higher frequency during peak hours. Frequency

would ultimately need to be dependent on what the demand can support, but would initially require subsidy to generate demand;

- more intensive service on parts of the network where demand is higher, and increasing frequencies as demand increases; and
- flexibility to expand to meet additional demand.

Another aspect of level of service is network resilience so the rapid transit system can operate even though there might be breakage somewhere in the system.

2.2.3 Interchanges and opportunities for encouraging use

Consideration must also be given to the position of stops in relation to centres of potential demand and convenience for different groups of users. As will be seen in later chapters this includes incorporating park and ride sites onto the RTS routes at some locations.

Whilst garden communities will take many years to build out and reach full size, incorporating park and ride sites could unlock use for a group of potential users from the outset and thus contribute to commercial viability in the early year of operation.

Figure 2-6: Santa Clara County BRT concept
Source: Valley Transportation Authority

It would be expected that park and ride sites would be located at transport hubs or interchanges where there might be other transport modes on offer. Consequently, park and ride has sometimes been referred to a park and choose.

These principles have guided the development of routes described in subsequent chapters.

2.3 Other considerations

2.3.1 Commercial viability

The RTS is expected to ultimately be commercially viable, i.e. revenue earned should cover operating and maintenance costs. This would mean that once capital costs have been covered, the service would be self-sufficient, and would not require day-to-day funding from local or central government.

However, the standard of service proposed (a ‘turn up and go’ style frequency) to be offered will mean that some early subsidy is likely to be necessary. This is because the high patronage envisaged will take time to build up naturally. Switching to public transport is a significant decision, and one that potential passengers will not be prepared to make until it is apparent that the RTS service is frequent, reliable and ‘here to stay’.

In this regard, the RTS will have the benefit of serving newly built garden communities, where its early availability will lock in demand from the outset. This will aid with early take-up of the RTS and underlines the importance of its being available at the start of the life of the garden communities. If it is not, the residents will begin to form habits of car dependency that will take some time to change.

2.3.2 Securing beneficial outcomes

The provision of quality public transport services has the potential to unlock economic, environmental and social benefits.

From an economic perspective, research has shown that the availability of public transport positively impacts spending in local centres, contributing to the vitality of town and city centres. The availability of public transport also increases accessibility to places of work, unlocking greater productivity by allowing people to move to more productive jobs

From an environmental perspective, mode shift away from car has clear benefits in reducing emission of greenhouse gases, but also emission of other pollutants that harm air quality and thus human health. The RTS is proposed to be largely segregated from traffic and to have priority measures in place to reduce the extent to which the vehicles stop to wait in traffic. This has the intended effect of reducing journey times, and thus better aiding modal shift, but has the additional benefit of reducing emissions (or energy usage) that occur when the RTS vehicle is stopped, and idling, and has to accelerate upon starting to travel again.

The provision of public transport also has social benefits, reducing social exclusion by improving access to jobs, education and training, as well as improving wellbeing by enabling a more active lifestyle.

These benefits are described in greater detail in a study undertaken for NEGC and the NEAs by ITP[4]. Of note is research that has shown the good benefit to cost ratios achieved from investment in RTS and sustainable transport measures.

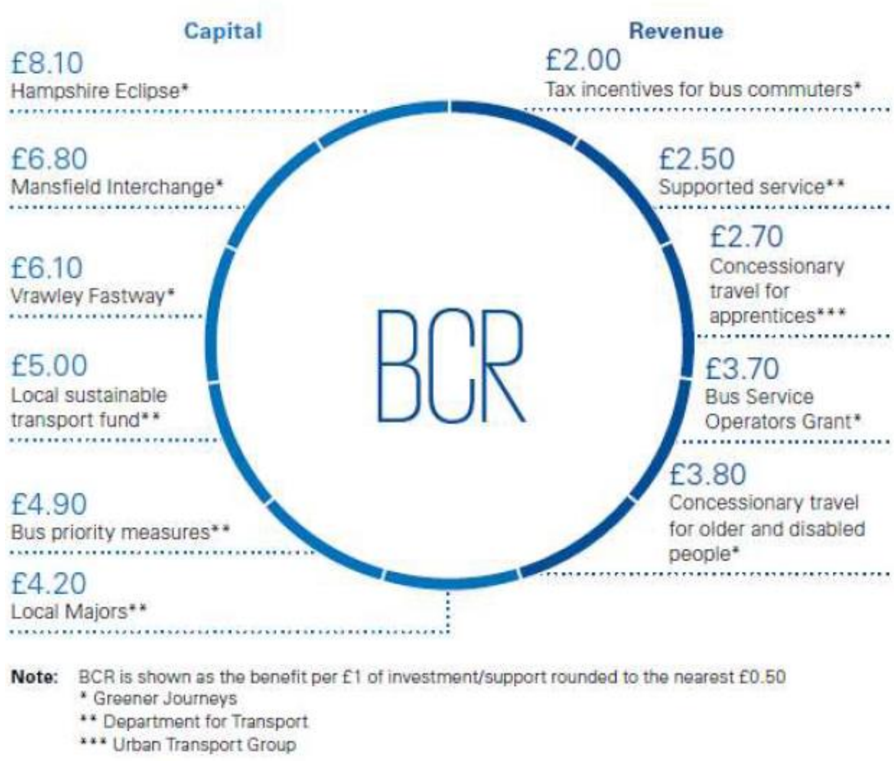


Figure 2-7: Benefit to cost ratios for capital and revenue on related RTS measures
Source: KPMG (2017), The 'true value' of local bus services

[4] *ITP (March 2019) "Positive Outcomes of Sustainable Transport Policy and Investment"*

2.3.3 Affordability and deliverability

The principles described thus far will result in an ambitious scheme that delivers a high-quality service. Delivery of the scheme will seek to draw upon a variety of funding sources, including:

- Housing Infrastructure Fund (HIF);
- Section 106 developer contributions; and
- other potential funding sources including instruments to collect developer contributions similar to the Strategic Infrastructure Tariff which has been envisaged through the change to Policy SP5 in the Garden Communities Local Plan Section 1, and financing through public works loans or other vehicles.

Hence, to ensure credibility and deliverability, the RTS scheme must be achievable within the likely budgets available from these sources. It should also be deliverable from an engineering, environmental and political perspective.

2.4 Adaptability to changes in technology

The world in currently in the midst of rapid advances in technology, and the field of transport in particular is experiencing significant changes at present. Examples of such changes include electric cars becoming mainstream and the idea of “mobility as a service” replacing the need for personal car ownership and fixed route transport networks.

Although fixed route rapid transit still has a significant role to play, it is important in developing this scheme, which has a long-time horizon, that potential future technological changes are considered. In addition to the cost considerations described above, the proper consideration of unforeseen change points to a need to avoid technologies that are specific to one type of vehicle or operational model.

What is unlikely to change, however, is the benefit that flows from the provision of a dedicated alignment, segregated to the greatest extent possible, solely for the use of sustainable travel. The assumption throughout this report is that that alignment would be used for fixed route rapid transit services, but that does not preclude its eventual use for sustainable travel under different operating modes. For example, post 2033, there is no reason to assume further changes, could be made to change to automated vehicles or even revisit the option of a light rail system.

There is further discussion of adaptability to future technological change in section 4.2.

3 Route options

3.1 Introduction

This section presents recommended alignments for the RTS. On some sections of the route, there is a single recommended alignment, but on most, several options have been identified. Typically, the options represent a continuum from easily deliverable, lower investment but less segregated, to more challenging, higher investment and more segregated.

The intention inherent in the vision for RTS is to deliver the most ambitious route with the most segregated alignment, thereby delivering the fastest journey times and the greatest perception of quality. It is also important to demonstrate that the scheme is deliverable, and for that reason a range of potential options are presented. In some cases, segregation from traffic will materialise over time as capital funding becomes available.

The route options have different associated capital costs, and different associated revenues and operating costs. Typically, the higher-capital options deliver higher revenue with a lower operational cost. The costs and revenues associated with the highest and lowest investment scenarios are shown in section 5.

3.2 Route section categorisation

The vision for the RTS is to have a route that is segregated from traffic to the greatest extent possible. The system will be capable of evolving to deliver greater segregation as patronage increases and technology evolves. Figure 3-1 shows generic examples of the desired level of segregation from other traffic, although it should be noted that the images shown do not necessarily reflect the wider place making objectives and public realm quality which are envisaged as part of the RTS for North Essex.

Figure 3-1: Route type 1: segregated – dedicated – Specially provided infrastructure for exclusive use of RTS in new roadway
Sources: Karl Fjellstrom, Far East Mobility, Wikimedia Commons[5], World Bank

Along many of its newer sections, the RTS is envisaged to have its own alignment, separate from other traffic, but with provision for walking and cycling alongside. Figure 3-2 is a concept image showing this configuration.

[5] *Gunawan Kartapranata [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)]*

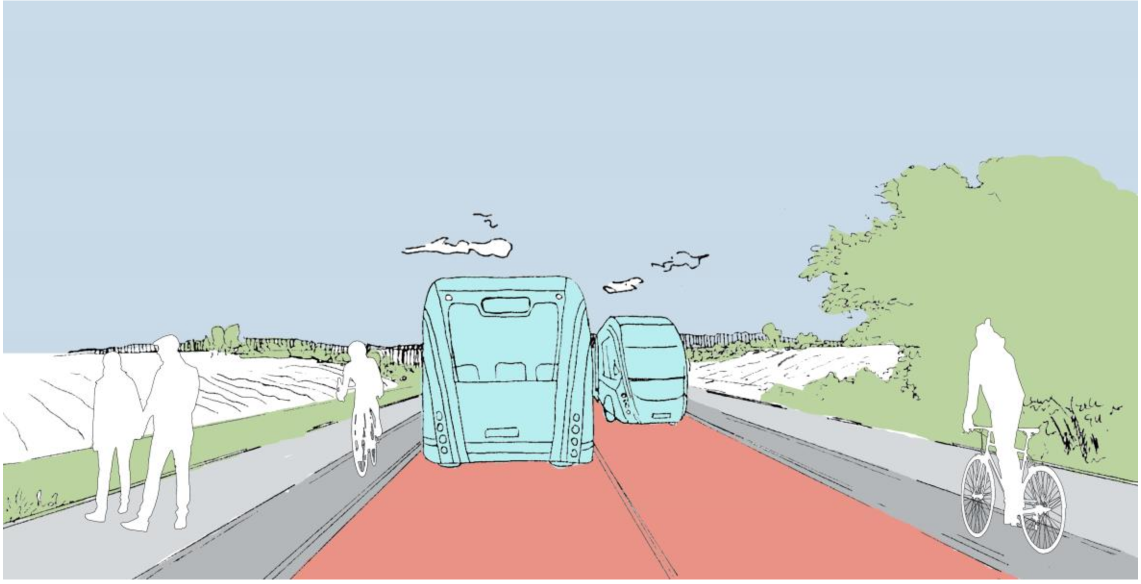


Figure 3-2: Concept image showing typical layout of dedicated RTS route

In developing route options and planned phasing, it is necessary to be explicit about the level of segregation that can be delivered on the various potential alignments identified. Consultants ITP and Jacobs have developed a categorisation of route sections, which is used in route option development. This describes the level of segregation from traffic that could be achieved on the route options. The categorisation is shown in the table below.

Table 3-1: Route types and characteristics

Type no.	Segregation	Infrastructure type	Characteristics
1	Segregated	Dedicated	Specially provided infrastructure for exclusive use of RTS in new roadway
2		Reserved	Provision of separate infrastructure space for RTS within existing highway
3	Restricted	Controlled	Access to the highway restricted to RTS and specified categories of user with significantly reduced traffic volumes
4		Place focus	Access to the highway restricted to RTS and specified categories of user with traffic calming and public realm improvements giving priority to walking and cycling
5	Unsegregated	Priority	Infrastructure open for use by several modes with specific priority measures for RTS on lead up to and through junctions
6		Shared	Infrastructure open for use by several modes with no specific priority for any particular mode

3.3 Overview of routes

In identifying the routes there has been considerable analysis of demand, which has been described in the North Essex Rapid Transit Study (Jacobs, 2017). Figure 3-3 summarises demand draws between key destinations.

