Report
February 2019

Edinburgh Tram: Full Business Case for the Tram Completion Project

City of Edinburgh Council
Our ref: 23277602
Client ref: 62-060031 PO2155886

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1 Introduction

Edinburgh Tram

1.1 Phase 1 of the Edinburgh Tram operates between Edinburgh Airport and the city centre (York Place). It opened in June 2014, and actual patronage has been in line with that forecast for the scheme. For the calendar year 2017 Edinburgh Tram patronage was 6.67m; an increase of 19% on 2016, and the line carried around 130,000 passengers per week. Year-to-date demand suggest that the patronage growth for 2018 is very strong, increasing by an annualised rate of more than 10%.

1.2 Edinburgh Tram was envisaged and planned as a network of routes, and full statutory powers exist to construct and operate the tram on a route from the city centre to Leith and on to Newhaven. Leith Waterfront to Newhaven is designated for significant housing development to support the City of Edinburgh Council's (CEC) ambition to accommodate population growth through to the 2030s.

1.3 In 2015 a comparative business case assessment of four Project options (to Newhaven, Ocean Terminal, Foot of the Walk and McDonald Road respectively) was undertaken by Joint Revenue Committee (JRC). This assessment showed that the Tram Completion Project performed best in terms of meeting the strategic and economic rationale for the corridor. Based on this assessment, CEC approved the further development of the Project, referred to as the Tram Completion Project.

1.4 An Outline Business Case (OBC) for the Tram Completion Project was prepared in June 2017, which reaffirmed the case the project. In September 2017 CEC approved taking forward the Project to procurement and the Full Business Case (FBC).

Purpose of this Report

1.5 The purpose of this report is to set out the Full Business Case (FBC) for the Tram Completion Project, based on the contractor costs for the project, and updating of the appraisal to take account of updated demand forecasts and costs that reflect the agreed scheme design and a review of other key assumptions.

1.6 Its focus is on the economic analysis (the benefit-cost ratio based on the present value of costs and benefits), but also includes a high-level assessment of wider appraisal criteria in line with Scottish Transport Appraisal Guidance (STAG).

1.7 This work is one several work streams that will inform the CEC's decision on whether to recommend the funding, final approval and implementation of the Tram Completion Project.

1.8 This is the final deliverable for this current commission.

2 Project Description & Estimated Costs

Introduction

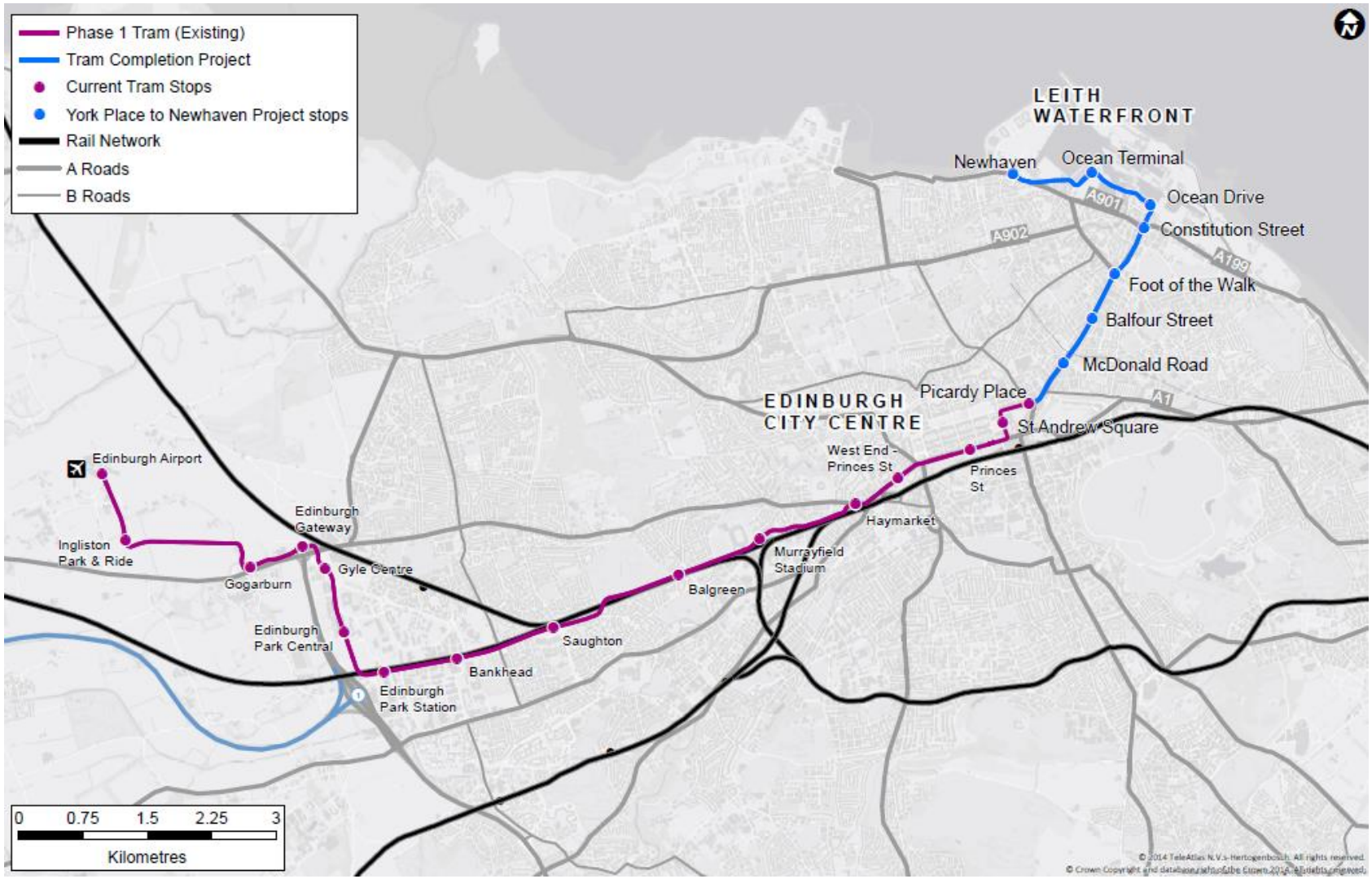
2.1 This chapter sets out a description of the route, and the operational assumptions upon which the appraisal is based. The operational assumptions, in terms of the tram frequency and assumed bus service recast, are the same as those for the Outline Business Case (OBC), prepared in 2017. The scheme design has been refined, and this is the basis for the contractor capital costs and the tram journey time assumptions.

Description of the Project

2.2 Phase 1 of Edinburgh Tram operates between the Airport and York Place. The proposed Tram Completion Project would start at York Place (the current York Place stop would be relocated to, and renamed as, Picardy Place), continue along Leith Walk and then serve the Leith Waterfront area, including Ocean Drive, Ocean Terminal and Newhaven.

2.3 The route alignment is shown in Figure 2.1.

Figure 2-1: Phase 1 of Edinburgh Tram and Tram Completion Project



2.4 The key route characteristics are summarised in Table 2.1 below.

Table 2.1 Route Characteristics

	Phase 1 (Airport – York Place)	Tram Completion Project	System Total
Stops – Total	16 current, including Edinburgh Gateway (opened Dec 2016) 15 with Project (York Place relocated to Picardy Place)	8 (incl. Picardy Place)	23
Route Length (km)	13.5	4.7	18.2

2.5 The Project could, subject to various approvals, be procured and constructed to commence service in 2023. This was therefore the assumed opening date used for the economic analysis presented in this report.

Route Consultation and Alignment Design

2.6 While the overall route is ostensibly the same as considered at the OBC Stage, there has been further route consultation on specific elements of the alignment, as part of the design development for the project.

2.7 Public Consultation "Taking trams to Newhaven" commenced in March 2018 for a six-week period. The consultation presented the public with the opportunity to review the proposals for the Tram Completion Project and feedback views and opinions.

2.8 In summary, 59% of respondents agreed that the line would benefit Leith and 58% said it would be easier to get around the local area. 42% of consultees said it would be good for local business and 91% were satisfied with current transport provision on Leith Walk.

2.9 When respondents were asked what would improve public transport provision in Leith Walk, the most popular response at 38% was "introduce a tram service" and 56% said they were likely to use Edinburgh Tram.

2.10 Several key themes emerged from the consultation;

- The need to accommodate all road users ensuring the best possible balance between pedestrians, cyclists, servicing, parking and traffic on Leith Walk, particularly between Pilrig Street and Foot of the Walk
- A perception that the project would divert resources from other CEC services
- The potential impact during construction. Support for local businesses was at the forefront of the CECs plans and they continue to work closely with businesses that are likely to be affected during the construction of the Tram Completion Project with a financial support scheme under preparation.

2.11 Four route/ alignment options were further considered in June in a series of workshops attended by stakeholders and, informed by this consultation, Option 3b was taken forward as the preferred option.

2.12 Option 3b includes shared lanes for transport and trams, dedicated cycle lanes on each side of the road, a central reservation with overhead tram wires and wider footways either side of the road.

2.13 The major change is a requirement to maintain a fully segregated cycle route along the length of Leith Walk. This necessitates a reduction in the width of the roadway between Pilrig Street

and the Foot of Leith Walk at Great Junction Street. Over this section, only one lane is provided in each direction, shared by general traffic, buses and trams.

2.14 Bus stops have been designed to accommodate up to three buses in a lay-by configuration, minimising potential delays to tram. Traffic signal staging has been adjusted to provide a green wave between Balfour Street and Foot of the Walk stops.

2.15 Also, in consultation with residents, the proposed Balfour Street tram stop has been revised slightly to improve access to Balfour Street. Iona Street, at Leith Walk is now fully closed to vehicular access. To compensate for this closure, Albert Street is to be signalised permitting all traffic movements at this junction.

2.16 These alignment refinements to the Tram Completion Project are consistent with the broader CEC policy for the Leith Corridor, which seeks to prioritise walking, cycling and public transport above private transport.

2.17 A number of bus routes are assumed to operate via Constitution Street; however, no bus stops have been assumed to be provided as these would impact on tram operation.

2.18 Figure 2-2 and Figure 2-3 show the geometric layout of Leith Walk from Pilrig Street to Foot of Walk.

Figure 2-2: Leith Walk- Option 3b Foot of the Walk to Springfield Street

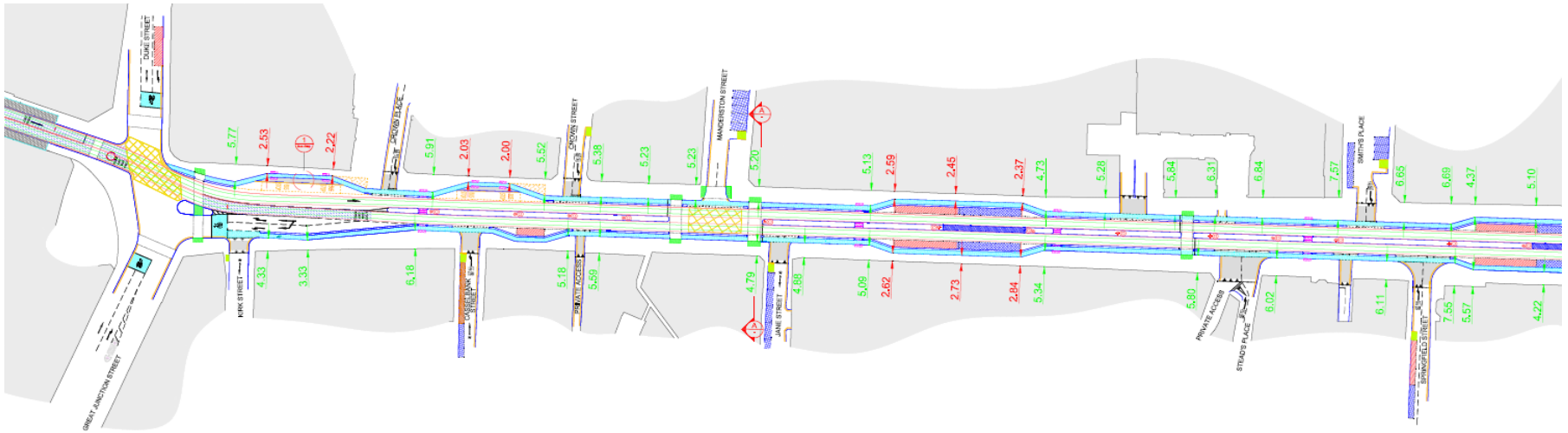
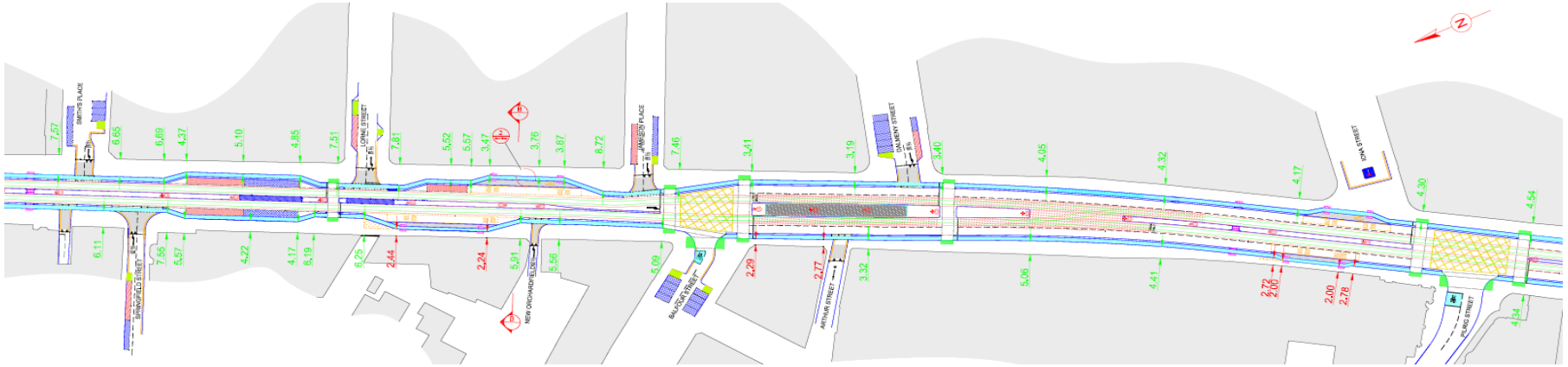


Figure 2-3: Leith Walk- Option 3b Smiths Place to Pilrig Street



Source: City of Edinburgh Council

Tram Service Pattern and Journey Time

Service Pattern

2.19 The current tram service (from the Airport to the city centre) operates at 8 trams per hour in the peak[1] and the inter-peak. The proposed service pattern for the Project is summarised in Table 2.2 and Table 2.3 for the proposed opening year (2023) and second forecast year (2032) respectively.

2.20 In each case, trams serving the Project would comprise a combination of the 8 tph on the current system being extended to run through to Newhaven, plus the addition of 4 and 8 services per hour (in 2023 and 2032 respectively) which would operate between Newhaven and Haymarket, where a turnaround facility exists to enable this.

Table 2.2: Tram Service Pattern 2023 Opening Year

	Peak	Inter-peak	Notes
Current & Do Minimum: Airport – York Place	8 tph	8 tph	Unchanged from 2017 frequency
Do Something: Project (total)	8 tph Airport to Newhaven 4 tph Haymarket to Newhaven	8 tph Airport to Newhaven 4 tph Haymarket to Newhaven	8 tph retained on Airport to York Place section Total of 12 tph on common section between Haymarket & Newhaven

Table 2.3: Tram Service Pattern 2032 Second Forecast Year

	Peak	Inter-peak	Notes
Current & Do Minimum: Airport – York Place	8 tph	8 tph	Unchanged from 2017 frequency
Do Something: Project (total)	8 tph Airport to Newhaven 8 tph Haymarket to Newhaven	8 tph Airport to Newhaven 8 tph Haymarket to Newhaven	8 tph retained on Airport to York Place section Total of 16 tph on common section between Haymarket & Newhaven

2.21 In both future years the Project modelling assumes the current Airport to City centre service frequency is retained. This means that the benefits of higher frequency on the Project are isolated and, for the purposes of the appraisal, are fully attributable to the Project.