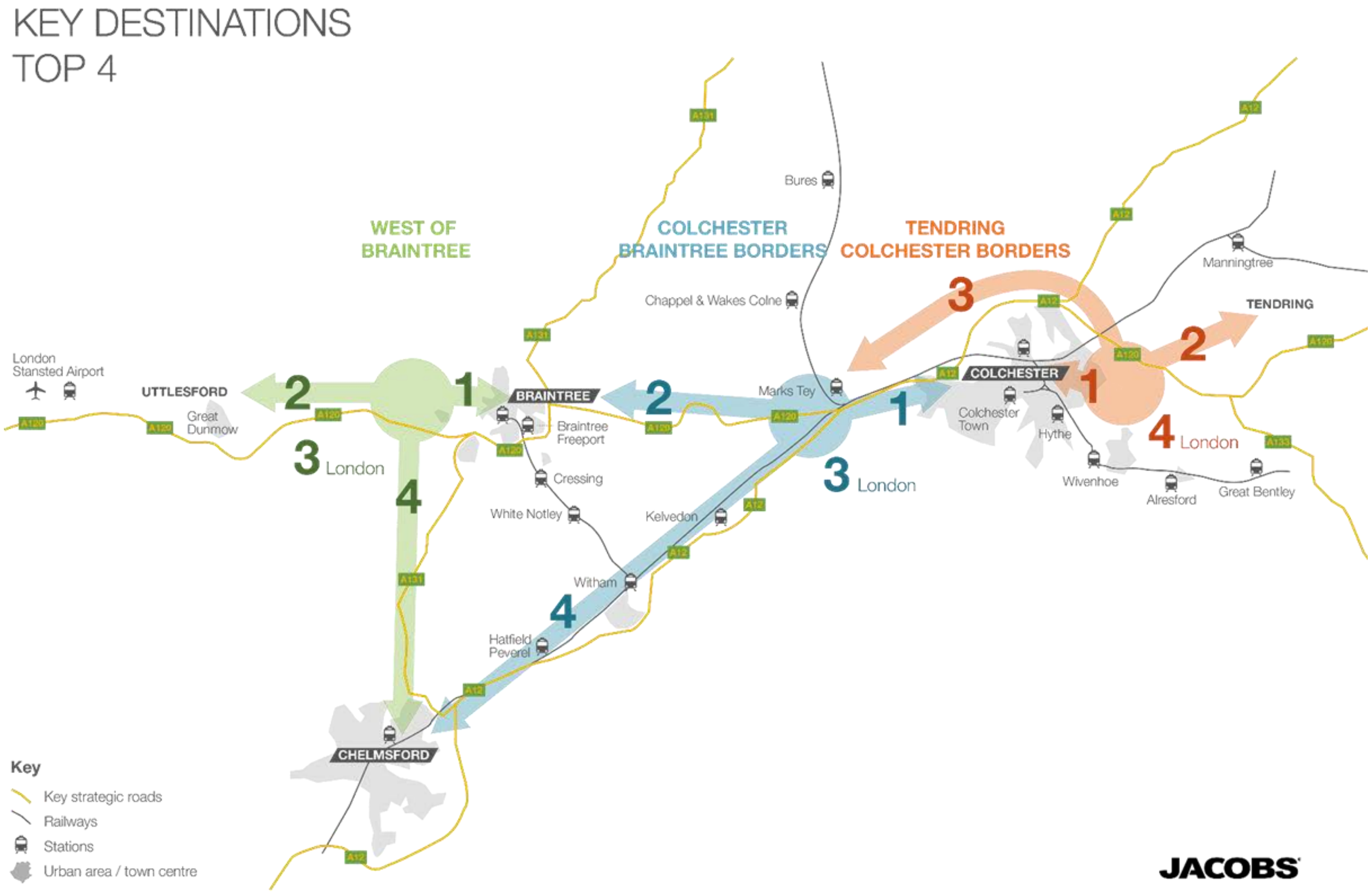


Figure 3-3: Demand from garden communities

It is proposed that RTS route is developed along the east west axis. However, in future years secondary service of additional routes could be added to connect to other destinations including Chelmsford.

Accordingly, the full RTS proposed to support Part One of the North Essex Local Plans comprises four main routes as follows.

Table 3-2: Route numbers and descriptions

Proposed RTS routes	
1	TCBGC – Colchester Town Centre – Colchester North P&R
2	Colchester – CBBGC
3	Braintree – WoBGC – Great Dunmow – Easton Park - Stansted
4	CBBGC – Braintree

Route 1 connects TCBGC (including new P&R sites), the University, Hythe, Colchester town centre, Colchester rail station, Colchester Hospital and the existing Colchester P&R site which also serves the Colchester Community Stadium.

Route 2 connects CBBGC, Marks Tey, Stanway and Colchester town centre where connections can be made to the destinations on Route 1.

Route 3 connects WoBGC eastward to Braintree and continues westwards to Stansted via Great Dunmow and the planned new development at Easton Park.

Route 4 links CBBGC with Braintree, connecting routes 2 and 3 and providing a through RTS link between Colchester and Stansted.

The route descriptions in the subsequent sections set out the characteristics of the route section and the assumptions made in determining the proposed route; together with an overview of new infrastructure required and proposed stops.

It is anticipated that some sections will initially use existing infrastructure, especially where there is reasonable capacity for RTS operation within current traffic levels, however priority measures are suggested where these may be required as the network develops.

While it is envisaged that the services operated will broadly correspond with the route described, the levels of service and origin and destinations pairs of specific services, together with the routing within the Garden Communities and associated new developments, may vary as the overall RTS network is developed.

3.4 Route 1: Tendring Colchester Borders Garden Community

The table below summarises the route sections whilst the figures show the options being considered. Note that the northern leg of this route reinforces the existing and established Colchester North park and ride service.

Table 3-3: Proposed sections in Route 1

Route 1: TCBGC – Colchester Town Centre – Colchester North P&R
Within TCBGC
TCBGC to Knowledge Gateway and University
Knowledge Gateway and University to Colchester Town Centre
Colchester Town Centre
Colchester Town Centre – North P&R

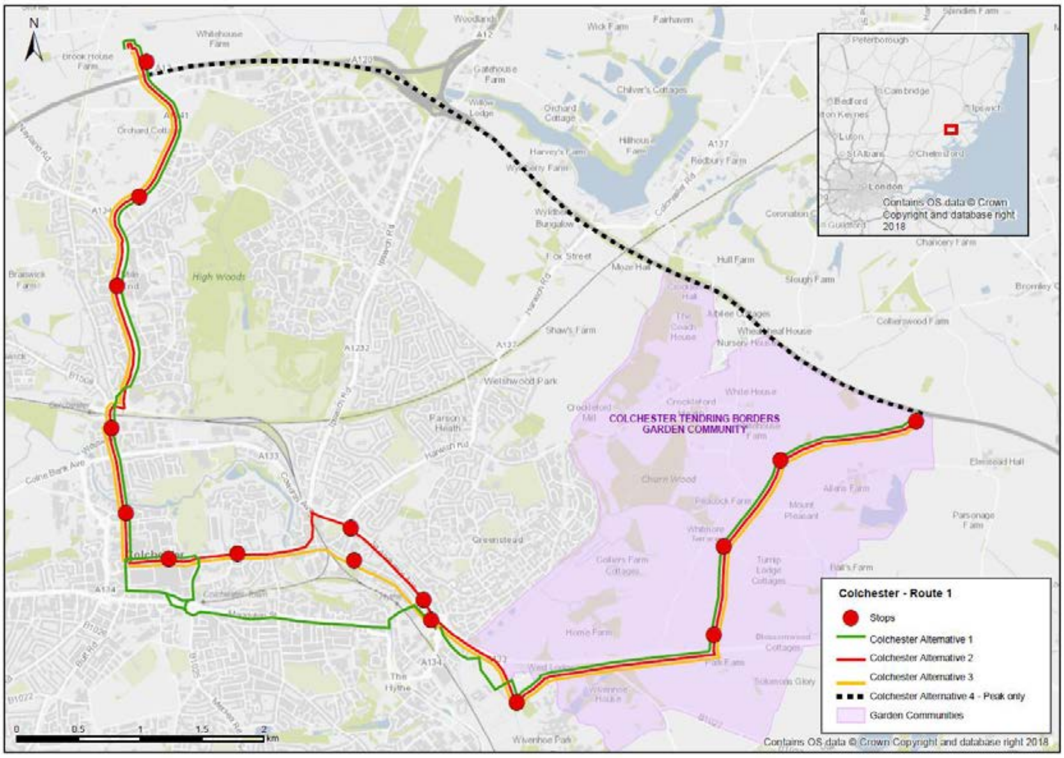


Figure 3-4: Route 1 options

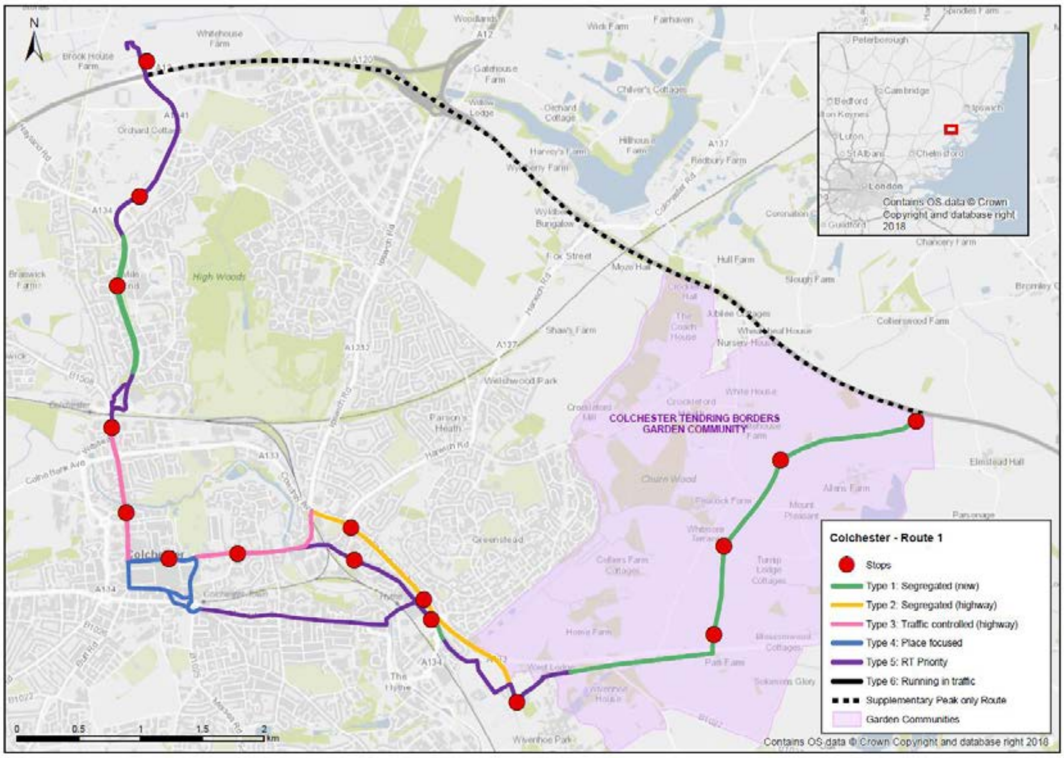


Figure 3-5: Route 1 options including type of infrastructure

The tables below provide further information on the development of route options.

Table 3-4: Within TCBGC

Route 1: Within TCBGC	
Overview	• New dedicated alignment through new development
Infrastructure type	• All new construction type 1 Dedicated
Options considered	• Peak hour service via North P&R to Colchester Station via A120 and A12
Interim options and variations	• Route built progressively from south as development proceeds

Table 3-5: TCBGC to Knowledge Gateway and University

Route 1: TCBGC to Knowledge Gateway and University	
Overview	• New dedicated alignment alongside A133, then via West Lodge, Nesfield Road and Capon Road to serve Knowledge Gateway.
Infrastructure type	• Type 1 Dedicated alongside A133 and past West Lodge, then Type 5 Priority through Knowledge Gateway.
Options considered	• Continuation alongside A120 omitting Knowledge Gateway. • Alternative route via Boundary Road and south side of University.
Interim options and variations	• Running as type 6 Shared on A133. • Separate Colchester to University service via RTS then Boundary Road.