2.22 The service pattern is shown schematically in Figure 2.3 and Figure 2.4 for the opening year and the forecast year. The proposed future service patterns have been discussed and agreed with Edinburgh Tram.

[1] There are three additional 'congestion-buster' services, between the Airport and Princes Street West, that operate in both the morning and evening peak hours.

Figure 2-4: Tram Service Pattern- 2023 Opening Year

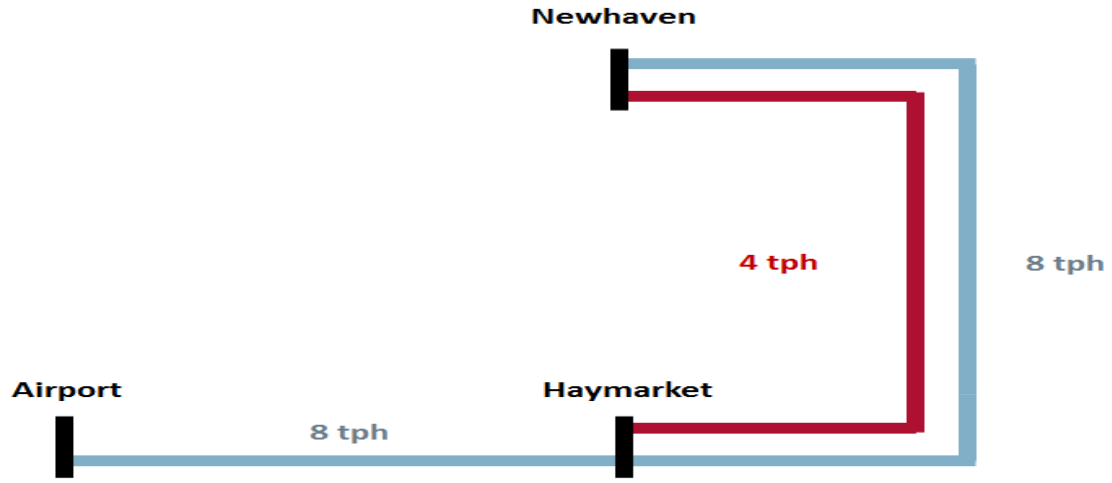
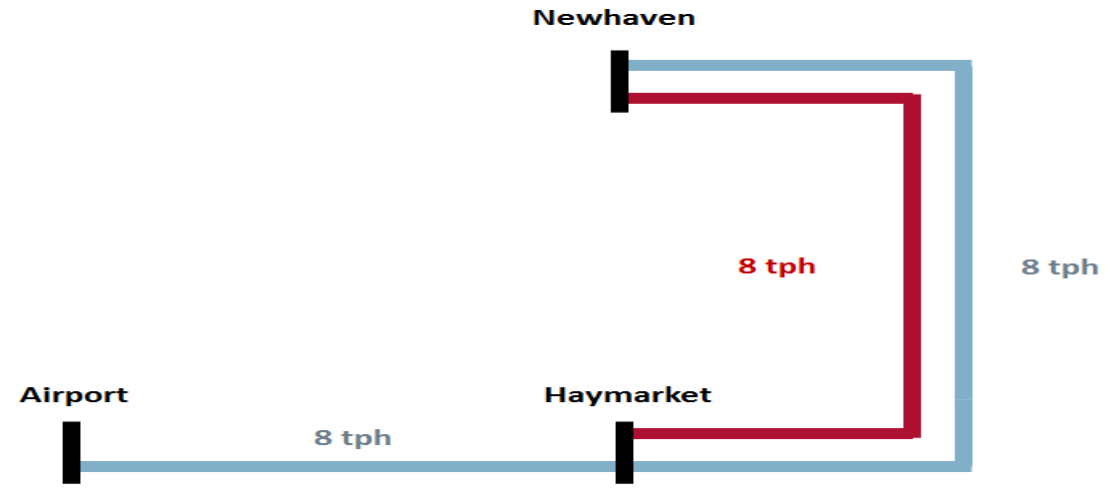


Figure 2-5: Tram Service Pattern- 2032 Second Forecast Year



Journey time

2.23 End-to-end tram journey times for the existing system are currently around 37 minutes. This represents an improvement on the journey times of over 40 minutes that operated prior to operational improvements delivered by Edinburgh Trams over the last couple of years. The journey times now being regularly achieved are in line with those that were originally forecast.

2.24 The journey times for the Tram Completion Project have been estimated using a VISSIM-based micro-simulation run time model developed by JRC. These journey times reflect the current scheme design, which was refined following the design consultation exercise undertaken in the summer of 2018. The journey times used for the operating costs and demand forecasts are presented in Table 2.4.

Table 2.4: Tram Journey Time (minutes)

Scenario	Airport – YP Peak	Airport – YP Off Peak	YP to Newhaven	YP to Newhaven	Combined	Combined
			Peak	Off Peak	Peak	Off Peak
2016 Current	37	37				
2022 & 2032 Forecast Years	37	37	17	17	54	54

2.25 It should be noted that Journey times presented above are rounded to the nearest minute. Timetabled (Phase 1) and modelled (to Newhaven) journey times vary slightly by direction, and these have been used for the detailed modelling. Furthermore, as noted below in Paragraph 2.28, it should be possible for further journey time savings prior to 2032.

Tram Vehicle Requirement

2.26 The tram vehicle requirement the number of operational vehicles required to deliver the service. It is the cycle time for one vehicle to make a complete cycle of the route, including layover and terminal times, divided by the service headway. This is commonly referred to at the Peak Vehicle Requirement[2] (PVR). Typically, an allowance is made for spare trams as, at any point, a proportion of the total fleet will be undergoing routine maintenance or could be out-of-service for unplanned reasons (e.g. breakdown, accident). In the case of Edinburgh Tram two spare vehicles have been assumed.

2.27 The overall vehicle requirement, in each forecast year, has been calculated based on the service patterns and frequency assumptions described above. These are summarised in Table 2.5.

Table 2.5 Tram Vehicle Requirement]

Forecast Year	Airport – Newhaven	Haymarket to Newhaven	PVR (excl. spares)	Fleet requirement (allowing for spare 2 in maintenance)
2023	17 PVR (@ 8tph)	5 PVR (@ 4tph)	22	24
2032	16 PVR (@ 8tph)	9 PVR (@ 8tph)	25	27

2.28 JRC has worked closely with Edinburgh Tram and reached a position whereby in the intervening period between 2023 and 2031 further journey time savings will be possible (a further reduction of 1 minute on the end to end journey time). This coupled with a reduced turnaround time at the Airport from 12 minutes to 5 minutes will lead to a reduced PVR in 2032, such that the assumed service level can be operated with the existing tram fleet of 27 vehicles.

2.29 Edinburgh Trams currently has a total vehicle fleet of 27 trams, which were originally purchased as part of the procurement for the Line 1A scheme. We understand that Edinburgh Trams is currently utilising this entire fleet to operate the current tram service, ensuring operational rotation of the fleet and all vehicles are utilised (attempting to equalise the mileage operated by each tram) and adequately maintained.

[2] Source: PVR estimates provided by Edinburgh Tram August 2018.

Capital Costs

2.30 The out-turn capital costs for the Project are presented in Table 2.6. These represent the incremental additional infrastructure and further scheme development costs (client and contractor) required to deliver the scheme (see notes[3]).

Table 2.6 Capital Cost Profile (out-turn £m)

Cost Type	2019	2020	2021	2022	Total
Capital and Risk	35.7	70.1	54.7	28.0	188.6
Support for Business	0.7	1.2	-	-	1.9
Total – out-turn	36.4	71.3	54.7	28.0	190.5

2.31 Capital cost sensitivity tests are included within the Economic Appraisal (Chapter 6).

Operating & Maintenance Costs

2.32 Operating and maintenance costs have been estimated and provided by CEC. These represent the incremental operating costs that are additional to those for Phase 1 and are presented in Table 2.7 below.

Table 2.7 Project Incremental Operating Costs (£m p.a., 2017 prices)

Service Pattern	Project Incremental Operating Cost (2017 prices)
12 tph operating between Haymarket & Newhaven (2023 opening year assumptions)	5.75
16 tph operating between Haymarket & Newhaven (2032 second forecast year assumptions)	8.6

Costs are presented in 2017 prices but include real inflation between now the respective forecast years.

2.33 The costs include CEC's concessionary reimbursement payment for concessionary travel on the tram. Within the economic appraisal these are taken to be the net costs from additional public transport usage, as the concessionary payments from former bus users are included in the Do Minimum and, in economic terms, are transfer payments rather than costs.

2.34 CEC has prepared operating costs for a period up to 2054 (this is when the CEC financial modelling extends to). Beyond this, real increase in operating costs of 1% per annum has been applied throughout the remainder of the 60-year appraisal period. The 1% increase is consistent with the real increase within CEC's financial modelling.

[3] Notes on capital costs:

- The costs do not include any 'sunk' (i.e. wholly unrecoverable) costs that have been incurred as part of previous construction and enabling works, notably the diversion of utilities.
- There are no land acquisition costs associated with the Project.
- No tram vehicle cost estimates have been included, as Edinburgh Trams has sufficient vehicles to operate the Project, as the vehicle procurement was based on the full scheme to Newhaven.
- Costs exclude Optimism Bias, which is included within the economic appraisal.

Lifecycle Costs

2.35 Lifecycle costs have been estimated by Turner and Townsend (T&T). These have been included within the economic appraisal as these are used in CEC's financial model. This includes renewal and replacement of all system elements, including tram vehicle renewal.

2.36 The lifecycle costs included are consistent with the maintenance of the system performance through the 60-year appraisal period.

Table 2.8 Lifecycle Costs (£m over 60 years, 2018 prices)

	Project Lifecycle Costs
Cost (£m, 2018)	178.1

2.37 The estimates include a profiling of these costs over the 60-year period and are detailed within the T&T cost report. This profile is used in the economic analysis. A real increase in lifecycle costs of 1% per annum has been applied throughout the appraisal period.

Bus Network Recast

Principles of Developing an Integrated Tram and Bus Network

2.38 Lothian Buses, though majority owned by CEC, is a commercial entity in a competitive market acting at arms-length from its major shareholder. This has various consequences:

- Any assumed bus changes cannot be guaranteed to take place
- Another bus operator may commence services in the area, potentially in direct competition with Lothian Bus and/or Edinburgh Tram
- Lothian Buses has a competitive incentive to provide highly comprehensive services including in the Leith area

2.39 With that said, the Project provides an opportunity for Lothian Buses to recast parts of its network to complement and work with Edinburgh Tram.

2.40 The Project would provide a new high quality, high capacity public transport service operating on the Leith / Newhaven corridor. As such, this affords the opportunity to reconfigure the bus network to ensure that bus and tram services are better integrated with the aim of:

- Maintaining good overall public transport accessibility throughout the corridor
- Rationalising bus services where there is a duplication of bus and tram provision
- Realising bus operating cost savings where services can be rationalised[4].
- Ensuring the operational efficiency of both bus and tram within the Leith Walk / Newhaven corridor. A reduction in the number of bus services will support the delivery of faster journey times on both bus and tram, compared to those possible at higher frequencies, due to reduced bus congestion. This is achievable while increasing the overall public transport capacity of the corridor, due to the higher passenger capacity of a tram.

2.41 The bus network recast options also support the wider objectives of the City in respect of:

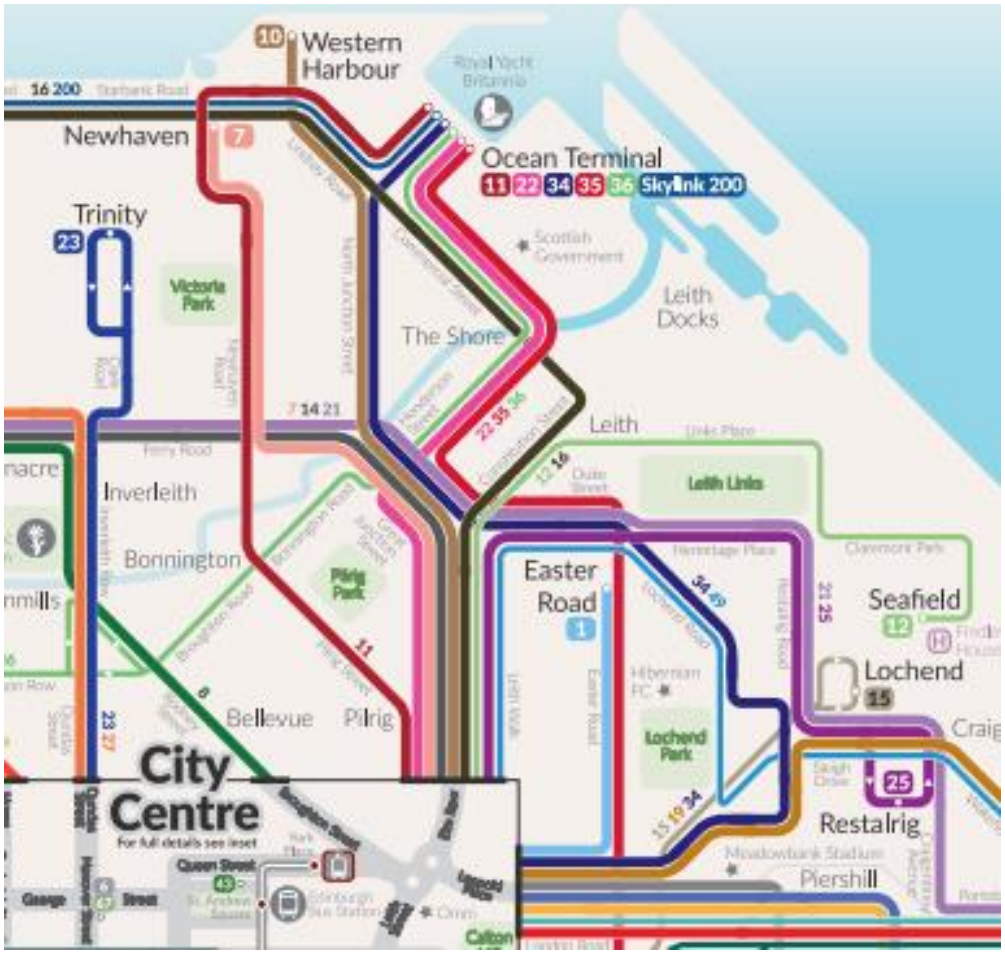
[4] For the purposes of the FBC these cost savings are included within the economic appraisal. In practice, the buses 'saved' could be redeployed on other parts of the bus network to provide new routes and services that support the City's wider objectives to support sustainable growth and encourage public transport mode share.

- **Promoting the integration of bus, tram and other modes**. The adopted Transport for Edinburgh Strategy for Delivery 2017-2021[5] states that 'TfE' (Transport for Edinburgh) will continue to support continued integration between bus and tram, including into areas of new development. The strategy identifies the role of network and service integration, enhanced and new modal interchange, integrated ticketing and travel information in supporting this.
- **Enhancing the quality of the environment and public realm within the city centre**. CEC has a stated ambition to enhance the overall quality of the city centre environment. This includes the ambition to reduce the number of buses running through the city centre, and along Princes Street. Tram offers the potential for a high quality, high capacity and zero emission (at point of use) mode that forms part of a range of measures to enable an enhanced city centre environment.