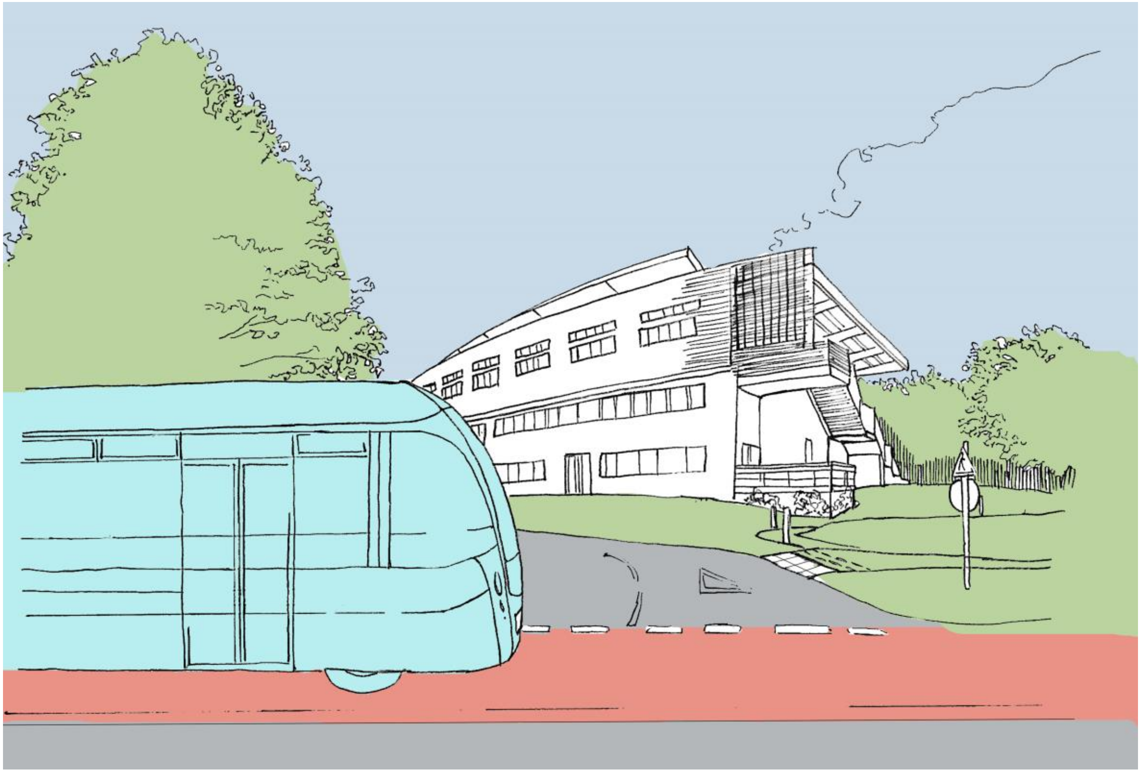


Figure 3-6: Concept image showing RTS at the university

Table 3-6: Knowledge Gateway and University to Colchester Town Centre

Route 1: Knowledge Gateway and University to Colchester Town Centre	
Overview	• Via existing road network in east Colchester with priority measures at key locations.
Infrastructure type	• Mainly type 5 Priority, with possible sections of Type 1 and 2.
Options considered	Three main options considered: • Greenstead Road, East Street, East Hill; • Clingoe Hill, St Andrew's Avenue, Ipswich Road, East Street; and • Hythe Hill, Barrack Street, Magdalen Street (A134).
Interim options and variations	• No intervention and shared running (Type 6).

Figure 3-7: Concept image showing RTS on A133 Clingoe Hill

Table 3-7: Colchester Town Centre

Route 1: Colchester Town Centre	
Overview	• Current one-way system via High Street, Queen Street, St Botolph's Street, Osborne Street, St John's Street, Head Street. • Possible two-way operation along High Street if type 3 or 4.
Infrastructure type	• Mixture of types 3, 4 and 5 allowing reserved or priority access.
Options considered	• Mixture of types 3, 4 and 5 allowing reserved or priority access. • A key option is looping around the town centre or altering the one-way system to allow RTS to travel through.
Interim options and variations	• Current North P&R runs in shared mode in town centre.

Figure 3-8: Concept image showing RTS in Colchester Town Centre

Table 3-8: Colchester Town Centre – North P&R

Route 1: Colchester Town Centre – North P&R	
Overview	• Via A1341/A134 Via Urbis Romanae.
Infrastructure type	• Partial existing type 2 Reserved infrastructure and sections of type 5, with scope for further upgrading to Type 1 or 2.
Options considered	• None
Interim options and variations	• Use infrastructure already there for limited stop P&R service.

Figure 3-9: Concept image showing RTS near Colchester Station

3.5 Route 2: Colchester - Braintree Colchester Borders Garden Community

This route provides a westward connection into Colchester Braintree Borders Garden Community.

Table 3-9: Proposed sections in Route 2

Route 2: Colchester Town Centre – CBBGC
Colchester Town Centre – Marks Tey
Within CBBGC

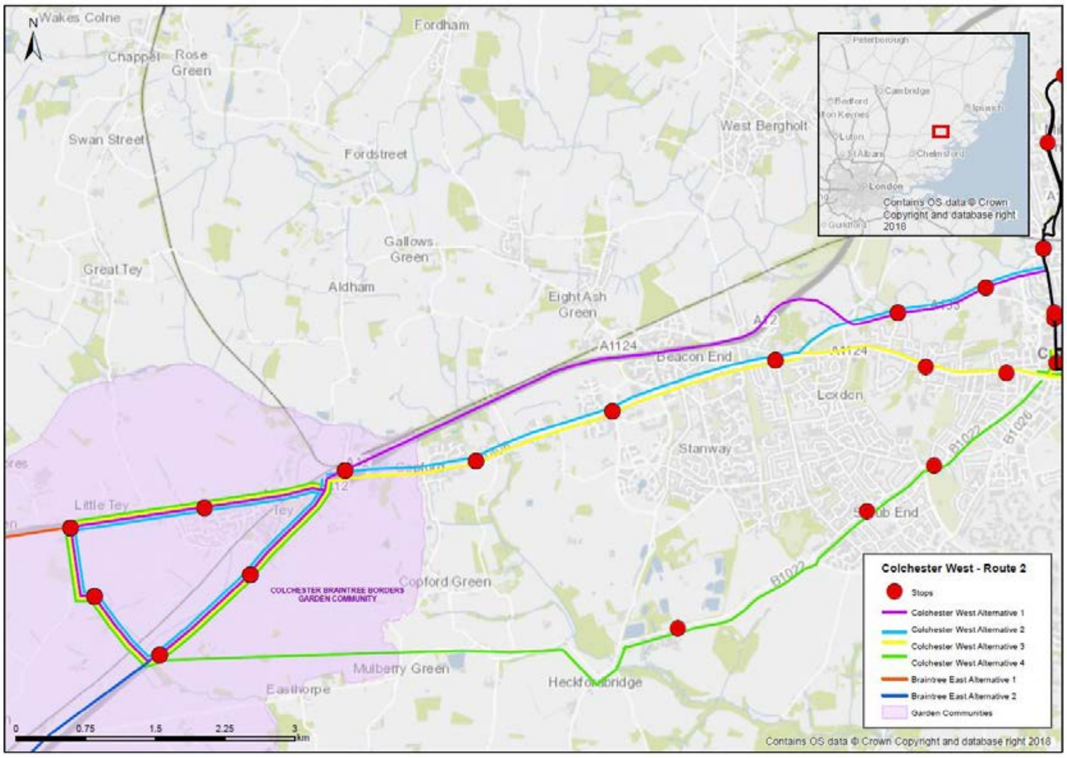


Figure 3-10: Route 2 options

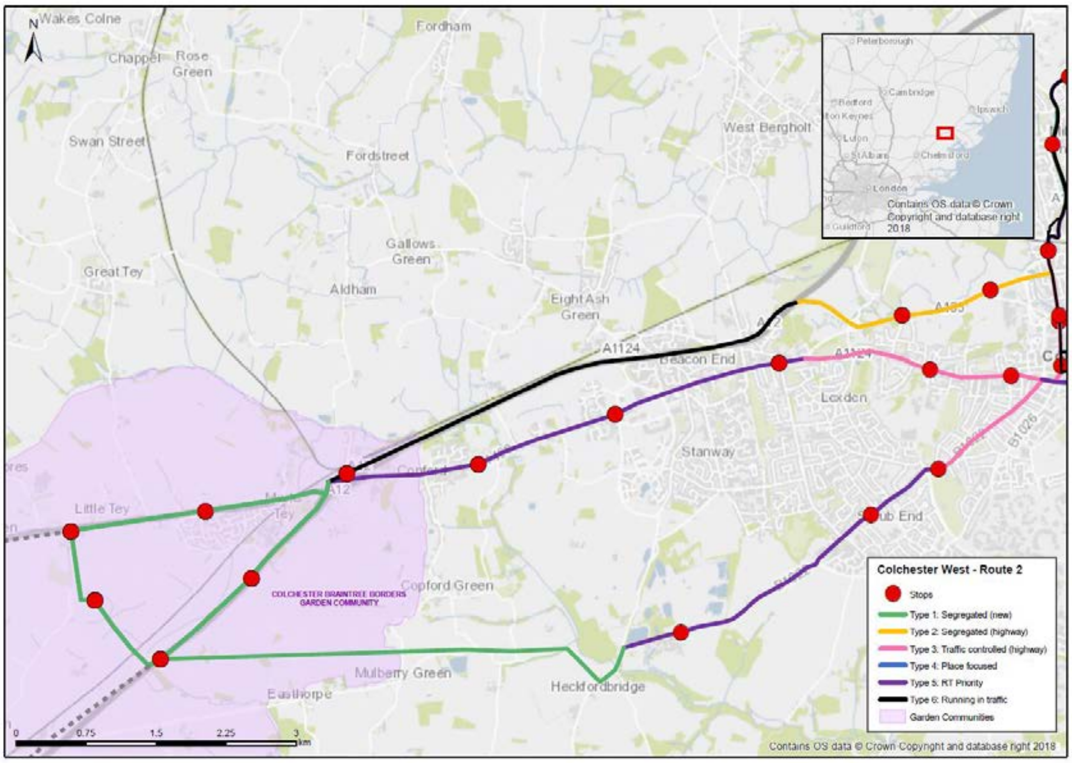


Figure 3-11: Route 2 options including type of infrastructure

The tables below provide further information on the development of route options.

Table 3-10: Colchester Town Centre – Marks Tey

Route 2: Colchester Town Centre – Marks Tey	
Overview	• A number of options are currently under consideration. All use the existing road network within Colchester, with reserved sections and restricted access where possible.
Infrastructure type	• A mixture of types 2-6 through the urban areas to the west of Colchester, with an option of new type 1 Dedicated infrastructure if the route enters the GC from the south-east.
Options considered	• A northern range of options includes an envelope between the A133/ A12 and the A1124/B1408 through Lexden and Beacon End. • A southern range of options includes the B1022 through Shrub End, continuing to the GC on new infrastructure either via Marks Tey or into the south-east corner of the GC near Copford Green.
Interim options and variations	• None