Current Bus Provision in the Leith/ Newhaven Corridor

2.42 The bus corridor between the city centre and Leith/ Newhaven is shown in Figure 2-6.

Figure 2-6 Current Bus Route Map



[5] http://transportforedinburgh.com/images/documents/TfE_Strategy_for_Delivery_2017_Final_Version_-_WEB_READY.pdf

Bus Service Levels

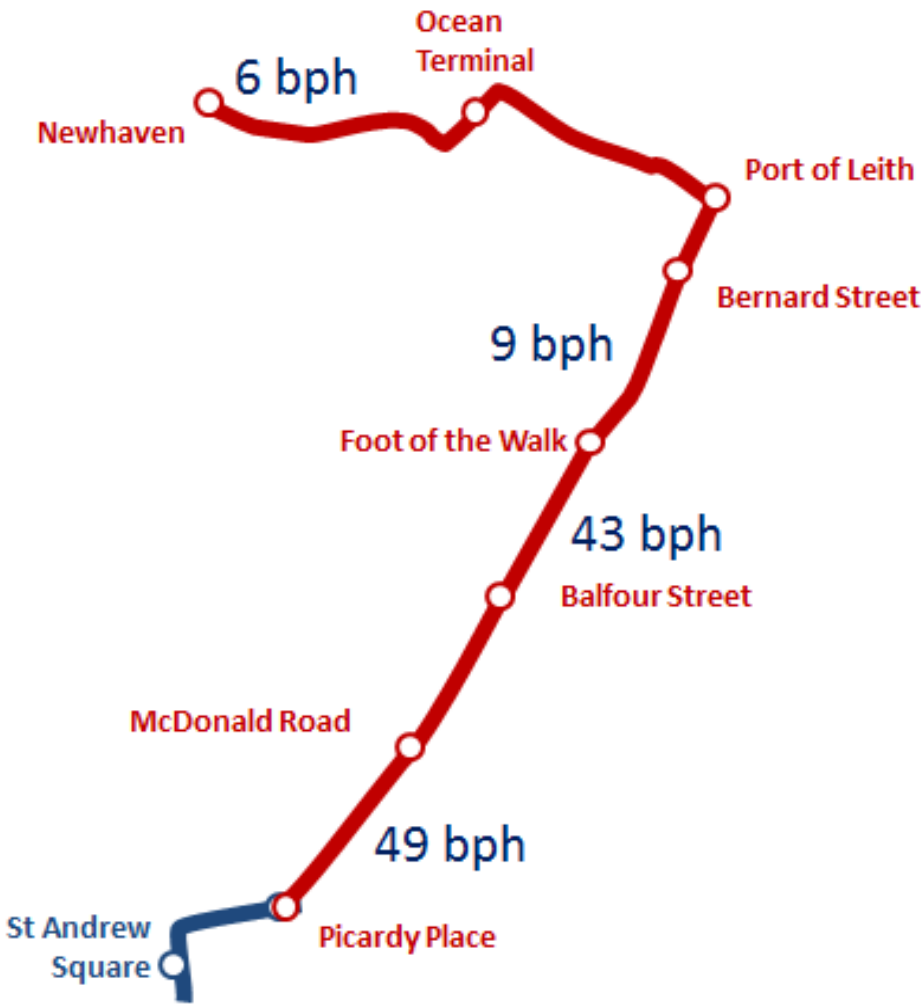
2.43 The peak level of service of bus services towards the southern (busiest section) end of the Leith corridor is shown in Table 2.9.

Table 2.9 Current Peak Bus Route Service Frequencies

Service	7	10	11	12	14	16	22	25	49	Total
Buses per Hour (bph)	5	6	6	3	5	6	8	6	4	49

2.44 The number of bus services that serve and broadly parallel the Project is shown schematically in Figure 2-7.

Figure 2-7 Current Bus Services serving the Project Corridor



Bus Recast Proposals

2.45 Within the FBC we have assumed a **'Central Case' recast option**, based on Lothian Buses 'with Tram' bus recast proposals, which were originally supplied as part of our earlier Project Option Assessment work in 2015. There has been no material change to the services provide on Leith corridor.

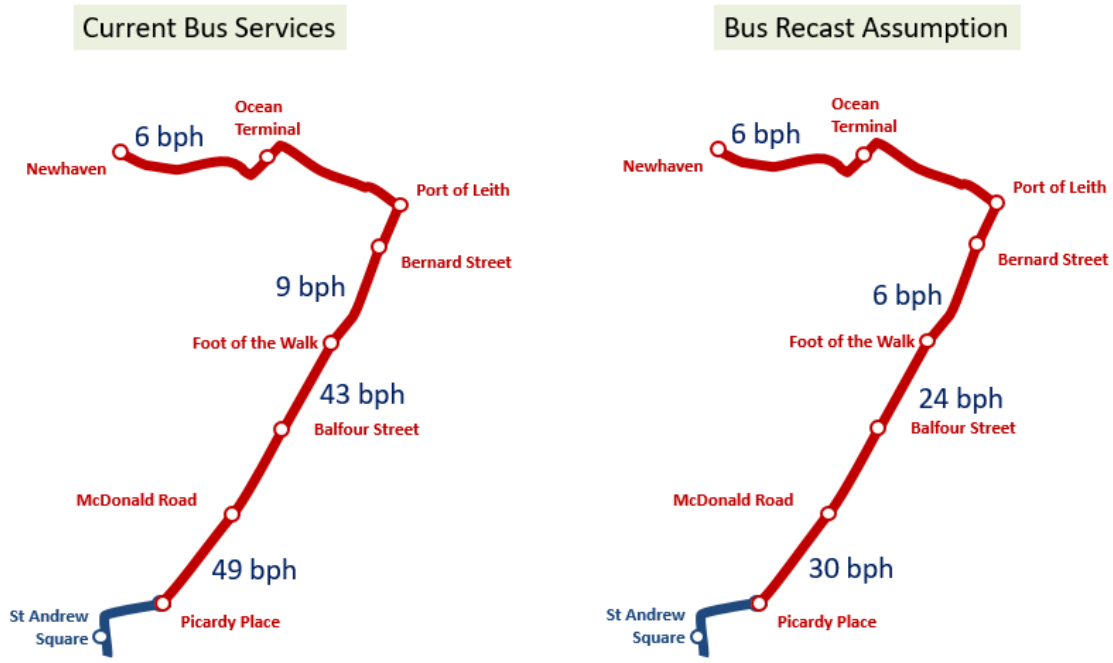
2.46 These are shown in Table 2.10.

Table 2.10 Proposed 'with Tram' Bus Recast

Central Case Recast
• Route 1 extended from Easter Road to Seafield (to replace route 12) • Route 10 diverted via MacDonald Rd and Bonnington Rd away from Leith Walk • Route 12 cancelled between St Andrew Square and Seafield • Route 16 diverted via The Shore and Henderson St away from Constitution St replacing route 22 • Route 22 cancelled between Leith St and Ocean Terminal • Route 25 diverted via Constitution St and The Links part replacing routes 12 and 16

2.47 The resulting changes in bus service frequencies resulting from the assumed recast are summarised in Figure 2-8

Figure 2-8 Bus Service Frequencies on Project under Bus Recast Scenarios



2.48 Under the recast the service frequency on the section south of Foot of the Walk reduces from 43 bph to 24 bph.

2.49 Under the Central Case recast the overall increase in public transport capacity is in the order of 30% on the section south of Leith Walk (where the most buses are removed) in 2022, and the capacity increase in 2032 (with 16 trams per hour) would be closer to 60%.

2.50 This suggests that there could be scope for further refinement and optimisation of the bus network once the tram is operational. The bus recast scenario represents an assumed reconfiguration of the bus network in conjunction with tram. While these are based on transport planning-led judgement, there has been no detailed testing, refining and optimisation the bus recast options. As such, it would be reasonable to assume that, with further refinement, the overall performance of the integrated tram and bus network (based on the trade-offs between coverage, frequency, capacity, and cost) could be enhanced through further detailed service planning in advance of opening.

2.51 The economic analysis presented in this report is based on the bus recast specification described above. The ability to test, refine and optimise the network, in the run up to and following implementation, represents a potential upside to the case presented.

Vehicle Requirement and Operating Costs Savings

2.52 The reduction in bus services under the recast scenario translates into a saving in the number of buses required.

2.53 Lothian Buses has provided the change in Peak Vehicle Requirement[6] (PVR) for each route and these values are shown in Table 2.11. The diversion of services 16 and 25 identified in Table 2-9 do not result in a change in the PVR, as these entail re-routing rather than extending current services. The other bus network changes do not alter the PVR.

Table 2.11 PVR Change under Central Case Bus Recast [7]

Route	Current Service Level	PVR Central Case	Central Case PVR
1	9	10	+1
12	7	5	-2
22	18	13	-5
Total			**-6**

2.54 This shows the PVR reduces by six buses under the Bus Recast. The reduction in PVR results in an associated cost saving. The cost saving per PVR has previously been advised by Lothian Buses, and this has been employed within the economic appraisal.

[6] Peak Vehicle Requirement – i.e. the number of buses operating on any given day to provide the planned service. The total fleet size will be somewhat larger as there is a need to cycle buses through depot workshops for planned maintenance

[7] As supplied by Lothian Buses (February 2015)

3 Forecasting Approach

Overview of Forecasting Approach

3.1 The JRC forecasting framework has been used to support the preparation of demand, revenue and benefit forecasts for tram since the mid-2000s. The models are updated and enhanced on a periodic basis to ensure the models are up-to-date and fit-for-purpose. The development of the FBC has included further enhancement to ensure the model framework is up-to-date and fit-for-purpose. These refinements are described in this section.

Overview of Approach

3.2 The forecasting model incorporates a series of sub-models which are run together to produce patronage and revenue forecasts.

3.3 The key elements of the forecasting models are:

- VISUM Network Model: This is the core model which forecasts patronage on the tram. It is a network model which forecasts mode choice across public transport and car modes separately for peak and off-peak. It also incorporates a demand and land use component which informs future year travel patterns;
- VISSIM micro-simulation models, which are used to represent and assess detailed junction and layout options along the tram corridor. These inform elements of tram design and are used to estimate tram journey times.
- The VISUM model is incremental using both observed and demand model matrices. To make best use of observed data, demand models are never used directly. Instead, the difference between the base demand matrix and the future demand matrix are added to the observed base matrix to create the forecast matrix used in the assignment, where *Future year demand = base observed matrix + (future demand – base demand)*
- The modelled time periods are an AM peak period (0700-0900) and an inter-peak period (1000-1200). An evening peak model is used to support micro-simulation analysis but is not used in the development of tram demand forecasts.
- Patronage & Revenue Model: This takes the final VISUM model demand and revenue outputs for public transport and produces a set of 'standard outputs' showing the change in tram demand, change in bus demand and more detailed information of segmented demand and line flows.

Recent Model Enhancements

3.4 The forecasts and appraisals in 2015 (Newhaven Options) and 2017 (Outline Buses Case for Tram Completion) were both independently reviewed, and each Review concluded that the forecasting approach and the forecasts were reasonable. The reviews also make specific recommendations, and our ongoing model development work has addressed specific points made as part of the independent reviews.

3.5 Key changes made to the forecasting models are listed below and described in more detail in the remainder of this chapter.

- Development of a fully updated 2016 base year to support the 2016 OBC, and used again for the FBC, comprising:
  - Calibration to new bus patronage counts in tram corridor
  - Calibration of highway demand to new count data in both the City Centre - Airport and City Centre - Newhaven corridors
  - Validation of model to observed tram demand data for 2016
  - Updating of tram journey times
  - Updating of bus journey times
- Revised forecast years of 2022 and 2032 with updated planning assumptions. These were fully reviewed again in 2018.
- Incorporation of recently introduced Lothian Buses services, including services 200, 300 and 400 which serve Edinburgh International Airport.
- The following bus routes have also been updated to reflect July 2018 service changes – 21, 29, 30, 34, 35, 37, 47.

Base Year Model Development, Calibration and Validation

Base Year Public Transport Networks

Routes and Services

- The bus network has been updated to reflect key summer 2018 service changes[8], including Lothian Buses services 200, 300 and 400 to the Airport.
- Changes reflect the First Bus withdrawal of services from East Lothian and their replacement with East Coast Buses routes
- The base year rail network was updated to 2016 service patterns. This includes the Borders Railway, Airdrie- Bathgate and enhancements to Edinburgh-Glasgow via Shotts services

3.6 It should be noted that Edinburgh Gateway is excluded from the base year models with neither trains nor trams serving this station. The Edinburgh Gateway stop opened in early December 2016; however, tram patronage data used for the model recalibration predates this. Edinburgh Gateway is represented in all future year models.

Base Year Bus Journey Times

3.7 JRC has used real time bus information (API data) to obtain bus journey times for a range of bus routes. A bespoke programme was used to record bus arrival times at stops for several services along Leith Walk and the Airport to City Centre (existing tram) corridor. Journey times were obtained over a period of weeks during February and March 2017. These were then analysed to provide observed AM peak period (0700-0900) and inter-peak period (1000-1200) journey times to be used in the base year and future year JRC demand modelling.

[8] The major changes as per the link below (including the re-introduction of Service 35 but now serving Heriot-Watt University) were made, not every single service route in the model.
https://www.lothianbuses.com/news/2018/07/service-change-29-july/

Base Year Tram Journey Times

3.8 Edinburgh Trams has implemented measures which have significantly improved journey times over the last couple of years, and the current timetabled end-to-end journey time is around 37 minutes. JRC obtained actual tram journey times during April 2018. These data were used to update base observed tram journey times for input into the peak and inter-peak JRC models. The analysis showed that the average tram journey times is around 37.5 minutes, in line with the timetabled time of 37 minutes.

Base Year Highway Networks

3.9 The Base year highway network is largely unchanged from the previous model iteration. City centre coding was updated in 2015 to reflect the introduction of tram with link capacities, junction layouts and signal timings adjusted accordingly. This has been reviewed and updated based on minor changes implemented since then to accommodate a standard 7.5-minute tram headway throughout the day. VISUM coding is based on associated city centre VISSIM micro-simulation models which were used to inform Edinburgh Trams in the development of latest January 2017 tram timetable.

3.10 Models incorporate additional network coverage and a disaggregated zone system, implemented as part of the West Edinburgh Transport Appraisal study. Additional detail was focussed on the rural West Edinburgh area, near the Airport, where significant future development is expected. Elsewhere, junction coding has been standardised across the city to ensure all traffic signals use actual signal time data rather than a default node delay function.

Base Year Demand

Base year bus demand

3.11 As part of the OBC bus occupancy surveys were undertaken to provide an up-to-date understanding of bus demand volumes within the Newhaven corridor. The survey was completed on behalf of JRC on Thursday 9th February 2017, at five sites on the corridor. The observed data was used to inform the bus volumes for the time periods that correspond to the JRC models, namely the AM Peak (07:00 – 09:00) and inter-peak (10:00 – 12:00).

Base year tram demand

3.12 Base year observed tram demand has been obtained from Edinburgh Trams. This includes:

- Annual data for the 2016 base year and full year 2017, which breaks demand down into premium (Airport) and other (remainder of corridor) demand, and provides boardings by stop.
- More detailed 2017 and 2018 data on tram demand by time-period (to inform updated annualisation) and demand within 15-minute time-slices (to inform capacity analysis)

Base year highway demand

3.13 The highway models have been updated periodically since 2015 to support CEC in is assessment of strategic and local development proposals. These updates include calibration of highway demand to new count data, notably:

- Transport Scotland data (2016) city-wide supporting air quality analysis
- Edinburgh St James data (2014) York Place - McDonald Road
- WETA data (2016) Newbridge to Maybury

- Leith Walk (2012), and
- Other CEC count locations (2012-2016)

3.14 The highway model was fully recalibrated in spring 2017 to support the tram OBC. No further update has been undertaken as part of the FBC modelling.

Base Year Recalibration

3.15 The base year public transport model was recalibrated to 2016 demand; this included several additional counts in north Edinburgh along the route of the tram.

3.16 At a network level, the overall bus demand within the model has been constrained to a series of screenline counts. Rail demand has been constrained to count data on all major routes to Edinburgh Waverley / Haymarket. By contrast, base year tram demand is wholly forecast by the VISUM model as part of the public transport assignment. No count data is included in the model and demand has been validated to available patronage data.

3.17 Although the demand model has not been recalibrated as part of this limited model update, trip ends have been revised, incorporating the latest CEC development assumptions. Elsewhere, TELMoS forecasts are unchanged from the 2017 OBC.[9]

3.18 Base year highway demand has been developed from the original (2006) prior matrices and adjusted using matrix estimation techniques. Traffic growth in the city centre and Leith corridors has been very limited over the period. More significant growth has occurred on arterial routes and the City Bypass.

3.19 As noted above, best use has been made of new count data undertaken across the city centre. For this model update, a key focus has been to ensure accurate highway model calibration along the York Place to Newhaven corridor and in the city centre. For this, recent data is available for all major junctions between York Place and the Foot of the Walk.

[9] Trip End Summary Technical Note 140918

Forecasting Parameters

Behavioural Parameters

3.20 The behavioural parameters used in the transport models are shown in Table 3.1.

Table 3.1: Public Transport Generalised Cost Parameters

Parameter	Previous Value	Source	Update Made for this Work
Value of Time	4.76 pence per minute (in 2005 prices)	Stated Preference	Uprated to 2018 prices[10].
Value of walk time	1.91 * IVT	Stated Preference	No change assumed
Value of wait time	2.55 * IVT	Stated Preference	No change assumed
Interchange penalty	12 minutes and 13 seconds per interchange	Stated Preference	No change assumed
Modal constant (applied as factor in in-vehicle time)	0.77 * IVT	Stated Preference	No change assumed
Operator change penalty	16 minutes and 48 seconds	Fare difference between operators	No change assumed as relates to a small proportion of trips

Commentary on Modal Constant

3.21 The modal constant is used to reflect and represent (in the modelling) the inherent benefit that passengers perceive for one mode over another, after allowing for all the travel time-related attributes (averaging waiting time, journey time etc.).

3.22 For tram the benefits over bus reflect 'non-time' based attributes, including:

- Smoother ride quality
- More attractive travel environment (at stops and in-vehicle)
- Greater reliability (less journey time variability)
- Greater certainty (fixed alignment provides confidence to travellers about routes and destination)
- Better information provision (real time information) and security at stops
- Presence of conductors

3.23 The modal constant for Edinburgh tram is based on Stated Preference (SP) research conducted in 2005. This work informed the development of a modal constant for tram of a 0.77 in-vehicle time factor (whereas the factor for bus is 1). This means, for example, that for a 20-minute tram journey this implied modal constant is 4.6 minutes (or just over 2 minutes for a 10-minute journey, and 7 minutes for 30-minute journey).

3.24 UK Tram research[11] showed that the mean value of 10.6 minutes (tram preference over bus) and median of 8.6 minutes (p48). The same research showed the constant used in the forecasting of

[10] Applied to all public transport users

[11] Support to UK Tram, Activity 7 Work Group "Benefits Involved in Appraisal Process", Analysis of Quantitative Research on Quality Attributes for Trams, 2009. Summary of modal constants on p48.

Edinburgh Tram was as the bottom end of range values for UK tram systems. This suggests that the constant employed for Edinburgh tram is a key potential conservatism within the overall economic appraisal.

3.25 Since the tram opened in June 2014, there are compelling reasons to suggest that people's positive perception of tram is significantly greater than the level implied by the constant based on the 2005 work.

3.26 In 2017 Transport Focus published a Tram Passenger Survey showing that passengers rate Edinburgh Tram highly with a satisfaction score of 99% compared with 97% in 2015, which is consistent across all passenger groups.

3.27 Some further key findings include that passenger satisfaction with both the length of waiting time and the punctuality of the tram remain very high, with 94 per cent of passengers satisfied with both factors (an increase from 91 per cent and 93 per cent in 2015). The satisfaction of passengers in terms of on-vehicle journey time and punctuality has again improved to 92% and 94% compared with 89% and 93% in the previous 2015 survey.

3.28 The number of first-time users has increased since last year, with 18 per cent of passengers being first time users in 2016 compared to 13 per cent in 2015. In terms of journey purpose more than half of passengers (57%) were travelling for a leisure journey and just under a third using Edinburgh Trams to commute (31%) and 12% using Edinburgh Tram for business purposes.

3.29 The Passenger Focus research also highlighted that Edinburgh has the highest level of satisfaction with staff and drivers amongst UK systems. It is likely that the presence of conductors significantly enhanced satisfaction. The constant based on the SP research takes no explicit account of the benefit of having conductors on board[12].

3.30 Taken together, the evidence above suggests that the modal constant to be applied for the purposes of tram demand and benefit forecasting may understate the benefits of tram.

3.31 Previous audits of the Edinburgh tram business case suggested there would be benefit in undertaking revealed preference surveys of current tram users to better understand the geographic composition of demand (i.e. final origin and destination, demographic profile), and their modal preferences. We have not, within the timeframe of this commission, been able to undertake such surveys, but continue to recommend that this is carried out in the future.

Awards in the Light Rail Sector

3.32 For the third time Edinburgh Tram has won the "Operator of the Year" award at the Global Light Rail Awards 2018. Edinburgh Tram was recognised in all four of the categories shortlisted for being highly commended in environmental & sustainability, most improved system and technical innovation infrastructure.

3.33 Edinburgh Tram has previously won Operator of the Year in 2015 and 2017 with criteria covering excellence in safety, customer experience, corporate values, as well as a proven record in reliability and financial performance.

3.34 Lesley MacInnes, Transport Convenor and Chair of Transport for Edinburgh, recently stated:

[12] The Stated Preference (SP) report did not include conductors in the 'choice' options presented to respondents as part of the SP research.

"Another excellent win for Edinburgh Trams – to be awarded 'Operator of the Year' for the third time is a testament to the service's efficiency, reliability and value to the people of Edinburgh. This success is thanks to the hard work and dedication of the team behind Edinburgh Trams."

3.35 This is again further anecdotal evidence that suggests that the modal constant to be applied for the purposes of tram demand and benefit forecasting may understate the benefits (success) of tram in Edinburgh.

Public Transport Fares

3.36 Public transport fares are based on 2018 fares, from which the average yield[13] (calculated separately for Airport and non-Airport trips) is derived based on information provided by Edinburgh Trams. Public transport fares are assumed to increase by 1% per annum in real terms, such that the cash fare of £1.70 in 2018 translates to a fare of £1.95 by 2032. The assumption on real increases is consistent with that employed in the CEC financial model.

Table 3.2 Public Transport Fare Assumptions

	2018 Actual		2023 Forecast		2032 Forecast	
	Cash fare	Avg yield	Cash fare	Avg yield	Cash fare	Avg yield
Bus / tram - corridor	1.70	1.20	1.77	1.25	2.03	1.44
Bus - Airport	4.50	4.10	4.68	4.27	5.38	4.90
Tram - Airport	6.00	5.13	6.24	5.33	7.18	6.13

Public Transport Revenues

3.37 The revenues within the economic appraisal are calculated based on the average yields above.

Values of Time

3.38 Within the model a single value of time is applied to all public transport trips. Within the transport model the value of time has been uplifted from the 2005 stated preference value to a 2016 value, to be consistent with the prices within the model. The value of time per person has been uplifted to 2016 prices, using a GDP deflator in line with WebTAG unit A1.1, section 2.6. The transport model has not been recalibrated for the FBC. WebTAG values reflect the July 2016 data book, as applied in the OBC analysis.

Vehicle Operating Costs

3.39 Vehicle operation cost values are based on WebTAG guidance (data book; Tables A1.3.7, 1.3.9, 1.3.11 and 1.3.15). The Retail Price Index is based on values from the Office of National Statistics.

[13] Yield represents the average revenue per trip which accrues to the operator of a system. The average yield takes account of period tickets (season tickets, travelcards), and concessionary travel (which is reimbursed at a level below the full fare equivalent) and therefore the average yield is less that the single cash fare.

City Centre Parking Charges

3.40 Parking charge is calculated as a deterrence function in the development of the mode choice model. The distribution / mode choice model has not been recalibrated at this stage and parking charges remain unchanged. Charges are not used directly in the assignment.

Forecasting of Future Years

3.41 The reference case scenario provides the future assumed levels of overall demand and changes in the transport network in the absence of the intervention being tested. The reference case therefore provides the counter-factual comparator against which the impact of the Tram Completion Project is assessed.

3.42 Two forecast years have been developed. These are:

- 2023 to represent the Project opening year.
- 2032 to be consistent with the horizon year for the Council's long-term planning assumptions.

Future Year Reference Case – Demand Assumptions

3.43 The development of the revised future year matrices has been consistent with the methodology developed for all previous forecasts. This includes representation of 'general' growth, to which the overall forecasts are constrained, and specific representation of key development sites. Major development proposals in Edinburgh have been identified by the Council, together with an estimate of the proportion of development forecast to be complete in each year.

Demand Growth Assumptions

3.44 The City of Edinburgh Council (CEC) VISUM model has been updated with new ("more than likely") planning data provided by the council to support the FBC. Data has been collated into anticipated development totals in forecast model for the forecast years of 2022 and 2032.

3.45 Information has been provided for major development sites across the city, including office, education, retail and commercial / leisure. Detailed information on housing development has also been captured, including all sites with greater than 50 units.

3.46 We reviewed the growth assumptions and 2018 development data, provided by CEC, was found to be consistent with that provided to Transport Scotland / Scottish Water. It includes likely build out rates for housing and a list of other commercial sites with planning consent (but not programmed).

3.47 Key developments which may directly benefit tram demand include:

- Edinburgh St James
- Haymarket
- Edinburgh Park
- International Business Gateway (IBG), and
- Leith / Western Harbour

3.48 Other important sites driving growth across the city include Waverley Gate, Quartermile Fountainbridge and development at Heriot-Watt and Edinburgh Universities and the city's BioQuarter.

3.49 Development sizes and build out rates are generally consistent with the previous OBC. There are, however, a couple of significant changes which have the potential to alter forecast tram demand, as discussed below:

- IBG1 and IBG2 – These sites were previously considered to be mixed use with a significant housing allocation across each. The focus at these locations is now around office and commercial development. The view of the Scottish Government is that IBG is a National Development with housing being subordinate to the primary role of business-led growth supporting strategic airport enhancement.
- Housing has now been omitted from these zones, in addition the percentage of office and commercial development space completed by 2032 and has been reduced slightly, reflecting the later start in developing these sites
- Leith Waterfront – this is now housing led, with a reduced emphasis on mixed use development. Although a mix of office, hotel and retail space is preferred, to date there has been limited uptake by the market for those uses.

3.50 Outside of Edinburgh, future year forecasts of background demand growth are based upon the latest available Transport Model for Scotland (TMfS) data. There is a high degree of consistency between TMfS and the CECs assumptions.

3.51 A separate technical note has been prepared setting out the detail of the development assumptions and their representation within the transport modelling. The resulting trip end totals for each forecast year are summarised in Table 3.4

3.52 Table 3.3 and Table 3.4

Table 3.3 Households Trip Ends by Area for 2016 and 2022 / 2032 Forecast Years, and percentage change

Households	2016	2022	2032	% change – 2016 to 2022	% change – 2022 to 2032
Edinburgh (total)	233,504	247,155	268,516	5%	9%
City Centre	13,317	14,344	15,068	8%	5%
Edinburgh Park	1,759	2,983	4,443	70%	49%
Leith	21,788	22,110	22,550	3%	2%
Leith Docks / Western Harbour	4,052	5,568	9,216	26%	66%

3.53 The scale of housing development in Leith Docks / Western Harbour is largest, overall. This is shown in the area labelled Leith Waterfront in Figure 3.1,

The largest increase in households, in percentage terms, is around Edinburgh Park. Compared with the OBC, there is now a focus on the delivery of a mixed-use development of housing, office and commercial space rather than the previously consented focus on office only.

3.54 Table 3.4 presents total employment by areas for the forecast years 2022 and 2032.

Table 3.4 Total Employment Trip Ends by Area for 2016 and 2022 / 2032 Forecast Years, and percentage change

Employment	2016	2022	2032	% change – 2016 to 2022	% change – 2022 to 2032
Edinburgh (total)	286,304	287,671	307,361	0%	7%
City Centre	61,290	64,404	69,276	5%	8%
Edinburgh Park	31,338	31,385	40,484	0%	29%
Leith	22,230	21,110	20,115	-5%	-5%
Leith Docks / Western Harbour	8,433	7,949	7,053	-6%	-11%

3.55 There is significant employment growth forecast across Edinburgh of over 20,000 jobs in total. At Edinburgh Park, jobs are forecast to expand significantly (+9,000 jobs from 2016 levels) based on both new development and more efficient use of existing office space. The city centre will also experience a significant increase in employment (+8,000 jobs).

3.56 Employment is forecast to decline outside of strategic employment areas (such as the city centre and Edinburgh Park) where residential development will be the focus of future development (e.g. Leith Waterfront is forecast to reduce employment over the period where it experiences significant planned housing growth).

3.57 The development of Leith Waterfront therefore has an important role to play in mitigating the increase in in-commuting, by providing new dwellings on brownfield sites within the City with good public transport access to the city centre and Edinburgh Park. This role would be enhanced through the development of the Project by improving public transport accessibility and helping to bring forward developments at a potentially faster rate and higher density than would otherwise be the case.

3.58 Within the economic appraisal, a sensitivity test has been undertaken to consider the impact of lower future growth in the Leith Waterfront area (See Chapter 5).

Future Year Reference Case – Network (Supply) Assumptions

3.59 The 2022 and 2032 forecast years assume the interventions described below are in place.

Reference Case Network Changes

3.60 The following schemes have been represented in the Reference Case network:

- A new tram stop at Edinburgh Gateway opened in 2016 and provides interchange with rail services; half hourly service by trains operating on the Fife Circle Line and hourly services by trains operating to and from more northerly destinations.
- The Queensferry Crossing opened in 2017 (the long-term main crossing of the Firth of Forth). The crossing and associated access roads is included in the 2022 and 2032 models.

Leith Programme and City-Wide 20mph Zone

3.61 There are two transport initiatives that will affect the operations of tram and all other transport users in both the reference case and do something scenarios. These are the Leith Programme of public realm enhancement along Leith Walk and the phased introduction of 20mph zones across the city, including along the length of Leith Walk.

3.62 The Leith Programme and 20mph zones are both part of a range of transport initiatives that seek to prioritise public realm, walking, cycling and public transport and to reduce the impact of motor vehicles (see box overleaf).

3.63 The text presented below is taken from the Edinburgh Local Transport Strategy 2014-19 and sets out the specific measures in the City Centre and Waterfront areas that have been identified to support the vision of a growing, more sustainable Edinburgh.

Figure 3-1: Policy Context for the Development of Tram – City Centre & Waterfront

Policy Context for the Development of Tram – City Centre & Waterfront

The City Centre

Edinburgh City Centre forms the commercial heart of south east Scotland and indeed the entire country. It is a centre for finance and business, retail, entertainment, tourism and Leisure. Its World Heritage Site status provides unique opportunities and challenges.

However, City Centre streets are still dominated by motor traffic. Completion of the first phase of the Tram project presents a great opportunity to change this. With this in mind, the Council is taking forward a plan to:

- improve the pedestrian experience in the core City Centre area and increase space for pedestrians;
- improve access to the City Centre;
- increase space for other uses (e.g. street cafes, entertainment, markets);
- offer dedicated cycle provision in the area; and
- reduce the detrimental impact of motor vehicles on the City Centre environment.

Growth areas out-with the City Centre - The Waterfront

Out-with the City Centre, Edinburgh's growth is focussed in three areas, West Edinburgh (including Edinburgh Park/Gyle and the Airport area), South East Edinburgh and the Waterfront. To grow in a way that protects the city's environment, these areas need supporting transport investment focussed on public transport, walking and cycling. In West Edinburgh, the Tram is the core of this investment package. Tram extensions could also play a similar role in other areas.

Improved transport connections will drive the renewal of Edinburgh's waterfront. Much of the required urban infrastructure is already in place, but improved connections to the City Centre are needed to unlock the area's sustainable regeneration. Key future projects include:

- measures to support growth in walking, cycling and bus use, through priority at junctions and new and improved links;
- improving public realm, including completing the Waterfront Promenade, with an interim inland section through Leith via the North Edinburgh Path Network[14];
- infrastructure to meet the requirements of the off – shore renewables industry; and
- potentially extending the Tram to Leith and Newhaven (for which the Council has Parliamentary powers).

[14] CEC initiative to promote sustainable travel in the city by either walking or cycling on designated 'quiet routes'.

Leith Programme

3.64 The Leith Programme covers environmental improvement work being carried out on Leith Walk, Constitution Street and Picardy Place and surrounding streets. These include:

- improving pavements and better streetscape
- improvements for cyclists, including dedicated and mixed-use lanes
- more greenery and less clutter

3.65 The works include:

- junction signal improvements
- road resurfacing and pavement replacement
- reinstating public artworks

20mph Zones

3.66 The City of Edinburgh approved a new speed limit network for Edinburgh at the Transport and Environment Committee on 13 January 2015, after three years of research and public consultation. The purpose of the new speed limits / zones is to reduce the risk and severity of collisions, and to encourage people to walk and cycle and spend more time in an area.

3.67 Key features of the network are:

- Residential roads, shopping streets as well as the city centre are included as 20mph roads
- The retention of a coherent and connected network of 30 mph and 40 mph roads.