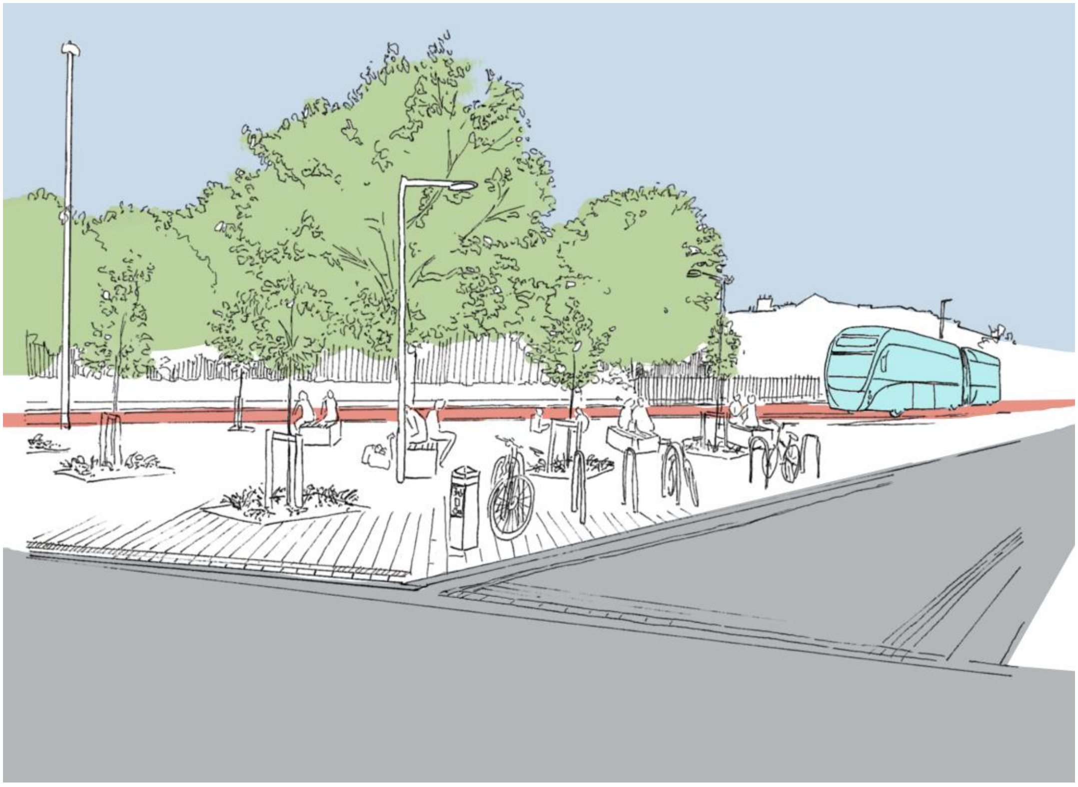


Figure 3-12: Concept image showing RTS on Lexden Road

Table 3-11: Within CBBGC

Route 2: Within CBBGC	
Overview	• Dedicated RT route, potentially using repurposed sections of current A12 and A120 after inauguration of new alignments. • Initial plans envisage a loop linking the town centre and one or more of the local centres.
Infrastructure type	• Type 1 Dedicated.
Options considered	• Detailed route subject to emerging masterplanning.
Interim options and variations	• Mixed use of sections of A120 prior to construction of new alignments.

3.6 Route 3: West of Braintree Garden Community - Braintree

This link connects Braintree with the West of Braintree Garden Community and Easton Park with Stansted Airport and Great Dunmow, creating an east-west Rapid Transit link between Braintree and Stansted Airport.

Table 3-12: Proposed sections in Route 3

Route 3: Braintree – WOBGC – Great Dunmow – Easton Park - Stansted
Braintree – WOBGC
Within WOBGC
WOBGC – Great Dunmow
Through Great Dunmow
Great Dunmow – Easton Park
Through Easton Park
Easton Park – Stansted Airport

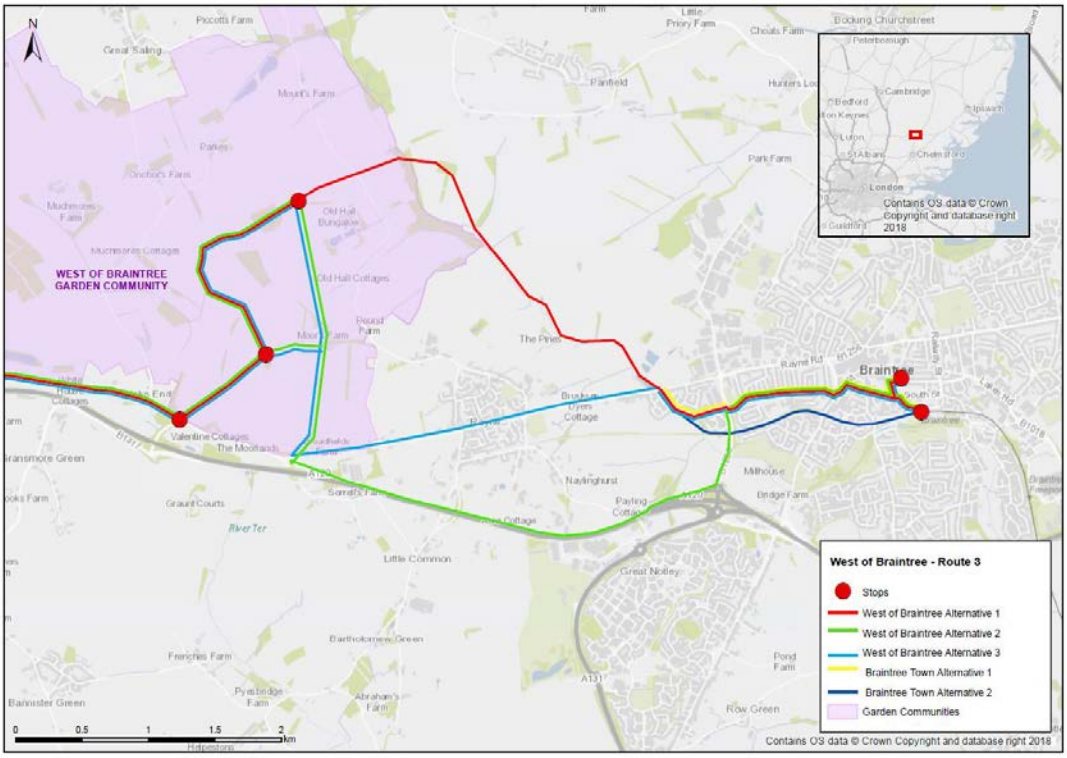


Figure 3-13: Route 3 options

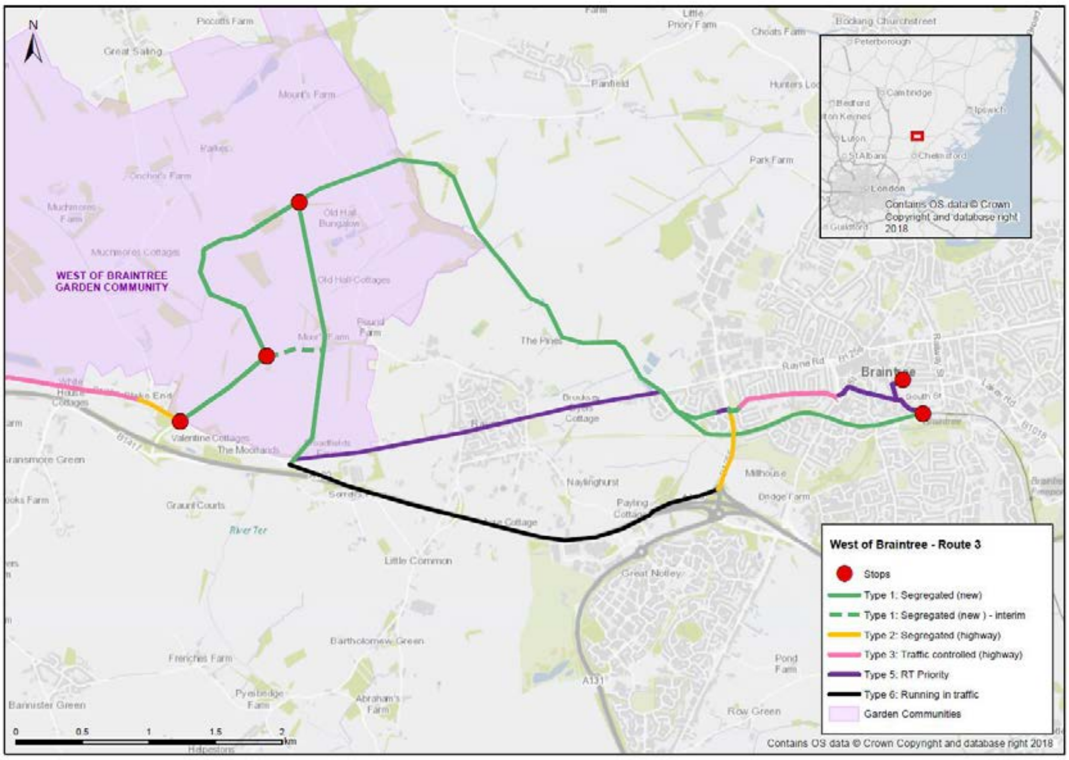


Figure 3-14: Route 3 options including type of infrastructure

The tables below provide further information on the development of route options at WoBGC and within WoBGC. Since the other sections on Route 4 are outside the boundary of NEAs, tables have not been provided describing route sections between WoBGC and Stansted Airport. However, the proposals can be seen in the figures provided, and have been described in detail in a parallel report prepared in coordination with this one for Uttlesford District Council.

Table 3-13: Braintree - WoBGC

Route 3: Braintree – WoBGC	
Overview	• Access to Braintree is proposed via the existing road network with terminals at both the rail and bus stations or by creating new infrastructure.
Infrastructure type	• There is a mix of types as shown in the plan.
Options considered	• Fully segregated northern route with alternative for segregated or shared access in Braintree. • Type 5 RTS priority along Rayne Road. • Shared running along the A120.
Interim options and variations	• The set of options lends itself to incremental phasing to suit available funding and build out at WoBGC. E.g. commencing with Type 5 infrastructure and the upgrading to Type 1 when funding is available.

Table 3-14: Within WoBGC

Route 3: Within WoBGC	
Overview	• New dedicated alignment through new development.
Infrastructure type	• Type 1 segregated infrastructure.
Options considered	• The options for route will be determined by the choice of connecting into Braintree.
Interim options and variations	• While WoBGC is being built out segregated network can be incrementally extended. RTS could be shared with vehicles in early years if required (although care should be taken that this does not undermine attraction of the RTS services).

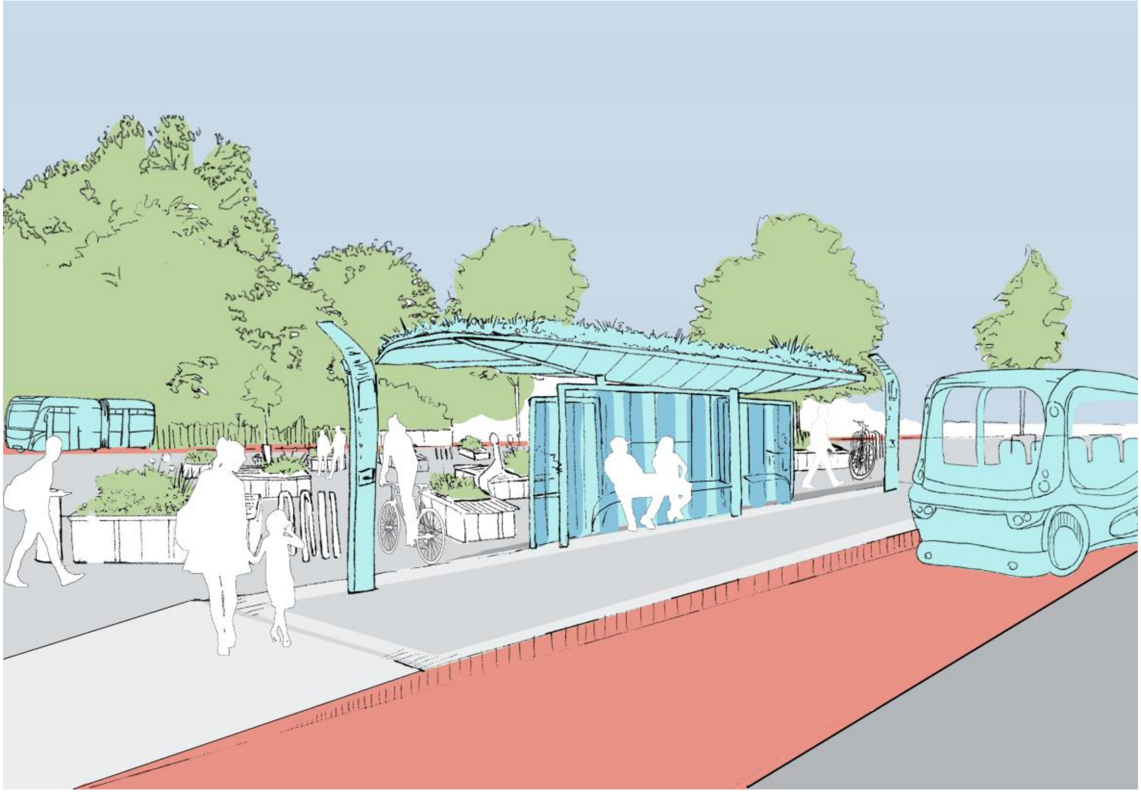


Figure 3-15: Concept image showing an RTS interchange within a garden community

3.7 Route 4: Joining the Braintree and Colchester subsystems

By 2033 it is expected that two RTS subsystems will be successfully operating based on the route options described in the previous subsections. That is a Colchester subsystem and a West of Braintree subsystem.