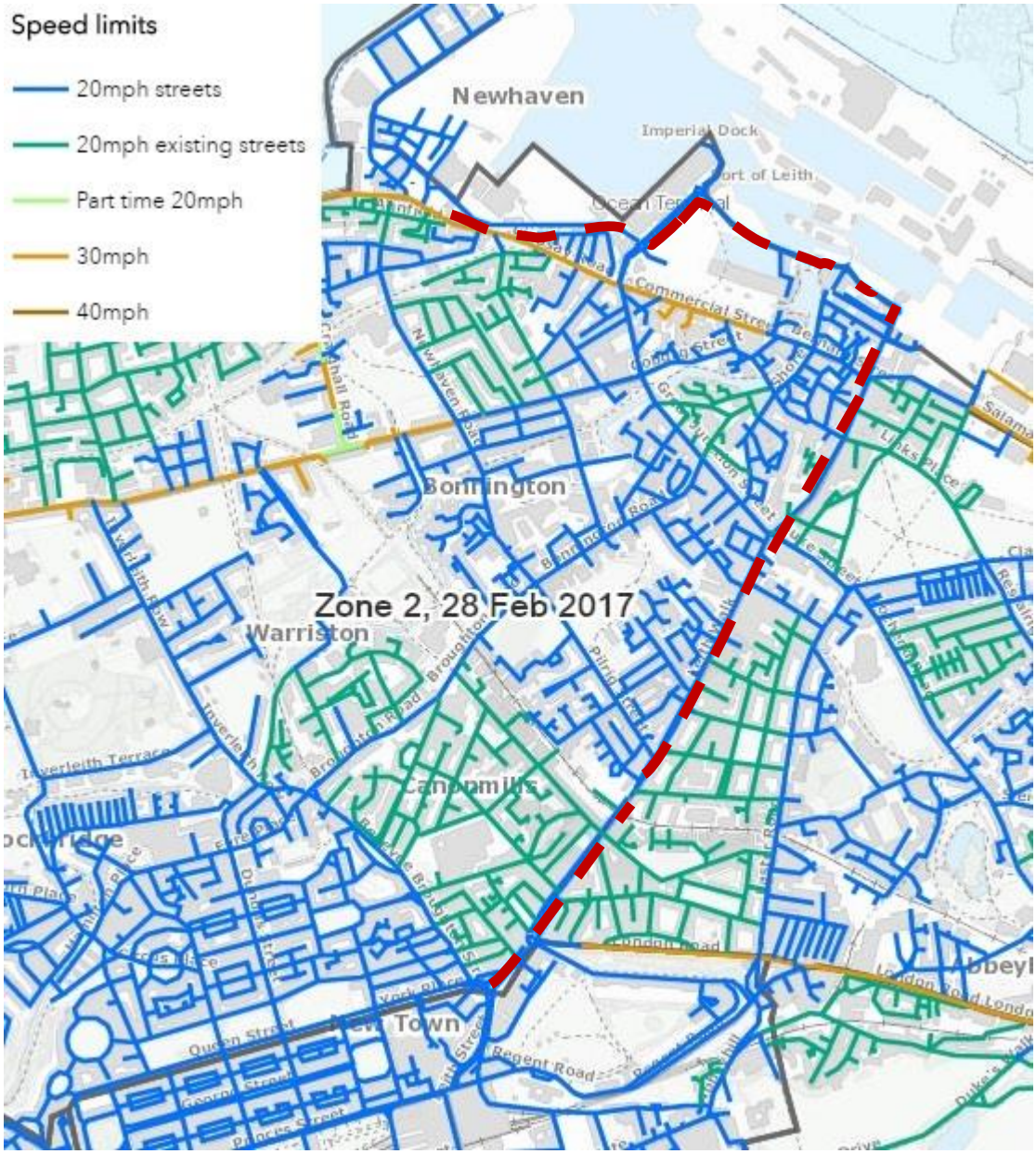
3.68 The 20mph zones are being implemented in phases, and the final phase of the 20mph network came into effect on 5 March 2018[15]. Tram journey times have been estimated in accordance with the speed limits dictated by the 20mph policy.

3.69 Leith Walk is part of the 20mph zone, while parts of the proposed tram York Place to Newhaven route remain at the previous 30mph limit[16]. This is shown in Figure 3-2.

[15] http://www.edinburgh.gov.uk/info/20243/20mph_for_edinburgh/1024/about_20mph_for_edinburgh

[16] http://www.edinburgh.gov.uk/info/20243/20mph_for_edinburgh

Figure 3-2 Proposed 20mph Zones (Tram Route shown as dashed line)



Forecasting of Public Transport Benefits (with Tram)

3.70 The overall public transport benefits and hence economic performance of the tram projects are driven by the relative attraction of tram versus existing / competing modes, which within the Leith corridor is exclusively bus. This section describes the modelling and forecasting approach and representation of the relative attractiveness of tram and bus.

Tram and Bus Forecasting Assumptions

3.71 The forecasts for the Edinburgh Tram Completion Project have been based on:

- The tram frequency assumptions set out in Table 2.2 and Table 2.3. This provides for 12 and 16 tph in 2022 between Newhaven and Haymarket respectively, of which 8 would run through to the Airport (the remainder turn-back at Haymarket)
- Tram journey times as set out in Table 2.4.
- The behavioural parameters used in the transport models are shown in Table 3.1.
- Parity with bus fares except for trips to and from the Airport (where both bus and tram fares are at a significant premium). These are set out in Table 3.2.
- A bus network recast as per Table 2.8.
- Bus journey times based on observed 2017 bus times.

3.72 The comparative attractiveness of tram and bus takes account of each of these journey attributes and converts them into a single measure of generalised journey time (GJT). In broad terms, the greater the GJT advantage for tram over bus for a given trip/ movement, the higher the mode share tram will attract.

Basis for Forecasting Public Transport User Impacts

3.73 Public transport user benefits have been forecast in VISUM for each of the two forecast years. The Department for Transport's (DfT's) Transport User Benefits Assessment (TUBA) has then been used to profile these benefits over the 60-year appraisal period.

Forecasting of Highway Impacts

3.74 The approach to the estimation of highway impacts is identical to that developed for the OBC. We have not modelled highway impacts within a transport network model. As noted above, there are a range of policy-led initiatives (e.g. 20 mph zones, Leith Programme, further public realm enhancement) which together seek to re-prioritise the Leith Corridor and City Centre in favour of pedestrian, cycle and public transport movements, and to moderate the impacts of car.

3.75 The tram designs have been developed to integrate with, and to support and enable, this overall ambition. Indeed, the further consultation, design and development of the tram alignment undertaken to finalise the FBC design reflects the desire to provide priority to pedestrians and cyclists.

3.76 If the Tram Completion Project were not to proceed, an alternative corridor treatment would need to be developed that adhered to the policy objectives. However, there is not a detailed set of 'Reference Case' assumptions of how the cycling, walking and public transport would be prioritised in the absence of tram. This reflects the imperative of developing an integrated and deliverable solution as part of the Tram Completion Project, rather than postulating how the corridor might be developed in the absence of tram.

Factors Affecting Highway Impacts

3.77 The introduction of tram will have counterbalancing effects on the highway network and on associated impacts on remaining vehicular traffic. These are:

- The Project will be associated with a **reduction in highway capacity** in some cases. These include:
  - The Leith Programme is a 'Reference Case' project which has been developed to improve pedestrian and cycling provision on Leith Walk. Key features are widened footways and cycle-ways and a corresponding reduction in carriageway width. The proposed tram design has been revised to minimise the need for further changes to footway and kerb positions. To achieve this, it is proposed that parking and loading will be prohibited on Leith Walk at peak times. Two lanes will be available in each direction; general traffic and buses will be permitted to use the nearside lane with trams and buses only permitted in the outside lane. In the inter-peak and off-peak periods, parking and loading will be permitted in the nearside lane, with all traffic sharing the single available offside lane with tram.
  - Conversion from two-way to one-way operation at key sections on the route.
- The Project will **change the traffic composition in the corridor**. While there will be tram vehicles introduced into the corridor, this will be offset by a reduction in bus and car traffic, such that the net effect is likely to be an overall reduction, albeit modest, in traffic volumes along the corridor, once the tram is implemented. With the tram in place there will be 12 tph trams along Leith Walk and a reduction in the number of buses per hour from around 46 to 23 on Leith Walk between Pilrig Street and Foot of the Walk[17]. The proposed frequency of tram is planned to be further enhanced by 2032 to 16 tph. To accommodate future demand, it is likely that future bus capacity would also need to increase by a corresponding amount in any 'Reference Case' scenario.
- Tram will also result in **a reduction in cars along the corridor because of modal shift** – this is likely to be modest, reflecting the already dominant position of public transport (bus). The impact of the Leith Programme and 20mph zone, as well as the broader policy to further prioritise non-car modes in the city centre and key radials, could reasonably be expected to further reduce highway demand in the corridor, meaning that fewer cars would be affected by tram and the background congestion levels would be lower (than in the available models).
- The Project can **support more sustainable patterns of land use and transport** through supporting more sustainable development in the Waterfront Area. The policy rationale for the tram options to Newhaven and Ocean Terminal is to serve and support the planned new (largely residential) developments along this section of Leith Waterfront. The presence of tram will influence both the travel behaviour of new residents and potentially the scale and density of new development. Residents in planned developments along Leith Waterfront are, with tram, likely to have a higher propensity to use public transport and a correspondingly lower propensity to use car. This is not captured in our current forecasts - which will therefore understate public transport benefits and overstate highway disbenefits. The proposed Tram route may also affect the nature, scale and timing of development. The

[17] This is based on a Lothian Buses paper provided to JRC to inform our 2015 Newhaven Options Assessment, detailing possible bus net frequencies post York Place to Newhaven. These are shown in Tables 2.8 to 2.10.

presence of a high capacity high quality tram system will help encourage developments at higher densities and with less provision for parking.

Basis for Forecasting Highway User Impacts

3.78 Our approach, recognising a degree of uncertainty around the highway impacts, is to present the economic appraisal based on a range estimate of likely outcome values. This is the same approach as adopted for the 2017 OBC.

3.79 These are:

- A 'central case' where non-user dis-benefits are equivalent to 10% of public transport benefits.
- An 'optimistic' case, with non-user impacts at zero. This is in line with findings on other UK tram systems.
- A 'pessimistic case' with non-user impacts at a level of dis-benefit equivalent to 20% public transport benefits of range.

3.80 The treatment is shown illustratively in Table 3.5 below.

Table 3.5 Highway Impact Range Estimates

	Central	Upside	Downside
Public transport benefit (illustrative)	100	100	100
Highway Impact - disbenefit	-10	0	-20

3.81 These range estimates are presented in Chapter 5 (Sensitivity Testing).

4 Demand, Revenue & Benefit Forecasts

Overview

4.1 This chapter presents the demand and revenue forecasts for the Tram Completion Project, based on the modelled time periods (morning peak and inter-peak), and presents annual demand and revenue forecasts.

4.2 The modelled demand is prepared for two forecasts years – 2023 (the proposed opening year) a second forecast year of 2032. The annual forecasts are based on:

- The application of annualisation factors to growth modelled period demand to annual demand. The annualisation factors reflect the usage profile on the existing Phase 1 (Airport to York Place) Edinburgh Tram route, as described below.
- A straight-line interpolation between 2022 and 2032 to obtain annual 'modelled' demand for the Tram Completion Project.
- Adjustment to the 'modelled' demand to reflect:
  - Demand 'ramp-up' on the York Place to Newhaven section of the line. Inclusion of demand 'build-up' to represent the period in the early years when people get accustomed to the tram, and hence demand 'builds up' to its potential level.
  - Demand build up is assumed to be 80% in the year of opening, increasing to 90% in year 2 and 100% three years after.
- Patronage growth from 2033 to 2052 is assumed to be 1% per annum. No demand growth is assumed beyond 2052 (i.e. demand over the second half of the 60-year appraisal period is assumed to be constant).

Real increase in revenues over time at a rate of 1% per annum (consistent with the assumption employed on fares).

Annualisation

4.3 Annualisation factors are used to convert model time-period demand to annual demand totals. JRC has updated the Edinburgh Tram annualisation factors based on observed tram usage profiles for the full year 2017.

4.4 Data was provided for ten different 'time slices' within each week day (over the c. 19 hours of operation), and the equivalent for weekends. This enabled the relativity to be derived between the average demand corresponding the respective peak and inter-peak model 2-hour periods, and peak / off-peak demand over the year.

4.5 The peak and off-peak annualisation factors, and their derivation, are summarised in Table 4.1 and Table 4.2.

Table 4.1 Peak Annualisation Factor

AM Peak Annualisation	Calculation	Demand/ factor	Time Period
Observed data, over 'modelled' 2 peak hours	a	3,417	Observed data 0700-0900
Annual observed data over peak period (3-hour morning peak and 2-hour evening peak)	b	2,227,285	Observed data 0700-1000,1400-1800, week days
Annualisation	**b/a**	**652**	

Table 4.2 Off Peak Annualisation Factor (based on sample profile data)

Off-Peak Annualisation	Calculation	Demand/ factor	Time Period
Observed data, over 'modelled' 2 inter-peak hours	a	2,229	Observed data 1000-1200
Annual observed data over week-day inter-peak and off-peak	b	4,063,455	Observed data: weekdays 0400-0700, 1000-1600, 1800-2359, plus weekends
Annualisation	**b/a**	**1823**	

Tram Completion Project Demand Forecasts

4.6 The model period and annual demand forecasts for the existing system and the Tram Completion Project are summarised below.

Modelled Period Demand Forecasts – Tram Completion Project

4.7 A summary of the incremental demand for the Project is provided in Table 4.3, for 2023 (scheme opening year) and 2032.

Table 4.3 Edinburgh Tram Phase 1 and Project Forecast Demand (2023 & 2032)

Demand	York Place to Newhaven - Incremental Demand, 2023	York Place to Newhaven - Incremental Demand, 2032
AM peak (pax in 2 hr peak)	4,449	5,301
Inter-peak (pax in 2 hr inter-peak)	3,219	3,568
Annual demand – modelled (million pax p.a.)	**8.8**	**10.0**
Annual demand – including build-up (million pax p.a.)	**7.0**	**10.0**

4.8 The table shows that modelled demand on the Project is 8.8m in 2023. Within the appraisal we have adopted build-up assumptions whereby demand takes two years to reach its modelled level. The demand allowing for build-up is 7.0m in 2022 (80% of modelled demand).

4.9 Demand is forecast to increase to 10.0m by 2032 for the Tram Completion Project – this growth largely reflects the increase in housing that is forecast to take place in the Leith Waterfront area over this period.

Annual Demand Forecasts – Existing System and Tram Completion Project

4.10 A summary of the annual demand for the Project, and the existing system is shown in Table 4.4, for 2023 and 2032.

Table 4.4 Edinburgh Tram Phase 1 and Project Modelled Demand

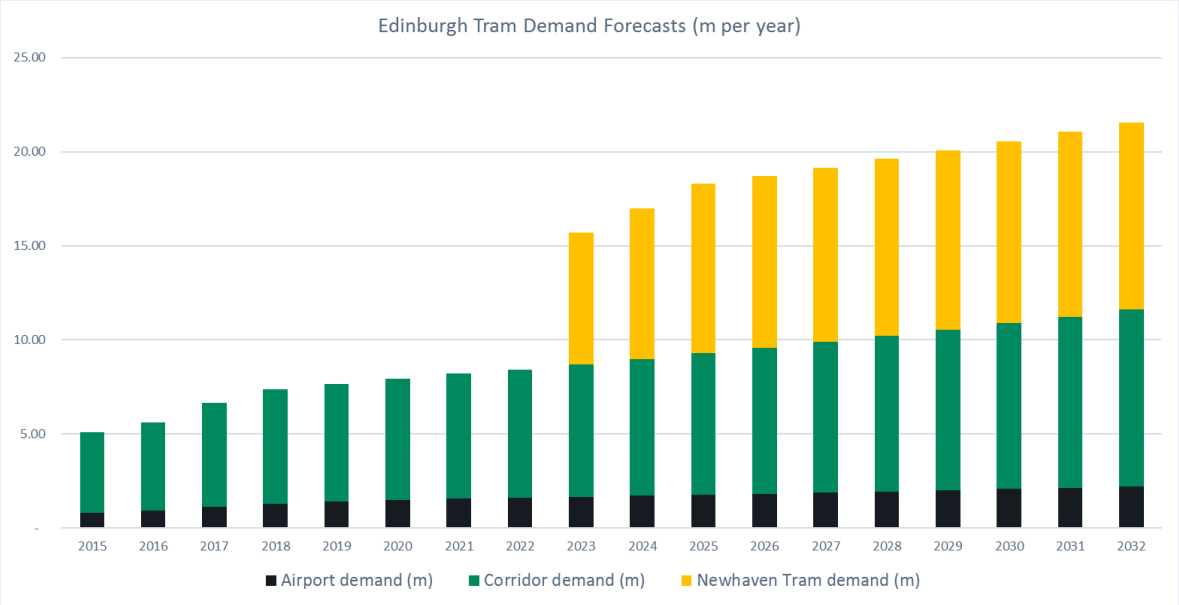
Demand	Annual Demand - 2023	Annual Demand - 2032
Existing system – Airport to York Place	8.7	11.6
Tram Completion Project	7.0	10.0
Annual system demand (million pax p.a.)	**15.7**	**21.6**

4.11 The table shows that:

- In 2023, demand on the existing system is forecast to be 8.7m, and the Tram Completion Project is forecast to add a further 7.0m (this figure allows for build-up), providing a total system demand of 15.7m.
- By 2032, demand on the existing system is forecast to increase to 11.6m and the Tram Completion Project demand is forecast to be an additional 10.0m trips per year. This growth to 2032 reflects the forecast planned growth within each corridor (e.g. around Edinburgh Park for the existing system and in the Waterfront area for the Newhaven Project), as well as growth in the city centre.

4.12 The forecast annual demand for the existing system and Tram Completion Project is presented in Figure 4.1. The project demand (shown in yellow) occurs from the 2023 opening year.

Figure 4-1 Edinburgh Tram Year on Year Annual Demand



Edinburgh Tram Peak Line Flows

4.13 Presented below are charts showing, by direction, the forecast number of boarders and alighters and load versus capacity across Line 1 (existing) plus the Tram Completion Project for one hour in the morning peak period. The charts assume a tram vehicle capacity of 250, and include a factor of 1.3 (derived from observed tram profile data) applied to the average hourly demand across the 2-hour modelled peak period, to reflect the 'peak within the peak'.

4.14 The Figures show that:

- There is sufficient capacity to accommodate forecast demand in each direction and in each forecast year.
- The dominant flow from the Newhaven extension is in the inbound (westbound) direction, with a sizeable number of boarders at each stop on the route and the maximum line- loading reached at Picardy Place, beyond which the number of alighters exceeds boarders, and the line load reduces.
- The key destinations on the route (there significant volume of people alight) are:
  - the city centre (St. Andrews to Haymarket), from both eastbound and westbound directions
  - Edinburgh Park / Gyle and the Airport (mainly for westbound / outbound trips). In 2032 there is also significant destination demand at Ingliston and Gogarburn, reflecting the significant planned developments adjacent to these stops.
  - Ocean Terminal (eastbound)

Figure 4-2: 2022 Peak Eastbound Boards, Alights, Loading and Capacity (1 hour)

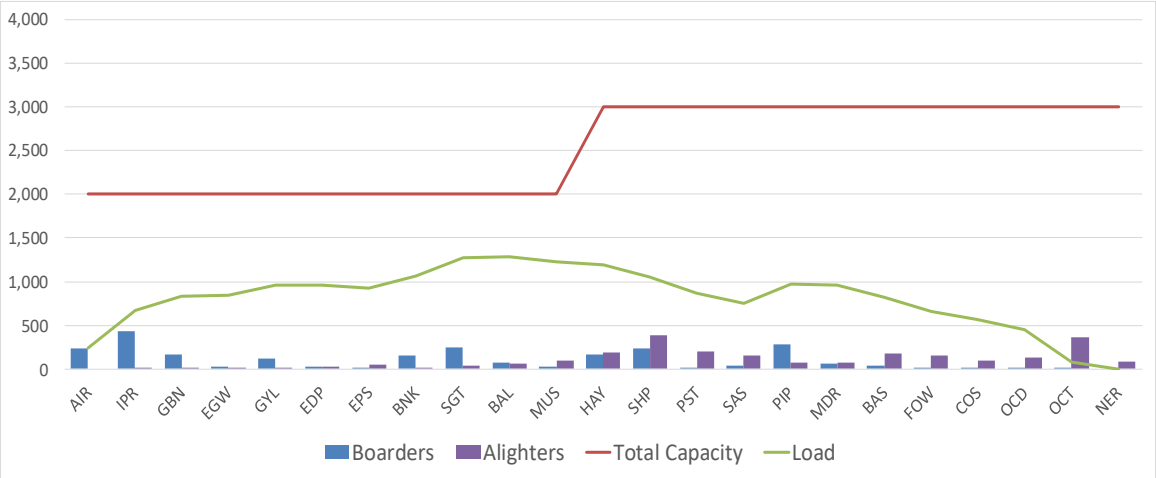


Figure 4-3: 2022 Peak Westbound Boards, Alights, Loading and Capacity (1 hour)

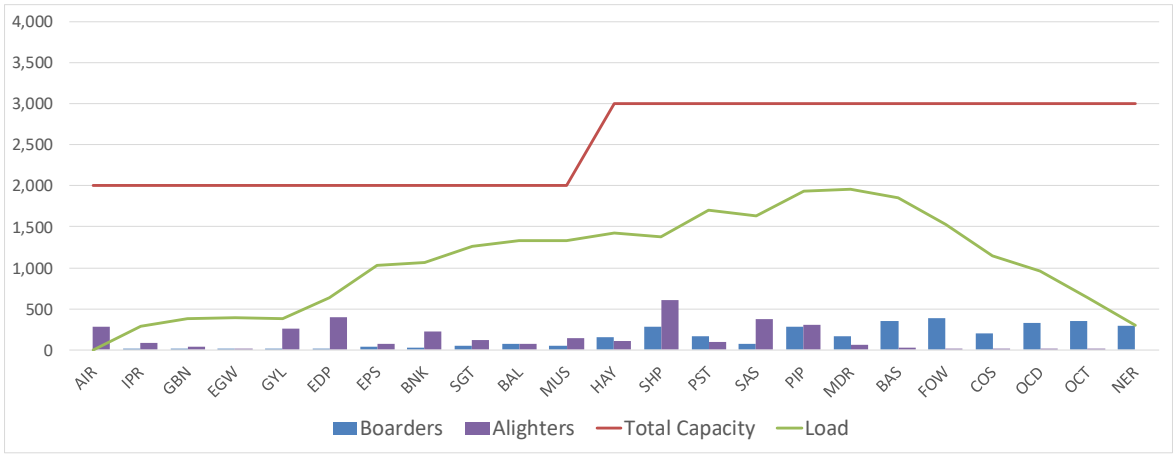


Figure 4-4: 2032 Peak Eastbound Boards, Alights, Loading and Capacity (1 hour)

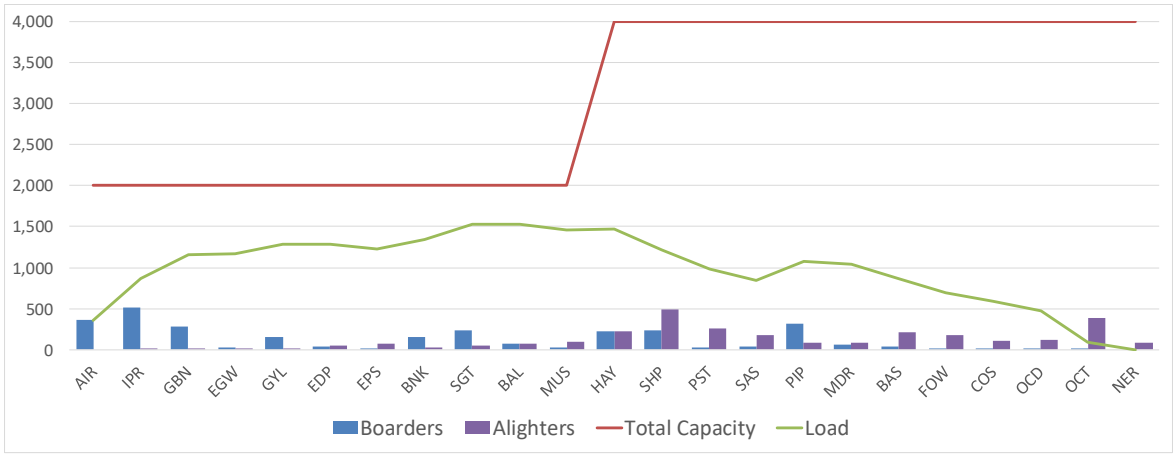
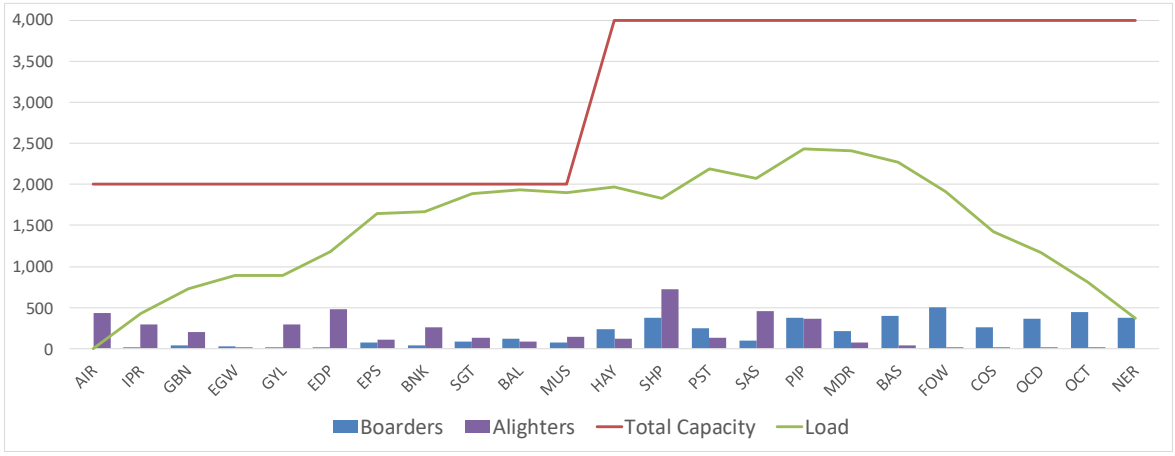


Figure 4-5: 2032 Peak Westbound Boards, Alights, Loading and Capacity (1 hour)



5 Economic Appraisal

Overview

5.1 The economic appraisal for the Project has been prepared in line with Scottish Transport Appraisal Guidance (STAG). The appraisal considers the flows of monetisable discounted costs and benefits over the appraisal period, and compares these to provide economic performance metrics, including the benefit to cost ratio (BCR).

5.2 The monetisable elements of the appraisal are only part of the wider STAG criteria, and there are additional benefits that need to be considered to support informed decision making. An assessment of the wider STAG benefits is made in Chapter 6.

Appraisal Assumptions

5.3 The key assumptions employed in the appraisal are set out below:

- Opening year 2023
- 60-year appraisal period (2023 to 2082)
- Discount rate of 3.5% per annum, reducing to 3% from 30-years after the current year
- The Department for Transport's (DfT's) Transport User Benefits Analysis (TUBA) software has been used to calculate scheme benefits. These include WebTAG default assumptions on parameters such as the value of time
- Demand build-up assumption of 80% in the opening year (2023), 90% in year 2 and 100% thereafter.
- The appraisal is presented in 2010 prices, and discounted to 2010 (as per DfT guidance and included in TUBA). All other cost and revenues have been converted to 2010 prices.
- A market price adjustment factor of 1.19 has been applied to all costs and revenues within the economic appraisal, to ensure that costs are expressed in market prices (inclusive of tax), to be internally consistent with benefits.

5.4 The two forecast years for the modelling described earlier in this report were 2022 and 2032. However, the opening year for the scheme is 2023, and all demand and benefits are therefore forecast from 2023 onwards. Values for 2023 were obtained from the model outputs by assuming linear interpolation between the two model forecast years.

Key Inputs into Economic Appraisal

5.5 The economic appraisal draws on inputs from several areas. These are described in the earlier chapters of this report and are summarised in Table 5.1.

Table 5.1 Appraisal Inputs

Input	Source	Treatment within Appraisal
Capital costs & lifecycle costs	Turner & Townsend (T&T),	Converted to 2010 prices. Application of Optimism Bias. Direct input in appraisal spreadsheet model
Tram operating costs – incremental for Project	Edinburgh Trams	Applied 1% real growth per annum and converted to 2010 prices Direct input in appraisal spreadsheet model
Bus operating cost savings, based on cost saving per peak vehicle no longer required.	Lothian Buses	Applied 1% real growth per annum and converted to 2010 prices Direct input in appraisal spreadsheet model
Public transport benefits	JRC, VISUM model outputs	Matrices of demand and generalised costs (i.e. to derive time savings) from VISUM model and input into TUBA. Demand beyond the second model year of 2032 is assumed to grow by 1% per annum to 2052. TUBA produces annual discounted cashflows.
Public transport revenues	JRC	Average yield per trips applied to change in tram and bus demand. Corridor yield for bus and tram - £1.20 per trip (2017/18). Airport yield for tram - £5.13 [adult single is £6, return £8.50, & most sales are single], Airport yield for bus - £4.10 (adult single is £4.50, return £7.50).
Highway benefits	JRC	Range estimates prepared
Revenues	JRC, VISUM produces change in revenue for: • Tram • Bus • Rail	Assumed inflation of 3%, growth above inflation of 1% and revenue loss due to fare evasion of 0.5% Direct input in appraisal spreadsheet model

Capital Costs

Profiling of Capital Costs

5.6 The capital costs are based on the contractor bid, and are presented as out-turn costs in Chapter 2. We have converted these into 2010 discounted cashflows through:

- Developing a cost profile based on the bidder construction profile and spend schedule
- Deflating the out-turn costs into 2010 prices using a GDP deflator, in line with DfT guidance.
- Discounting the costs for a 2010 discount year based on the standard appraisal discount rate of 3.5%.

5.7 This treatment is summarised in Table 5-2 for the Project.

Table 5.2 Treatment of Capital Costs for Appraisal (Base Option - Newhaven)

	2019	2020	2021	2022	TOTAL	Notes
Cost profile	19%	37%	29%	15%	100%	Based on construction programme
Out-turn cost for appraisal (£M)	36.4	71.3	54.7	28.0	190.5	As per bidder estimate
Costs 2010 Prices (£M),	31.5	60.7	45.8	23.0	160.9	Deflated using GDP deflator
Costs, 2010 Prices, discounted (£M)	23.1	43.0	31.3	15.2	112.7	Discounted at 3.5% p.a.
Costs 2010 Prices, discounted, with optimism bias (£M)	24.5	45.6	33.2	16.2	119.5	Optimism bias of 6%

Risk and Optimism Bias

5.8 We have applied optimism bias of 6%, in line with both current webTAG guidance for tram (light rail) projects[18]. The 6% rate is also consistent with current STAG (Rail) guidance.