At some point after 2033 it would be an aspiration to connect the subsystems. However, neither RTS viability nor growth at garden communities depends on this connection being made. But the connection, referred to as Route 4, is included in this plan as it contributes to the overarching objectives for sustainable growth.

Table 3-15: Proposed sections in Route 4

Route 4: CBBGC – Braintree
CBBGC – Braintree
Within Braintree

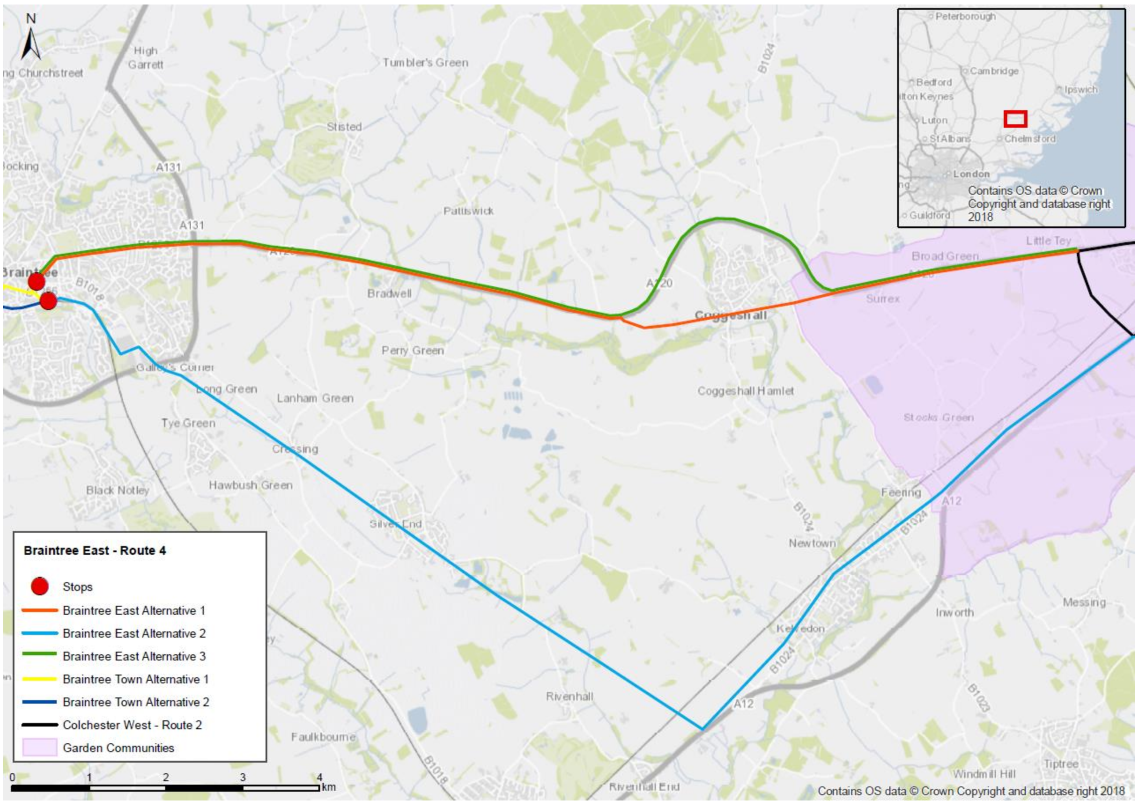


Figure 3-16: Route 4 options

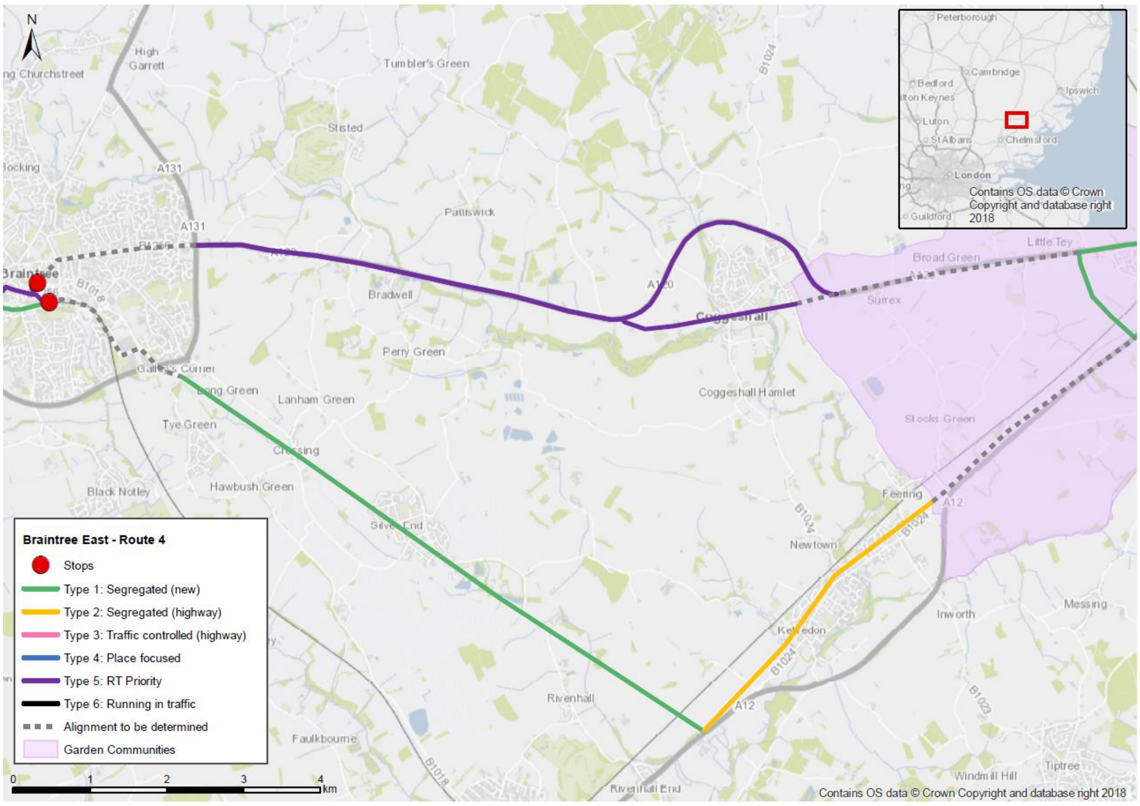


Figure 3-17: Route 4 options including type of infrastructure

The tables below provide further information on the development of route options.

Table 3-16: CBBGC – Braintree

Route 4: CBBGC – Braintree	
Overview	• The route will be co-ordinated with new proposed highway infrastructure. This means either following the old A120 or incorporating RTS track adjacent to the proposed.
Infrastructure type	• Utilising old roads would be based on Type 5 priority measures, whilst following new roads would enable Type 1 or Type 2 segregation.
Options considered	• A12 and then following the proposed A120. • Following the old A120 route.
Interim options and variations	• It would be expected that a variation would be required at Coggeshall. Access to RTS from Coggeshall should be considered even if not all RTS services stop there.

A route through Braintree from the east to the town centre will likely follow existing road alignments. However, considerable consultation and investigations will be required before a set of options can be derived. Since Route 4 provides a long term extension, this is not considered problematic. Here in North Essex and in other large towns across the country, there will be a trend of road space allocation in favour of rapid transit schemes in order to support economic growth whilst achieving environmental objectives, especially air quality improvements.

4 Supporting measures and future evolution

The introduction of the RTS in isolation would have an impact on mode shares, but to support a long term sustained shift to sustainable travel, a variety of complementary policy and infrastructural measures will be required. These include policy measures designed to support the RTS scheme itself, and measures that support integration with other forms of transport, particularly walking and cycling.

In addition to considering the measures required to support the RTS, it is important to consider the ways in which technology will develop over the life of the RTS scheme, and the opportunities that will be afforded to RTS as a result. In this section, the impacts of autonomous vehicles, electric vehicles, and of new forms of demand responsive transport (or ride-sharing), as well as the potential impacts of unforeseen technological developments, are considered.

4.1 Supporting measures

4.1.1 Policy changes in support of RTS

There are a number of areas where delivery of the RTS can be supported by policies that will aid its optimal delivery. These include:

- the safeguarding of routes for the RTS in and off the garden communities;
- ensuring that infrastructure decisions support the development of the RTS, i.e. balancing new infrastructure provision so that rapid transit is delivered, and not just additional highway capacity;
- reduced availability of parking in the garden communities and other new developments served by the RTS;
- over time, increasing parking charges and having a wider parking strategy with the objective of reducing parking and reducing car trips to town centres, which could also usefully consider pricing and levies; and
- restricting vehicle access to town centres, thereby helping to provide a better walking and cycling environment.

The requirements to reallocate road space away from the car and towards sustainable modes, and to restrict parking to further discourage car use will feature in the future development of large towns throughout the UK, to facilitate both economic and environmental efficiency. It will not be possible for large towns to continue to grow indefinitely with a presumption that the car will continue to be the dominant transport mode.

Adoption of a policy such as this is consistent with developments elsewhere in the country and more locally – for example, the transport strategy being followed in Chelmsford, Essex[6]. In this example trips from outside Chelmsford are encouraged to use park and ride or switch to rail. Meanwhile remaining trips are directed onto the most appropriate routes to reach their final destination using innovative signage systems. This allows road space to be maximised for public transport and active modes within the city limits of the Chelmsford area. This in turn reduces car journeys going into the central zone of Chelmsford where the emphasis is on creating and maintaining high quality public realm with remaining traffic distributed as efficiently as possible. Hence, the transportation interventions in the outer area, city-wide zone and central zone are mutually supportive leading to a far more efficient and environmentally sensitive use of road space, which also supports the Chelmsford City Growth Strategy[7].

4.1.2 Walking and cycling

Private cars offer flexibility and high levels of comfort, and over the course of the 20th century many cities were adapted to make full use of them. Motorised mobility results in higher levels of road congestion and contributes to local air pollution. At the same time, car-oriented cities directly undermine the viability and attractiveness of public transport, walking and cycling, which are the historical foundation of mobility in many cities.

Walking and cycling can make a wide range of contributions to sustainable urban mobility, but of particular relevance to the RTS scheme is that they can act as powerful complements to rapid transit, meeting the requirements of short distance travel. Cycling, especially, will allow RTS users to access more distant stops and stations compared to walking. For a given trip configuration, this would mean a small time-saving could be made. However, the real power of enabling public transport users to cycle to RTS is that they can access a wider range of stations for any given access travel time. This means travellers can optimise their whole journey to better suit their needs – this could include cycling to a station that has direct services to the destination, rather than requiring a transfer, or allowing travel through a neighbourhood with attractive activities (such as shopping or an opportunity to visit a friend) on route.

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[6] https://www.essexhighways.org/transport-and-roads/highway-schemes-and-developments/highway-schemes/chelmsford-future-transport-network.aspx

[7] https://www.essexhighways.org/highway-schemes-and-developments/major-schemes/chelmsford-city-growth-package/highway-schemes-and-developments/major-schemes/chelmsford-city-growth-package.aspx

4.1.3 Public realm improvements

Improving the appearance of an area is not just to make people feel good when they visit, shop, work or live there - although that is important. If an area has been upgraded and is attractive it will be healthier, safer and cleaner and therefore more people will want to go there. It also means that businesses will be more likely to invest money, to build or to trade there, which improves the economy and creates jobs.

High quality open spaces and safer and cleaner streets will encourage better access for all people and provide better connectivity to RTS. The upgrades should include the following:

- new high-quality paving, with new plants and trees with regard to biodiversity objectives;
- improving street lighting;
- making junctions safer for cyclists and pedestrians and traffic calming measures;
- widening footpaths for pedestrians; and
- adding well designed street furniture such as seating, bins and hanging basket stand, whilst avoiding unnecessary clutter.