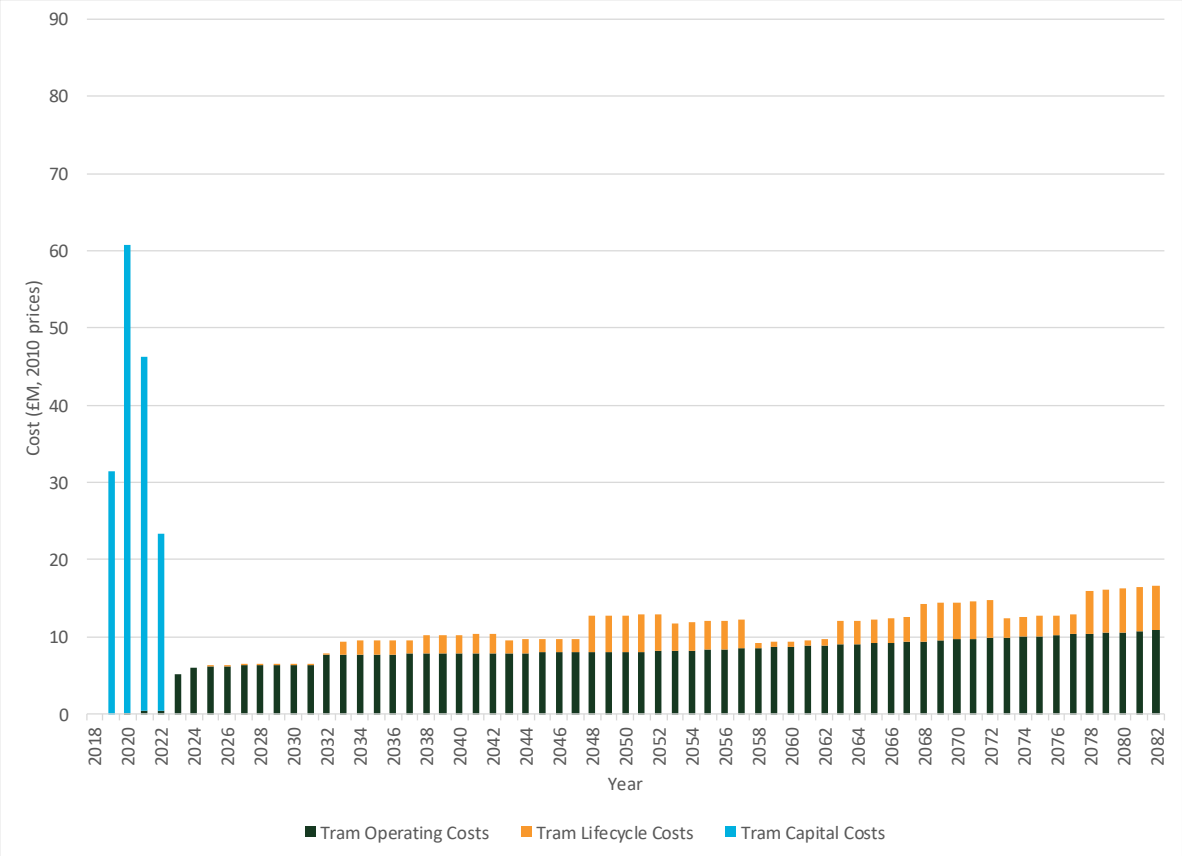
5.9 A sensitivity test has been undertaken at the higher optimism bias level.

Lifecycle and Operating Costs

5.10 Lifecycle costs, tram operating costs and bus operating cost savings have been estimated throughout the 60-year appraisal period, as set out in Chapter 2. All costs have been converted to 2010 prices and discount year, based on the same method applied to the capital costs. Both operating and lifecycle costs include a real increase of 1% per annum throughout the appraisal period.

5.11 The overall undiscounted tram costs through the appraisal period are summarised in Figure 5-1.

Figure 5-1 Undiscounted Tram Costs over 60-year Appraisal Period (Newhaven)



5.12 The capital costs, represented by the blue lines, are incurred up-front (to 2022), while the operating and maintenance costs (dark green) are incurred over the course of the 60-year appraisal and increase in real terms by about 1% per annum. Operating costs show a stepped increase in 2032, reflecting the assumed year in which the service level would increase from 12 to 16tph. Tram lifecycle costs (orange) are also incurred throughout the appraisal period, though the

[18] https://www.gov.uk/government/publications/webtag-tag-unit-a1-2-scheme-costs-july-2017

profile reflects the assumed point at which items (vehicles, track, systems) need renewing or replacing.

Economic Appraisal Results

5.13 The economic appraisal results for the Project are presented in Table 5.3. This is based on the Transport Economic Efficiency (TEE) and Public Accounts table as per appraisal guidance.

Table 5.3 Economic Appraisal Results (£ 000s, present value over 60 years, 2010 prices and discount year)

	Project	Comment
Benefits		
Public Transport User Benefits	£475,864	Generalised time savings to PT users
Highway User impacts	-£47,586	Disbenefits equivalent to 10% of PT benefits
Private provider revenue impacts	-£32,556	Revenue impacts on rail and non-Lothian bus operators
Tax impacts	-£402	Loss in exchequer VAT income from additional fares (exempt)
Total Benefits	***£395,320***	
Costs & Financial Impacts		
Capital costs	-£142,149	Includes 6% optimism bias
Tram opex	-£155,344	
Tram lifecycle	-£38,154	
Tram advertising	£0	
Bus opex savings	£18,082	From Lothian bus 'recast' of services
Tram revenues	£365,702	Additional tram revenue
Lothian bus revenues	-£330,628	Loss in Lothian Bus revenue
Total Costs and Financial Impacts	***-£282,491***	
Economic Performance		
Net Present Value	***£112,829***	***Total benefits - Total costs***
Benefit Cost Ratio	***1.40***	***Total benefits / Total costs***

Interpretation

5.14 The key finding of the economic appraisal is that the Project would deliver a positive economic performance, delivering £1.40 of benefit for each £1 spent.

Comparison with OBC Economic Case

5.15 The benefit-cost ratio presented in the 2017 Outline Business Case (OBC) was 1.64:1.

5.16 The overall level of forecast benefits (in terms of time savings to passengers) are of a similar order to those that underpinned the OBC. Similarly, the net costs are also of a similar order, whereby

the increase in capital costs (from the OBC) has been offset by a reduction in forecast operating, maintenance and lifecycle costs.

5.17 The key change between the OBC and the FBC is that the Department for Transport's guidance has been updated and that, as part of this update, the value of time used to monetise travel time savings has been reduced[19]. Moreover, the latest guidance also includes a reduction in the growth in the value of time over time, which is used to increase benefits broadly in line with forecast productivity growth. The combined effect of these changes is to reduce the benefits by around 12%. This change is the primary factor which explains the reduction in BCR within the FBC.

Sensitivity Testing

5.18 We have undertaken number of sensitivity tests to test the robustness of the economic performance of the Project under a range of scenarios. The sensitivity tests we have undertaken are described below and summarised in Table 5.4:

- Highway impacts tests based on:
  - An 'optimistic' case where highway impacts are neutral
  - A 'pessimistic' case where disbenefits are equivalent to 20% of the level of public transport benefits.
  - (the central case assumes disbenefits are equivalent to 10% of the level of public transport benefits)
- Sensitivity tests around the level of public transport benefits, keeping highway disbenefits constant. These are:
  - Upside: +20% in public transport benefits
  - Downside: -20% in public transport benefits
- A growth sensitivity looking specifically at the impact of future developments on Leith Waterfront not coming forward at the same rate or level as assumed. This has been based on factoring down benefits in the Newhaven corridor.
- A low growth sensitivity test, looking at no assumed growth beyond the second model year of 2032.
- A higher capital cost sensitivity. This is based on a level of optimism bias at 20% rather than the central case assumption of 6%.
- A sensitivity test based on the findings of the Flyvbjerg review of cost risk, which recommended that an overall risk allowance of 57% applied to the capital costs. This compares with an allowance of around 23% in the central case, which comprises a combination of Quantified Risk Assessment (QRA) plus the application of 6% optimism bias.
- Sensitivity tests on the impact of journey time changes using elasticities calculated from outputs from model tests.

[19] This reflects updated research. The value of time for commuting has increased, but those for business and leisure have reduced, and the net effect is a reduction in the order of 3%.

Table 5.4 Sensitivity Tests

Scenario	Sensitivity Test
Central scenario	1.40
Highway impacts of zero (neutral)	1.57
Highway disbenefits at 20% of PT benefit	1.23
Public transport benefits +20%	1.74
Public transport benefits -20%	1.06
Lower Waterfront Development / Growth	1.17
No demand growth post 2032.	1.20
Higher capital costs +20%	1.27
Higher capital cost risk allowance (57% overall risk)	1.25
Journey time +10%	1.30
Journey time -10%	1.73

Interpretation

5.19 The sensitivity tests show that:

- The benefit-cost ratio for Project remains positive (above 1:1) under all the sensitivity tests considered.
- The two capital cost sensitivities, the first looking at total costs (including base costs and risk) increasing by 20%, and the second looking at applying a higher risk (57%) allowance to the base cost each show that the BCR would remain comfortable above parity, with BCRs of 1.27 and 1.25: 1 respectively.
- The sensitivity with the greatest impact on the overall economic performance is the +/- 20% public transport benefits tests. Under a test where public transport benefits reduce by 20% the Project BCR would remain above 1:1. Conversely, under a scenario where public transport benefits were 20% higher the scheme would deliver a benefit-cost ratio of 1.74:1.

6 Outline STAG Assessment

Overview

6.1 This Chapter provides an outline assessment against the range of objectives set out in Scottish Transport Appraisal Guidance (STAG).

6.2 A full STAG assessment was undertaken to support the case presented to the Parliamentary Inquiry that formed the basis of securing powers to build the Project. The nature of the scheme is largely unchanged and the strategic policy context within which the scheme has been developed has been re-informed by the statutory policy documents adopted since the Inquiry.

6.3 For this report we have therefore updated, at a high-level, the assessment of how the scheme performs against STAG appraisal criteria. This provides a validation that the project remains consistent with, and supportive of, the wider spatial planning and policy objectives that is was originally developed to meet.

Policy Context & Performance against Planning Objectives

Economic Context

6.4 There is significant growth planned for Edinburgh over the coming decades. This reflects its status as the national capital, and its economic role in key economic growth sectors including finance and business services, legal, bio-science and others.

6.5 Over the next decade Edinburgh is expected to be home to a faster growing population than anywhere else in Scotland. The National Records of Scotland 2012 based projections suggest that the city should be planning for an additional 54,400 people up to 2022 and an additional 136,400 by 2037, taking the total population from 482,600 to 619,000 over a 25-year period.

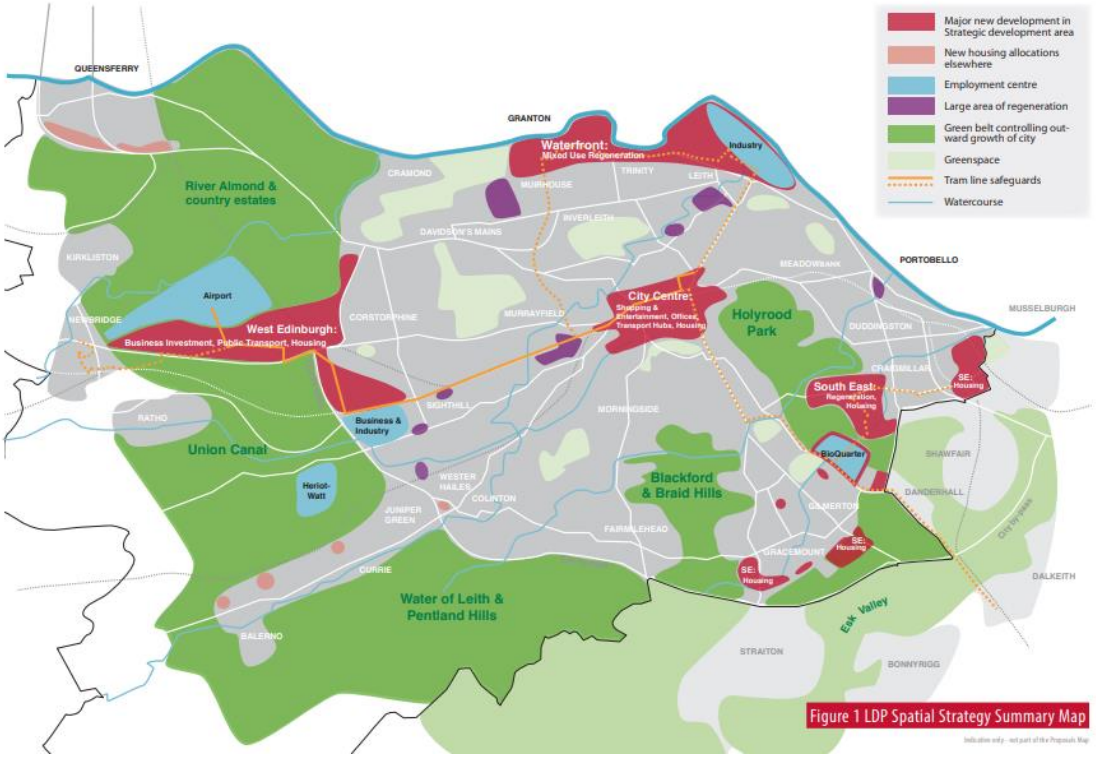
6.6 Edinburgh is a major employment hub which attracts a workforce from both within the city and surrounding areas. The city's economy has been relatively resilient during the economic downturn and is set to grow strongly as economic conditions improve. The 'central' forecast from Oxford Economics predicts that total employment in the city will grow by 7.6% between 2013 and 2022 (from 324,900 to 349,700).

Spatial Planning Context

6.7 The Local Development Plan (November 2016) sets out the spatial strategy for how this growth should be planned for and accommodated.

6.8 The spatial strategies of the adopted Edinburgh City Local Plan and the emerging Edinburgh Local Development Plan direct most of the planned growth of the city to four strategic development areas. These are all connected by a network of potential tram lines. This can be seen from Figure 6-1 taken from the Spatial Strategy summary diagram of the second proposed Local Development Plan (red denotes major housing development opportunities and blue major employment development opportunities).

Figure 6-1 Spatial Strategy summary adopted Local Development Plan (November 2016)



6.9 The Local Development Plan prioritises housing delivery on brownfield sites, in particular those in the waterfront areas of Leith and Granton. Completion of the tram connection to these areas would help boost that delivery. In addition, Leith is one of the defined strategic business centres to which major office development is directed, and a location with significant employment land potential.

6.10 The Local Development Plan strategy for retail centres prioritises the city centre, including St James, and Leith Walk, as well as defined commercial centres, including Ocean Terminal, Cameron Toll and Fort Kinnaird.

6.11 The Local Development Plan also identifies the importance of Edinburgh BioQuarter as a centre of growth, and the ongoing regeneration of Craigmillar and its expansion at Greendykes.

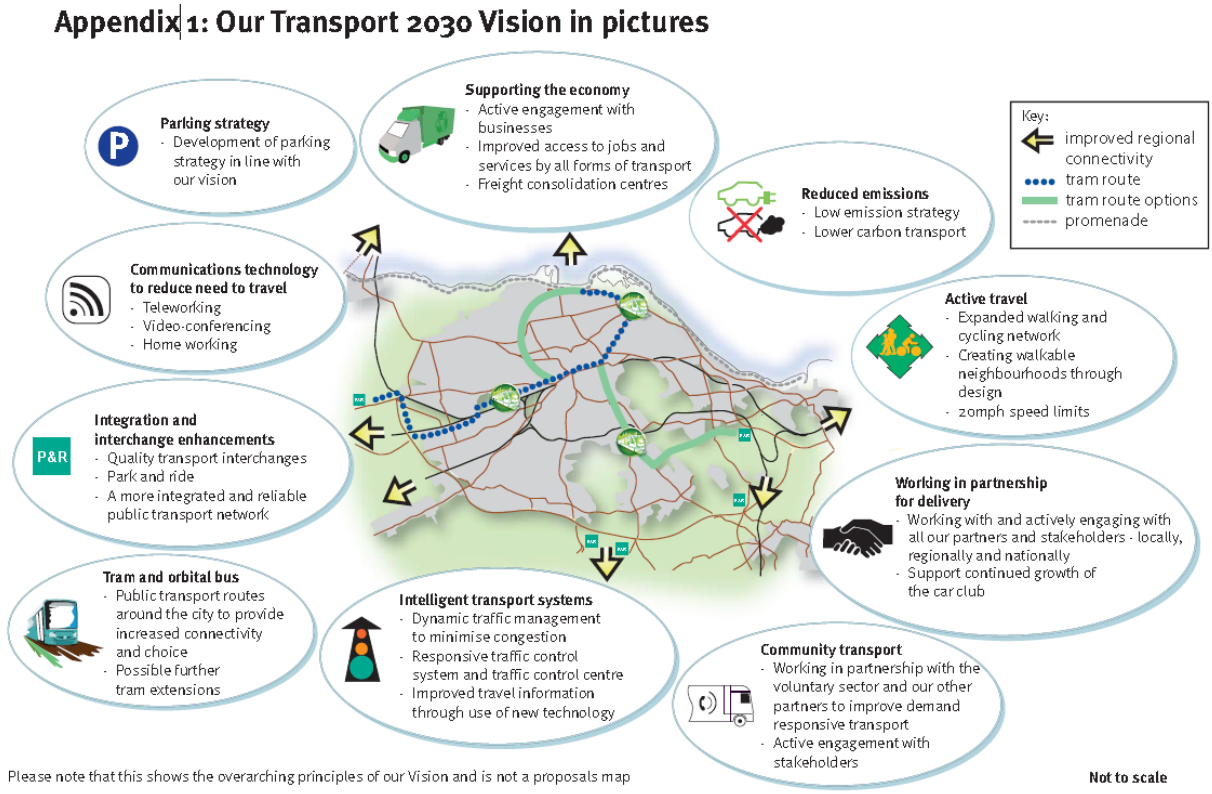
Transport Policy Context

6.12 The development of transport infrastructure will play a key role in shaping the pattern of future growth and development, and hence in delivering the spatial strategy and the long-term economic growth that this will support.