All these improvements will not only have a positive impact on RTS accessibility, but they will have major effects on the local economy. For example, public realm improvements may help attract new residents and create mixed communities, and also in commercial areas might boost overall business activity and increase jobs.

4.1.4 Connecting public transport services

While the RTS will serve the main centres of activity and homes on garden communities, it is expected that distributing public transport services would be introduced on garden communities when they reach their full size. It is expected that these services would be on-demand with the potential for early adoption of fully autonomous vehicle technologies when and if available. Provision for these secondary distributor routes is, however, being made in the design of garden communities.

Additional peak hour or seasonal local services would be expected to evolve. In Colchester, these could include services around the entire University of Essex (note Route 1 only stops at the Knowledge Gateway) and peak hour services directly between TCBGC and Colchester train station via the A120. Other potential secondary services include routes between Chelmsford and Braintree.

In the next detailed stages of planning for RTS, further consideration will be given to secondary and connecting services jointly with operators.

4.1.5 RTS Park and Ride

The planned Park and Ride (P&R) sites will form a vital part of any changes to parking strategies in North Essex. The P&R sites will:

- enable parking strategies that might restrict the availability of parking in town centres, by ensuring that there are alternative means of access; and
- improve the viability of the RTS in several mutually reinforcing ways since
    - traffic along the RTS alignment is reduced, due to the availability of the P&R site with access to the RTS (along with measures discouraging parking in town centres);
    - the reduced traffic improves RTS journey times, making the service more attractive of demand; and
    - the increased fare income enables the RTS to be operated more frequently, again making it more attractive.

An initial high level analysis indicates that 400-900 trips in peak hour could be added to the RTS service when considering the potential for drivers to use RTS from the west or east. This initial forecast is based on evidence of park and ride usage in Chelmsford. As part of a current study currently, park and ride forecasts are being prepared. Park and Ride usage is likely to accelerate the time required to reach profitability. Park and Ride is a key element of the movement strategy in North Essex, and it will effectively complement the implementation of the RTS.

4.2 Future evolution

In recent years, the transport market has been changed by significant developments in technology. App-based companies such as Uber have disrupted the taxi market, and innovated with services such as Uber Pool, which allows passengers to pay less while sharing a car with others.

More recently, this ride-sharing concept has been deployed using vans or minibuses. Several pilots of such schemes are in operation in the UK, e.g. ViaVan in London, ArrivaClick in Liverpool and Sittingbourne.

Autonomous (self-driving) vehicles are in the advanced stages of development, and there is the possibility of their deployment on public transport or ride-sharing services.

These technological advancements are pertinent to the development of a medium to long term plan for a scheme such as the North Essex RTS. In particular, technology presents important opportunities to adopt and embrace technology to produce better outcomes for passengers, potentially at a lower cost. Some examples of these opportunities are as follows.

- **Electric vehicles** are already significantly gaining ground, and electric buses are in service or planned to be so across the UK at the time of writing. It is reasonable to assume the RTS will be operable with electric vehicles, thereby delivering even greater reductions in emissions of both greenhouse gases and chemicals harmful to health;
- **Autonomous vehicles** could be deployed on the primary or secondary RTS routes, or both. Self-driving vehicles would mean a saving in staff costs, thereby reducing the operating costs of the service and enabling greater frequencies, which in turn would stimulate greater demand, thereby enhancing the 'virtuous circle' of viability. Alternatively, if it was considered desirable to have a staff member on board, staff could adopt a more customer-centric role, helping with passenger queries, luggage, buggies, travel planning etc.
- **New forms of demand responsive transport** (also known as microtransit or ride-sharing) could be deployed on the secondary routes, and if demonstrably beneficial, the trunk RTS route. Existing commercial bus operators have already begun experimenting with app-based ride-hailing service provision. This model allows vehicles to be routed in real time based on passenger demand. In theory this allows for more efficient use of vehicles and a better service to passengers. It may represent the best option for service provision on the secondary routes, and could be combined with autonomous technology, such that passengers would travel in autonomous, demand-responsive 'pods'. Further work will be necessary to determine the model for operation of the secondary RTS routes.

On the RTS trunk route, it is likely that a high-capacity, high-frequency, fixed route service will remain the best model of service provision, but this should continue to be monitored over time. As discussed in section 1.2, the most crucial aspect of the delivery of RTS is securing a dedicated space for sustainable transport.

5 Viability and operating model

5.1 Capital cost

For each route section an indicative range of capital costs is provided based on benchmarked costs from BRT schemes, along with costs for a Park and Ride site or interchange hub (as appropriate) at each Garden Community. These are shown in the table below. The exact phasing of this capital expenditure is flexible, and elements of the scheme can be delivered as funding becomes available. The capital costs shown in the table below do not include the provision of Park and Ride sites, and do not explicitly include costings for specific structures (such as the bridge over the railway at CBBGC) along the route.

Table 5-1: Capital cost estimates

Full route capital costs (£m, current prices)	Lower investment		Higher investment	
	Capital cost	End-to-end AM peak journey time	Capital cost	End-to-end AM peak journey time
Route 1: TCBGC - Colchester North P&R via Colchester town	£38.4m - £55.4m	37 mins	£46.8m - £65.1m	27 mins
Route 2: Colchester Town - CBBGC	£45.1m - £62.2m	29 mins	£58.9m - £82m	23 mins
Route 3: Stansted - Braintree via WoBGC	£51m - £70.8m[8]	56 mins	£87.1m - £122.7m	44 mins
Route 4: Braintree - CBBGC	£37m - £53.3m[9]	33 mins	£37m - £53.3m**	33 mins
Total for all routes by 2051	**£171.5m - £241.7m**	**155 mins**	**£229.8m - £323.1m**	**126 mins**

To ensure these cost forecasts are reasonable, two recent UK BRT schemes have been selected, and the per-km infrastructure cost compared to that calculated for North Essex RTS. A comparison of the costs is shown in the table below. The scheme per km costs are based on the midpoint of the costs shown in the table above, with costs associated with park and ride sites or interchange hubs excluded. Land acquisition costs are not explicitly considered in the above.

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[8] *Lower investment option for route 3 not considered in detail - assumption of a mainly bus-priority based scheme.*
[9] *Alignment options for route 4 to be determined*

Table 5-2: Capital cost estimate benchmarking

<table>
<tr><th>Capital costs (£m)</th><th>Lower investment cost (£m per km)</th><th>Higher investment cost (£m per km)</th><th>Bristol cost (£m per km)</th><th>Leigh - Salford cost (£m per km)</th></tr>
<tr><td>Route 1: TCBGC - Colchester North P&R via Colchester town</td><td>3.2</td><td>4.6</td><td rowspan="5">4.6</td><td rowspan="5">5.5</td></tr>
<tr><td>Route 2: Colchester Town - CBBGC</td><td>2.9</td><td>4.1</td></tr>
<tr><td>Route 3: Stansted - Braintree via WoBGC</td><td>2.3</td><td>4.1</td></tr>
<tr><td>Route 4: Braintree - CBBGC</td><td colspan="2">3.4</td></tr>
<tr><td>Total for all routes by 2051</td><td>2.8</td><td>4.1</td></tr>
</table>

The analysis above shows that the midpoints of the costs assumed in Table 5-1 are in some cases slightly lower than the benchmark schemes. However, routes 3 and 4 contain long sections of running through greenfield sites, which might reasonably be expected to result in lower per-km costs, and this is borne out in their cost estimates. In general, however, the benchmarking exercise demonstrates that capital costs are likely to be at the higher end of the ranges shown in Table 5-1.

5.1.1 Phasing of capital cost

This report provides a set of options for implementation of the RTS route, and this necessitates the provision of a ranged estimate of capital costs.

Here an **indicative** phasing of capital costs for each of the four RTS routes is set out. To develop this phasing, it was necessary to use a single investment scenario. Consistent with the goal of achieving a route as segregated as possible, the indicative capital phasing below is based on the 'higher investment' scenario. The use of the higher investment scenario for this purpose does not preclude the eventual adoption of other possible combinations of route section alignments for construction. Rather, it is intended to provide an indication of how capital cost would be incurred over time under a sample scenario.

Please note that in some sections, the development of detailed phasing has identified a requirement for interim route sections which are later superseded by more segregated alignments. This adds some capital cost to the total, and this is set out in the tables below.

Table 5-3: Route 1 – indicative capital cost phasing

Route 1: phased capital costs based on higher investment scenario (£m)	On TCBGC	Off TCBGC	Total
2024 – 2028	£2.1m - £3.1m	£10.3m - £14.8m	£12.4m - £17.9m
2029 – 2033	£8.1m - £9.1m	£11.3m - £16.4m	£19.4m - £25.5m
2034 – 2051	£6.4m - £9.3m	£16.5m - £23.8m	£22.9m - £33.1m
Total	**£16.6m - £21.5m**	**£38.1m - £55m**	**£54.7m - £76.5m**
of which interim routes		*£7.9m - £11.4m*	*£7.9m - £11.4m*
Total excluding interim routes (corresponds to Table 5-1)	**£16.6m - £21.5m**	**£30.2m - £43.6m**	**£46.8m - £65.1m**

Table 5-4: Route 2 – indicative capital cost phasing

Route 2: phased capital costs based on higher investment scenario (£m)	On CBBGC	Off CBBGC	Total
2024 – 2028	-	-	-
2029 – 2033	£14.6m - £18.4m	£10.8m - £15.6m	£25.4m - £34m
2034 – 2051	£18m - £25.9m	£21.6m - £31m	£39.6m - £56.9m
Total	**£32.6m - £44.3m**	**£32.4m - £46.6m**	**£65m - £90.9m**
of which interim routes	*£3.9m - £5.7m*	*£2.2m - £3.2m*	*£6.1m - £8.9m*
Total excluding interim routes (corresponds to Table 5-1)	**£28.7m - £38.6m**	**£30.2m - £43.4m**	**£58.9m - £82m**

Table 5-5: Route 3 – indicative capital cost phasing

Route 3: phased capital costs based on higher investment scenario (£m)	On WoBGC	Off WoBGC	Total
2024 – 2028	£8.3m - £11.9m	£23.4m - £33.7m	£31.7m - £45.6m
2029 – 2033	£14.6m - £18.4m	£11.1m - £16.0m	£25.7m - £34.4m
2034 – 2051	-	£29.7m - £42.7m	£29.7m - £42.7m
Total	**£22.9m - £30.3m**	**£64.2m - £92.4m**	**£87.1m - £122.7m**
of which interim routes			
Total excluding interim routes (corresponds to Table 5-1)	**£22.9m - £30.3m**	**£64.2m - £92.4m**	**£87.1m - £122.7m**

Table 5-6: Route 4 – indicative capital cost phasing

Route 4: phased capital costs based on higher investment scenario (£m)	Off garden communities
2034 – 2051	**£37.0m - £53.3m**

Table 5-7: Indicative capital cost phasing – all routes

All routes: phased capital costs based on higher investment scenario (£m)	On garden communities	Off garden communities	Total
2024 – 2028	£10.4m - £15.0m	£33.7m - £48.5m	£44.1m - £63.5m
2029 – 2033	£37.3m - £45.9m	£33.2m - £48.0m	£70.5m - £93.9m
2034 – 2051	£24.4m - £35.2m	£104.8m - £150.8m	£129.2m - £186m
Total	**£72.1m - £96.1m**	**£171.7m - £247.3m**	**£243.8m - £343.4m**
of which interim routes	*£3.9m - £5.7m*	*£10.1m - £14.6m*	*£14.0m - £20.3m*
Total excluding interim routes (corresponds to Table 5-1)	**£68.2m - £90.4m**	**£161.6m - £232.7m**	**£229.8m - £323.1m**

5.2 Revenue forecast

Revenue forecasts have been developed using outputs from a multi-modal transport model. It should be noted that these revenue forecasts are linked to the higher investment and lower investment scenarios, and *not* to the phasing described above in 5.1.1. Thus, the journey times inherent in that phased approach to capital may result in lower demand and revenue than that presented here in 2033.

The transport model forecasts passengers for a single AM peak hour. The model methodology is described in Appendix A. AM peak demand is converted to annual demand using the factors in Table 5-8.