6.13 The Edinburgh 2050 Vision is an ongoing campaign and all council strategies recognise the role of transport in delivering the wider objectives of the City, including the City Centre Transport Strategy, Mobility Plan and Development Plan.

> "The Development Plan and Economic Development Strategy are also key contexts for transport initiatives in the city. Within the Council, achieving our vision will require the Transport Service to work with other Services and Departments including Planning, Economic Development and Services for Communities." Edinburgh 2030 Vision

6.14 The appendix to the Vision sets out the transport initiatives that will support the overall vision, with tram routes forming a central component of the vision.



6.15 The Vision also sets out a set out a number of transport objectives:

- be **environmentally friendly** - reducing the impacts of transport, playing its full part in reducing greenhouse gas emissions
- be **healthy** - promoting Active Travel with streets appropriately designed for their functions, with an emphasis on encouraging walking, cycling and public transport use and a high-quality public realm; improving local air quality; be accessible and connected; supporting the economy; and providing access to employment, amenities and services
- be **smart and efficient** providing reliable journey times for people, goods and services
- be part of a **well-planned, physically accessible, sustainable** city that reduces dependency on car travel, with a public transport system and walking and cycling conditions to be proud of
- be **safe, secure and comfortable**
- be **inclusive and integrated**
- be **customer focussed and innovative**
- be **responsibly and effectively maintained**

Performance against Planning Objectives

6.16 This policy context sets the context for the assessment of the Edinburgh Tram Completion Project against planning objectives, presented in Table 6.1.

Table 6.1 Project Assessment against Planning Objectives

Planning Objective	Assessment	Comment
Supporting the Spatial Strategy	√√√	The Project has the strong potential to support the delivery of identified housing and employment opportunities.
Sustainable Economic Development	√√√	The spatial strategy is developed to support the overall growth of Edinburgh in a sustainable manner.

6.17 The Tram Completion Project offers the potential to:

- Increase the attractiveness of major development sites, enhancing their overall viability and potentially bringing them forward at a faster rate than would otherwise be the case.
- Support the nature and scale of development, by supporting higher density development with a lesser requirement for parking than would be the case without the tram.

6.18 The proposed Project would also support the spatial development strategy and the wider economic objective of supporting the planned population and jobs growth within Edinburgh in a sustainable manner.

Environment

6.19 We have not undertaken a detailed assessment of environmental impacts as part of this study. The securing of powers for the (then) Line 1 scheme included an assessment of environmental impacts and identified appropriate mitigation measures that were included in the scheme design and development.

6.20 The granting of powers implicitly suggests that there were no unacceptable environmental impacts for the full route (to Newhaven).

Accidents and Security

Accidents

6.21 The Project has the potential to reduce accidents through the transfer of car trips to tram. However, the Leith corridor already has a very high public transport mode share so the absolute change in vehicle kilometres will be modest (and low compared to Phase 1, where park and ride is an integral part of the scheme).

Security

6.22 Edinburgh tram offers a high level of security, in particular through the presence of Ticketing Services Agents and CCTV and Help Points both on board and on street.

6.23 The most recently available data for passenger surveys undertaken in 2015[20] suggests the 96% of passenger are satisfied with personal security on board compared with 92% in 2014. The survey

[20] http://d3cez36w5wymxj.cloudfront.net/wp-content/uploads/2016/05/25141326/Tram-Passenger-Survey-Edinburgh-Trams-Autumn-2015-results.pdf

also confirmed that Personal safety and stop remains high at 94% and no change from the previous survey in 2014.

Economy - Transport Economic Efficiency

6.24 The assessment of Transport Economic Efficiency is the primary focus of this report, and the economic appraisal is presented in Chapter 5. This shows the project would deliver a positive benefit-cost ratio.

Economy - Wider Economic Benefits

6.25 Wider economic benefits are productivity benefits that are not captured within the estimation of 'conventional benefits' based on generalised time savings. This is because other markets impacted by a transport scheme (e.g. labour market, output market) are not operating under conditions of perfect competition. Wider Impacts are completely additional to standard transport user benefits.

6.26 Guidance from the Department for Transport (DfT) on Wider Impacts[21] is intended to quantify the potential economic impacts of transport improvements upon business and workers' productivity and the resulting increase in output.

6.27 The wider benefits of applicability to Edinburgh Tram are agglomeration and labour supply / move to more productive jobs. Each of these is described below.

Agglomeration

6.28 Agglomeration benefits value the productivity benefits of firms being 'effectively' closer together. The concept of 'effective density' is a measure of the employment density of a place and the other places around it, scaled by the distances between them. There is a positive relationship between effective density and productivity. Some sectors and hence locations have higher agglomeration elasticities – meaning that a given improvement in 'effective density' results in a higher productivity benefit. Edinburgh supports a number of specialised clusters in areas such as financial and business services, legal services, technology and bio-science.

6.29 Transport investment can increase effective density in two ways:

- First, **by reducing transport costs** and thereby improving accessibility around and between jobs. This, in effect, brings firms closer together. This effect can be measured for all transport investment, and there is a direct linkage between the transport accessibility changes (from transport modelling) and the agglomeration effect.
- Second, **where transport investment changes the scale or location of employment** in an area or between areas. In this case the change in the number of jobs in an area directly affects the 'effective density'.

6.30 The Project would reduce the transport costs between a number of key employment locations including:

- Around Leith Waterfront including the Scottish Executive
- The city centre via five stops between Picardy Place and Haymarket.

[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370532/webtag-tag-unit-a2-1-wider-impacts.pdf

- Reduction in travel time via direct tram connection to major employment locations on the Phase 1 line, notably Edinburgh Park and Edinburgh Airport.
- Reduction in travel times to a range of locations within the city and beyond, via interchange with rail at Waverley, Haymarket and Edinburgh Gateway, and bus (city centre).

6.31 The Project would also support the change in scale and location of jobs through:

- Directly supporting the bringing forward of employment related development in the Leith Waterfront area.
- Increasing the attractiveness of the employment locations in the city centre and Edinburgh Park by expanding the effective labour market catchment through reduced travel costs, and through helping bring forward major residential development in Leith Waterfront.

6.32 We have not calculated agglomeration benefits as part of this work. However, the inclusion of agglomeration benefits for public transport projects in large urban areas (UK outside London) is typically adds in the range of 15%-40% above conventional transport benefits.

Improved Labour Supply

6.33 The Project would connect major existing and planned employment destinations (city centre, Edinburgh Park) with the Leith corridor, which has among the highest population density in the city) and major planned areas for new residential developments along Leith Waterfront towards Newhaven.

6.34 Though this the tram will connect existing and new jobs with existing and new residents, ensuring that labour market accessibility is enhanced (businesses will find it easier to recruit, and workers have access to more jobs), and that the economic growth that this support will be delivered in a sustainable manner, though integrated transport and land use planning.

6.35 There will be locations that are not served by tram that will, as a result of the scheme, exhibit worse comparative accessibility, and this logically will result in some displacement or relocation of activity from elsewhere to the tram corridor, at least in the shorter term.

6.36 However, the purpose of Tram Completion Project is to support the overall level of economic growth of Edinburgh through enhancing the viability and attractiveness of major housing and employment sites identified in the spatial strategy. In this context, employment should not be viewed as 'zero-sum' (where tram only results in distributional effects). Rather, the Project can help support a level of economic activity (jobs, development, and housing) at a greater level that would otherwise be the case. Table 6.2 summarises the assessment of Wider Economic Benefits for the proposed Project.

Table 6.2 Wider Economic Benefits Assessment of the Project

	Tram Completion Project - Assessment
Agglomeration	√√√
Improved Labour Supply	√√√

Economy - Economic Activity and Locational Impacts

Local Economic Impacts

6.37 Local economic impacts are concerned with which geographic locations and which sectors are likely to gain / lose as a result of the project.

6.38 In geographic terms, the project will support existing businesses and expansion of activity in key employment locations, in particular the city centre and Edinburgh Park. The growth in these locations will be driven by the expansion of higher-value service sector jobs which would probably only locate in the city centre or high-grade premises such as those in Edinburgh Park.

6.39 It is therefore unlikely that other locations within Edinburgh would be material 'losers' as a result of the project.

6.40 As noted above, the Project aims to support the delivery of planned jobs and housing growth. Without tram this growth would either be at a lesser scale, take longer to come forward or need to be accommodated in a less sustainable manner (i.e. growth would have to be supported by greater levels of in-commuting).

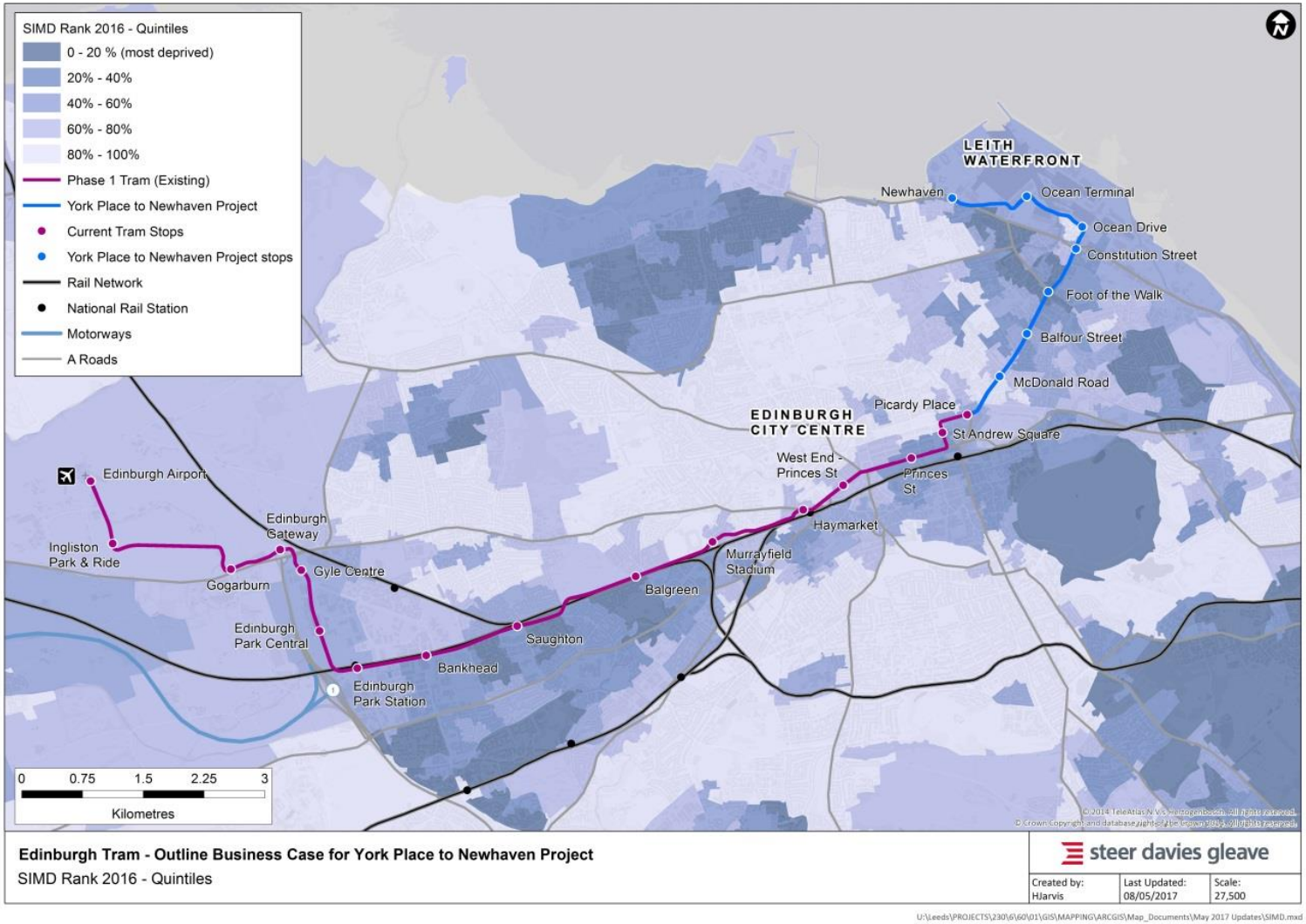
National Economic Impacts

6.41 Net impacts at the national level are unlikely to be significant. However, key sectors such as business and financial services and bio-science / technology are mobile and internationalised, and enhancing the attractiveness of Edinburgh as a location to locate (through good transport, access to a large labour pool etc., direct access to Airport) will help maintain and enhance Edinburgh's competitive position as a place that high-value internationally mobile businesses want to locate and expand in.

Distributional Impacts

6.42 The Project serves a corridor of comparatively high unemployment and deprivation, as shown in Figure 6-2. The tram Project will provide improved accessibility to residents along the corridor to the range of job opportunities in the city centre and along the Phase 1 corridor (e.g. Edinburgh Park).

Figure 6-2 Index of Deprivation (from Scottish Index of Multiple Deprivation Interactive Map)



6.43 Our assessment of Economic Activity Location Impact (EALI) s is presented in Table 6.3.

Table 6.3 EALI Impact

	Tram Completion Project - Assessment
Local Economic Impacts	√√
National Economic Impacts	√
Distributional Impacts	√√

Integration

6.44 The Project would provide more direct journey opportunities (avoiding interchange) as well as interchange opportunities at a range of destinations including the city centre (rail at Waverley and Haymarket, bus), Edinburgh Gateway and at Park and Ride at Ingliston.

Land Use and Policy Integration

6.45 The Project has been developed to support the City's spatial strategy and hence wider economic policy objectives. The Project fully supports the City's transport policy objectives.

6.46 Our assessment against integration is presented in Table 6.4.

Table 6.4 Assessment of Integration Impacts

	Tram Completion Project - Assessment
Transport Interchange	√√√
Land Use Transport Integration	√√√
Policy Integration	√√√

Accessibility and Social Inclusion

6.47 The Project would enhance accessibility and social inclusion.

Community Accessibility

6.48 The public transport network coverage and access to local facilities is reasonably good throughout the corridor, reflecting the good existing bus network coverage. Tram will improve this accessibility but will not transform any specific movement from being 'inaccessible' to 'accessible'.

Comparative Accessibility

6.49 The impact of the tram will be greater here, as it improves the comparative accessibility by public transport for a range of movements – those from the northern end of the route and from the whole York Place to Newhaven route to a range of employment and other opportunities on the Phase 1 corridor.

6.50 Our assessment of accessibility and social inclusion is presented in Table 6.5.

Table 6.5 Summary of Accessibility and Social Inclusion Impacts

	Tram Completion Project - Assessment
Community Accessibility	√
Comparative Accessibility	√√√

7 Conclusion

7.1 This report presents the Full Business Case for Edinburgh Tram Completion Project. It builds on an earlier Outline Business Case that was accepted and approved by City of Edinburgh Council in 2017 and is in accordance with Guidance from Transport Scotland and Department of Transport.

7.2 It also sets out the economic case for the Edinburgh Tram Completion Project. This shows that the central case delivers a benefit to cost ratio of 1.4:1, and that the BCR would remain positive under a range of scenarios and sensitivity tests undertaken.

7.3 Additionally, the outline STAG assessment demonstrated how the project contributes to a range of wider policy objectives and outcomes, in particular supporting the spatial planning and development strategies for the city, and improving transport accessibility in areas of comparatively high deprivation.

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