To convert the demand forecast into a passenger revenue forecast, the demand is multiplied by an assumed yield of £1.50 per passenger. This amount is based on guidance received from a bus operator with services in the area, and excludes any income from government, i.e. it represents total farebox revenue (*excluding* concessionary revenue) divided by the total number of passengers (*including* concessionary passengers). This is because the modelled demand will include some passengers eligible for concessionary travel, but these passengers will not produce revenue from a government perspective.

Table 5-8: Annualisation factors applied to peak hour demand forecasts

Factors to convert AM peak demand to annual demand	
AM peak hour to full AM peak	2.75
AM peak hour to off peak	4.00
AM peak hour to full PM peak	2.75
AM peak hour to full day (sum of factors above)	**9.50**
Annualisation factor (working weekdays only)	250
Overall annualisation factor (single peak hour to full year)	**2,375**

All revenue estimates are presented in current prices – i.e. based on the sort of revenue per passenger that the service would attract were it in existence at the time of report issue.

Table 5-9: Revenue forecast

Calculation of forecast revenue	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Total annual demand (millions)	1.7 million	6.0 million	14.6 million	8.7 million	19.2 million
Average yield (£, current prices)	£1.50				
Forecast revenue (£m, current prices)	£2.6m	£9.0m	£21.9m	£13.1m	£28.8m

A breakdown of revenue by route is shown below, but it should be borne in mind that the number of trips generated is linked to provision of the entire RTS system (with the exception of route 4 in 2033) and it cannot therefore be assumed that the same number of trips would occur if only one route section were provided.

Table 5-10: Revenue by route

Forecast revenue by route	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Route 1: TCBGC - Colchester North P&R via Colchester town	£2.6m	£3.2m	£6.7m	£5.5m	£11.1m
Route 2: Colchester Town - CBBGC		£2.0m	£3.7m	£3.0m	£6.3m
Route 3: Stansted - Braintree via WoBGC		£3.8m	£7.3m	£4.5m	£9.3m
Route 4: Braintree - CBBGC			£4.2m		£2.0m
Total revenue	**£2.6m**	**£9.0m**	**£21.9m**	**£13.1m**	**£28.8m**

From an operator's perspective, and for the purpose of establishing that the service could be viably run, it would be more appropriate to include revenue from government. Indications from the same local operator are that this would result in revenue being approximately 25% higher. Thus, the values for revenue reported here are conservative, as they exclude this revenue stream.

As a sensitivity, the revenue based on this higher amount has been calculated and the result shown below.

Table 5-11: Revenue sensitivity – yield incorporating government income

Revenue sensitivity – yield including government income	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Total annual demand (millions)	1.7 million	6.0 million	14.6 million	8.7 million	19.2 million
Average yield (£, current prices)	£1.88 (25% higher)				
Forecast revenue (£m, current prices)	£3.2m	£11.3m	£27.4m	£28.6m	£36.1m

5.3 Operating costs

Here only the higher level estimates of operating costs are presented. It should be noted that these operating cost forecasts are linked to the higher investment and lower investment scenarios, and *not* to the phasing described in 5.1.1. Thus, the slower journey times inherent in that phased approach to capital may result in higher operating costs than that presented here in 2033. Conversely, there may be less route maintenance required than that presented below for 2033.

Based on the modelled journey times and the proposed frequencies of service, a Peak Vehicle Requirement (PVR) for each of the route sections has been calculated. This PVR is then multiplied by an estimated annual cost of operation, being £225,000. This cost includes depreciation and maintenance of the vehicle and the cost of employing drivers to operate it.

The estimate is based on industry experience of the typical annual cost of operating a bus, which ranges from £160,000 to £250,000. A value towards the upper end of this range has been chosen to reflect the quality of service intended to be provided.

With regard to frequency, the modelling assumptions are as follows:

- **in 2026 and 2033**, a high-quality turn-up-and-go style frequency of 6 vehicles per direction per hour (**every 10 minutes**) along the alignment length;
- **by 2051,** as demand increases, an increase to 8 vehicles per hour (**every 7.5 minutes**) on **routes 1, 2 and 3**;
- **in 2051,** a **10-minute headway** on **route 4** (Braintree to CBBGC) due to the lower demand on that route; and

- under the **higher investment** scenario, in **2051**, it is commercially viable to increase the level of service to 12 vehicles per hour (**every 5 minutes**) on **routes 1 and 3**.

The above modelling assumptions are necessarily conservative, as the intention behind the modelling and forecasting is to demonstrate viability. As outlined in the results below, under most scenarios (with the above frequency assumptions) the RTS service is forecast to generate a surplus. Therefore, the modelling indicates that greater frequencies could be supported at an earlier stage, which would in turn generate greater demand. For example, in the higher investment scenario:

- a 5 minute frequency would be viable on route 1 from 2033 or earlier;
- a 7.5 minute frequency would be viable on route 3 from 2033 or earlier;
- a 5 minute frequency would be viable on route 2 by 2051; and
- on all routes, frequency increases would occur gradually over time, and where 5 minute frequencies are introduced, this could happen well in advance of 2051.

Note that although the routes are referred to separately in the descriptions of frequency above, it is envisaged that the majority of services would be through services, eventually providing a direct route all the way from Stansted to TCBGC. Where frequencies vary by route, the additional services would be operated as short workings.

The operating cost estimates are presented in the table below. As with revenue, all operating cost estimates are presented in current prices. It is important to note that on a like-for-like basis, operating costs under the higher investment scenario are lower. Where they are shown as higher in the table below, this is because of greater demand resulting in a greater peak vehicle requirement.

Table 5-12: Operating cost forecast

Calculation of forecast operating costs	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Peak vehicle requirement	9	30	45	23	47
Cost per vehicle	£225,000				
Total cost (£m, current prices)	£2.0m	£6.8m	£10.1m	£5.2m	£10.6m

Note that planning undertaken by NEGC assumes a network of routes within the garden communities. It is envisaged that the core of the RTS scheme will comprise a “trunk” service eventually extending across north Essex, and the estimates of operating costs are based on this trunk service. Infrastructure provision within the garden communities would allow for complementary connecting and/or branch services – capital and operating costs for these are not included here.

Additional to the cost of operating the service, new infrastructure would need to be maintained. There are a variety of methods by which high level maintenance costs can be calculated – two of them have been used to ensure a sensible estimate. These are:

- **unit cost per route km** – based on route length and a maintenance cost estimate of £60,000 per route km per annum from the Luton busway project; and
- **proportion of capital cost** – Based on guidance from the Institute for Transportation and Development Policy (ITDP) and scheme capital cost.

The results of the two methodologies are close to each other, and the average of the two has been adopted.

Table 5-13: Maintenance cost estimates

Calculation of forecast maintenance costs	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Per km unit cost approach (£m, current prices)	£0.7m	£2.7m	£3.9m	£2.6m	£3.8m
Proportion of capital approach (£m, current prices)	£0.5m	£2.0m	£2.6m	£3.1m	£3.7m
Average (£m, current prices)	**£0.6m**	**£2.4m**	**£3.3m**	**£2.9m**	**£3.8m**

The total of both operating and maintenance are shown in the table below.

Table 5-14: Total operating and maintenance cost

Total operating and maintenance costs	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Operating cost (£m, current prices)	£2.0m	£6.8m	£10.1m	£5.2m	£10.6m
Maintenance cost (£m, current prices)	£0.6m	£2.4m	£3.3m	£2.9m	£3.8m
Total (£m, current prices)	**£2.6m**	**£9.1m**	**£13.4m**	**£8.0m**	**£14.3m**

5.4 Commercial viability

Based on the operational cost and revenue assumptions described above, a summary of the commercial viability of operating the RTS service is shown in the table below.

Table 5-15: Operating surplus / deficit by route

Annual operating surplus / deficit (£m, current prices)	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Route 1: TCBGC - Colchester North P&R via Colchester town	-£0.1m	£0.6m	£3.6m	£3.5m	£7.7m
Route 2: Colchester Town - CBBGC		-£0.6m	£0.8m	£0.7m	£3.8m
Route 3: Stansted - Braintree via WoBGC		£0.0m	£2.4m	£0.8m	£3.4m
Route 4: Braintree - CBBGC			£1.7m		-£0.5m
Total for all routes by 2051	**-£0.1m**	**-£0.1m**	**£8.5m**	**£5.0m**	**£14.5m**

Note with regard to the above estimates that:

- RTS trips and their associated revenue have been distributed across the routes based on where they originate. The number of trips generated is linked to provision of the entire RTS system (with the exception of route 4 in 2033) and it cannot therefore be assumed that the same number of trips would occur if only one route section were provided;
- all monetary values are presented in current prices. In a detailed appraisal, consideration would need to be given to fares and operational costs potentially inflating at different rates. However, it should be noted that fare

increases would be within the control of the operator, and could be coordinated with cost increases for e.g. parking;

- the demand and cost estimates presented in this report are based on modelling work in which it has been necessary to make a number of assumptions. The modelling undertaken is intended to provide a strategic indication of whether the RTS scheme should continue to be examined. Further detailed modelling work would be required to confirm or revise these estimates as part of a business case process;
- in a full business case it would be necessary to consider the extent to which the revenue earned by the RTS has been abstracted from existing bus services, and any knock-on effects this might have (e.g. withdrawal of service or increased subsidy requirement);
- in the modelling there is some evidence of crowding in 2051, that may necessitate additional peak services being operated at additional cost. These would be unlikely to significantly erode the surplus shown; and
- these operational viability estimates are not explicitly linked to the capital cost phasing described in 5.1.1, with the exception of the higher investment, 2051 values.

Based on the operating surpluses shown in the table above, it is apparent that the RTS would generate a surplus during most of its operating life. The exact level of profitability depends on the initial level of investment – significant surpluses are generated by 2033 in the high investment / low journey time scenario. In the 2033 low investment scenario, the service makes a slight overall loss.

5.4.1 Necessity for early subsidy

The revenue and cost estimates above present 2026 modelled revenue forecasts on Route 1 (serving TCBGC) as a proxy for revenue and cost in the initial stages of TCBGC's development. It can be observed that Route 1 makes a slight operational loss of less than £100,000 per annum. This implies that the extent to which 'pump priming', or early subsidy to generate patronage, will be required is limited.

However, it should be noted that this modelling does not take account of any phased introduction of a segregated route, or the necessity to subsidise traditional bus services at the very early stages of garden community development. Additionally, evidence from elsewhere demonstrates that new services can require subsidy for several years before. Thus, an element of 'pump priming' should be continued to be assumed to be necessary when services are introduced, despite the indication of a profitable service in the medium term from the modelling.

Detailed analysis will also be required to determine the extent to which RTS abstracts demand from existing bus services – where this occurs, subsidy may be required to avoid withdrawal of bus services in locations not served by RTS.

5.4.2 Potential drivers of higher profitability

It should be borne in mind that the profitability forecast presented in Table 5-15 is based on a number of conservative assumptions, and profitability may actually therefore be higher.

Firstly, the revenue estimate excludes income from government. From a business case perspective, it is correct to exclude this, but in looking at the commercial viability of the service in practice, revenue from government should be included. Profitability by route under a sensitivity test in which revenue from government is included is shown in the table below.

Table 5-16: Operating surplus / deficit by route – government revenue included

Annual operating surplus / deficit (£m, current prices)	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Route 1: TCBGC - Colchester North P&R via Colchester town	£0.6m	£1.4m	£5.2m	£8.5m	£10.5m
Route 2: Colchester Town - CBBGC		-£0.1m	£1.7m	£4.5m	£5.4m
Route 3: Stansted - Braintree via WoBGC		£0.9m	£4.2m	£7.5m	£5.8m
Route 4: Braintree - CBBGC			£2.8m		£0.0m
Total for all routes by 2051	**£0.6m**	**£2.2m**	**£14.0m**	**£20.5m**	**£21.7m**

Although under this sensitivity Route 2 continues to require some cross-subsidy in the lower investment scenario, it is apparent that there is a significant surplus by 2033.

An additional source of demand not included in the estimates used to calculate profitability is the plan for new Park and Ride sites at the Garden Communities. There is the potential for Park and Ride to act as a significant driver of additional demand and hence revenue.

5.4.3 Phasing and funding

The level of profitability will also be dependent on:

- the phasing of the development of RTS infrastructure;
- the phasing of housing development at the garden communities; and
- the mode share captured at the garden communities.

There is a complex interaction between the above factors, and the exact phasing of the delivery of the scheme is flexible. As a minimum, it would be desirable to secure funding for the lower investment option described in this report.

Where there are funding gaps, there is the potential to operate parts of the RTS service in mixed traffic as a short-term measure, and the adoption of BRT as a mode makes this possible. For a variety of reasons, including consistency with the vision described in this report, this would be undesirable, and the intention should be to avoid this wherever possible.

As a longer-term goal, the delivery of the higher investment options is the most desirable outcome and would deliver a number of benefits as outlined below.

5.5 The case for higher investment route options

In this report a variety of route options has intentionally been presented in order to demonstrate the range of potential outcomes that can be delivered. The inclusion of lower investment options demonstrates that the scheme is deliverable, and indications are that it would ultimately be commercially viable even in this form.

Table 5-17: Passenger numbers under lower and higher investment scenarios

Annual passengers (millions) under high and low investment scenarios	2026	Lower investment		Higher investment	
		2033	2051	2033	2051
Route 1: TCBGC - Colchester North P&R via Colchester town	1.7 million	2.1 million	4.4 million	3.7 million	7.4 million
Route 2: Colchester Town - CBBGC		1.4 million	2.4 million	2.0 million	4.2 million
Route 3: Stansted - Braintree via WoBGC		2.5 million	4.9 million	3.0 million	6.2 million
Route 4: Braintree - CBBGC			2.8 million		1.4 million
Total for all routes by 2051	**1.7 million**	**6.0 million**	**14.6 million**	**8.7 million**	**19.2 million**

However, this report has also presented route options requiring higher investment with shorter journey times. What is apparent from the passenger numbers shown above, and the financials shown in Table 5-15, is that although the capital outlay to deliver these route options is higher, they deliver:

- higher patronage, and thus higher revenue, as a result of shorter journey times;
- lower operating costs, also as a result of shorter journey times; and
- higher mode shares for RTS both on and off the garden communities.

Thus, the more aspirational, segregated routes offer not only better outcomes from a sustainability and quality of life perspective, they also result in a more commercially viable service that will more quickly recover capital and deliver an income stream for further investment in sustainable forms of transport.

5.6 Operating model

Aside from rail, public transport services in the areas to be served by the RTS are currently predominantly operated under a deregulated market-led system. Bus services are provided by operators where they can make a profit, with some services operated with financial support from Essex County Council.

The construction of dedicated infrastructure for the RTS will enable other potential operating models to be considered for its operation. Because part of the route will run on dedicated infrastructure (i.e. not public road), it will be possible to restrict access to that infrastructure. In theory, ECC could go out to tender for an operator and set service standards through a contract. If the service were profitable, ECC could seek to retain some of that profit through contractual arrangements with operators. There are a variety of possible operating models, such as:

- open access – like bus services, any operator would be free to use the infrastructure. Additional services could be subsidised if necessary;
- open access with minimum specifications – ECC could allow any operator to use the infrastructure, provided certain minimum standards were met – e.g. vehicle specification, branding etc. Additional services could be subsidised if necessary;
- contracted services – ECC could go out to tender for an operator, utilising a variety of risk mechanisms. This would allow tight control over the functioning of the service but would involve the council taking on more risk than under the models outlined above; and

- public operator – a subsidiary company set up directly to operate the service. This would also involve risk to ECC.

The above examples are limited, and within each there are many potential variations. At this point in the planning of the RTS, it is not necessary to identify a preferred operating model.

What is most important to note is that the provision of infrastructure gives the local authority greater control than would be the case with bus services. As a bare minimum, ECC could allow private operators to run the RTS services on a deregulated / open market basis, but with minimum quality specifications relating to off-vehicle ticketing, vehicle quality, branding and other service elements. This means that the vision and principles of the system set out earlier in this report can be secured.

6 Conclusion

This report has developed the vision for RTS across North Essex and provided a strategic level of detail appropriate for the NEA's Local Plans.

For the purpose of modelling and feasibility, this report assumes that RTS will use bus and trackless tram type technologies. If these technologies are applied appropriately as part of an integrated and sustainable transport system, they can deliver the same place-making and transport objectives as rail-based solutions. The other elements of garden community planning and the sustainability led transport plans of ECC and NEAs have ensured that that foundations for this integrated approach are in place. In addition, bus technologies have numerous benefits over others considered, including affordability, flexibility and a greater capacity to adapt to changes in technology over time.

This report has clearly identified route options. These must be part of wider public consultation and reviewed during the design stages. Such work has already begun on Route 1 between TCBCG and Colchester as part of a Housing and Infrastructure Fund bid. However, the route options identified could usefully be safeguarded for RTS. That is consideration for the needs of RTS be considered by planning and highway authorities should applications for developments along the routes come forward. To a large extent this is happening already. The routes are:

- **Route 1** connecting Tendring Colchester Borders Garden Community, a potential eastern park and ride site, the university, the main rail station, the hospital and the existing Colchester northern park and ride site;
- **Route 2** connecting Colchester Braintree Borders Garden Community, a potential western park and ride site, the town centre and the rail station;
- **Route 3** being planning jointly with Uttlesford District Council and connecting Stansted with Braintree via the West of Braintree Garden Community; and
- **Route 4** connecting Braintree and the Colchester Braintree Borders Garden Community, and in doing so connects the two subsystems that would have been created.

The capital cost requirements of the routes have been identified. Given the strategic stage of work, low and high estimates have been provided corresponding to the route options. It is worth noting that operational viability is strengthened with the higher cost options which introduce greater segregated sections of RTS route. This is a result of improved journey times. The higher cost options are also likely to deliver the vision for place-making, health and quality of life.

Based on the low and high cost options a transport model has been used to forecast the number of passengers using RTS. This has been used alongside yield per trip to estimate viability in order to establish that the overall system seems viable and robust. The routes also support each other and the strongest system combines all four routes.

By the end of the Local Plan period in 2033 it is expected that Route 1, 2 and 3 will be in place. The aim is to invest at the high end of capital estimates (c.£150m-£200m). This higher end investment would help reach an operational viable system in a faster time frame. Note that these costs include infrastructure to the west of WoBGC toward Stansted which is outside the boundary of NEA.

Post 2033, the intention is to extend the level of segregation on Routes 1-3 and introduce Route 4, which connects the two subsystems. The timescales for this further investment will be timed according to funding availability.

Significant investment is planned as part of the garden communities. However, it is expected that additional bids will be made to government through opportunities such as the Housing Infrastructure Fund. The first such bid has been made for TCBGC. Other funding mechanisms, similar to the Strategic Infrastructure Tariff, are envisaged through the change to Policy SP5 in the Garden Communities Local Plan Section 1. In addition, given the potential viability of the proposal loan arrangements can be considered.

Consequently, the proposals for RTS set out this report are considered highly achievable and highly likely to meet the objectives for garden communities in North Essex.

Appendix A: Passenger demand forecasting methodology

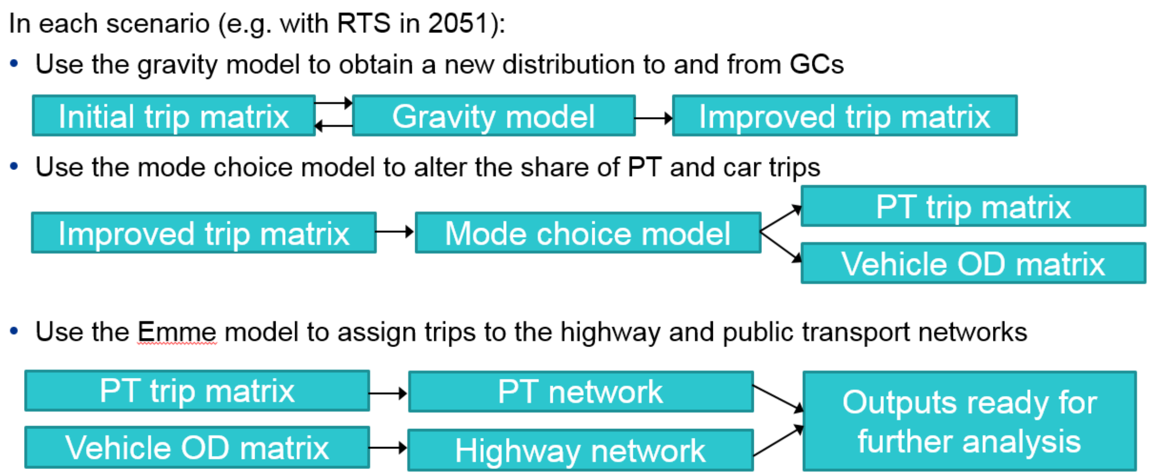
A calibrated multimodal EMME transport model has been developed. The base year assignment model has been calibrated to an AM peak hour in 2014 and combines highway and a public transport (PT) models.

The highway network merges the networks from the A120 and Colchester SATURN models. The highway base demand matrices have been derived from the A120 SATURN model, since that is the more recent of the two SATURN models.

The PT model includes bus and rail networks which have been coded into EMME. The PT base matrix has been synthetically created by combining:

- NTEM data from 2014 (to provide trip ends);
- Census 2011 journey to work data, for distributing all Home Based Work trips and those Home Based Other trips on train; and
- SATURN highway base matrix for distributing Home Based Other trips on bus.

The following chart provides a high-level and simplified explanation of the key modelling steps.



Growth in trip generation

Development growth has been identified from the draft Local Plans for Colchester, Braintree, Tendring and Uttlesford districts, which includes the garden communities. For these developments, trip rates obtained from TRICS have been used to forecast the number of highway trips. For deriving PT trip rates, the following formula has been used:

$$PT_{trip\ rate} = Car_{trip\ rate} * \frac{PT_{share}}{Car_{share}}$$

In 2026, an appropriate proportion of Local Plan growth has been used. In 2033 the full draft Local Plan growth has been used. In 2051, the only developments that have been included are the garden communities. In all years, the highway trips have been controlled to NTEM.

For peripheral zones in the EMME model, growth in highway and PT trips has been taken from NTEM. At Stansted Airport trips were increased according to its conditional planning application to expand from 35mmpa to 43mppa.

Distribution

In most cases, the distribution of trips to and from a development is based on the model zone in which it is located taken from the base model. Exceptions are where a development occurs at a greenfield site where the base distribution is not similar. This occurs at the garden community developments and Easton Park, where a synthetic distribution was required.

The synthetic distribution was derived from a gravity model based on the Tanner function which has the advantage of not forcing unrealistically short trips onto the public transport and highway modes. Note that the synthetic distribution was only used for the trips to and from garden community zones: this ensured the usable parts of the prior matrices were retained.

Mode choice

An incremental mode choice model was included to capture modal shift as public transport improves (due to the RTS) relative to the highway. It is calibrated based on the behaviour of the base model. It works by altering the share of public transport trips if there is a change in the PT generalised cost relative to highway generalised cost.

Assignment

The EMME model has a highway component and a public transport component. It assigns a fixed number of highway trips and a fixed number of PT as calculated in the mode choice model. (It does not assign trips between the highway and PT networks.)

Highway trips are assigned to the highway network through an optimisation procedure which considers the generalised cost of journeys. The generalised cost function is:

$$G_{Car} = t_{walk} * V_{\text{walktime}} + t_{ride} + \frac{d * VOC}{occ * VOT}$$

where:

- t_{walk} is the total walk time to and from the car;
- $v_{walktime}$ is the weight to be applied to walking time (see below).
- t_{ride} is the journey time spent in the car (which changes with congestion);
- VOC is the vehicle operating cost per km for a journey of d km, dependent on purpose;
- occ is the number of people in the car (who are assumed to share the cost);
- VOT is the appropriate value of time; and

PT trips are assigned to the public transport network according to a similar procedure. However, trips can be assigned to combinations of bus, rail and RTS networks. The PT generalised cost function is:

$$G_{PT} = t_{walk} * V_{\text{walktime}} + t_{wait} * V_{\text{waittime}} + t_{ride} + C_{interchange}$$

where:

- t_{walk} is the total walking time to and from the service;
- t_{wait} is the total waiting time for all services used on the journey;
- $v_{walktime}$ and $v_{waittime}$ are the weights to be applied to time spent walking and waiting;
- t_{ride} is the total in-vehicle time;
- $c_{interchange}$ is the interchange penalty if the journey involves transferring from one service to another (It is calculated as a time penalty multiplied by the number of interchanges).