# Extended Tay Estuary Rail Study

## Updated Business Case

Report

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# CONTENTS

# FIGURES



# TABLES

# Executive Summary

## Overview

1. The Extended Tay Estuary Rail Study (TERS) STAG type appraisal was completed in June 2009 by Steer Davies Gleave on behalf of TACTRAN. It proposed a package of stopping services in the TACTRAN area, complementary to Project 23 of the Strategic Transport Projects Review (STPR) and based on an understanding of STPR Project 17, the Highland Mainline (HML) proposals at the time.
2. The study identified a preferred long term option of an hourly Glasgow – Arbroath service. However, this requires infrastructure improvements between Perth and Glasgow because present capacity is restricted such that a single timetable path has to be shared for services running to Perth, Inverness and Dundee. This means a Glasgow to Arbroath service cannot run in the same hour as a Glasgow to Inverness service.
3. Two different timetable options were derived which worked around this constraint:

   - An extension to Arbroath of the Glasgow – Perth service in the hours when Glasgow – Inverness services do not operate; and
   - A "shuttle" between Perth and Arbroath which permits interchange at Perth for Glasgow services.

4. A "hybrid" option was developed which combines both to permit a reasonably regular direct service between Arbroath and Glasgow with the "shuttle" to Perth used to provide the hourly local service frequency in the hours which the direct train to Glasgow cannot operate.
5. Since publication of the 2009 TERS report, TACTRAN has continued to engage with the rail industry to progress the study outputs towards delivery. Transport Scotland could not support further development of the TERS scheme until their own proposals for HML were finalised. The TERS scheme recognised the political importance of HML and therefore developed a flexible timetabling approach to fit around the HML scenarios.
6. In November 2010 the Scottish Government announced HML proposals to increase the number of daily services between Inverness and Edinburgh / Glasgow from 9 to 11 per day in each direction. There remains a long term aspiration to a full hourly service and faster journey times, as proposed by STPR. The HML timetable for introduction in December 2011 is different from that assumed by the study in 2009. It not only provides additional services between Glasgow and Perth, but also between Perth and Dundee.
7. Follow up meetings with Transport Scotland and Network Rail have also identified the following issues which would benefit from further clarification:

   - Further analysis of the performance impact of a TERS service terminating at Arbroath station and in particular clearing the down line before the next train arrives in the signalling section;
   - Network Rail has issued a draft of its Scotland Route Utilisation Strategy Generation Two which forecasts more optimistic growth levels than STPR in the

medium term. As a result Network Rail has offered views as to how operating cost and demand forecasts should be estimated; and

- Transport Scotland has reiterated the precedence of HML over TERS and requires demonstrable evidence that the services do not conflict.

8. This document provides an update to the June 2009 report which takes account of all of these developments. It is not a full STAG type report, but is a stand alone report which develops a number of short and long term options and their performance against the study Planning Objectives and in economic terms.

## Option Development

### *Long Term Option*

9. The timetables from the 2009 study were overlaid onto the First ScotRail (FSR) timetable bid for December 2011. It was then apparent that the improved Glasgow, Perth and Dundee services being introduced with HML provide an opportunity to deliver a generally hourly Arbroath to Glasgow service with interchange at Perth in the hours which Glasgow to Inverness services operate.

10. To further guarantee the implementability of this long term timetable option, the performance impact of the option was tested in RailSys and, once validated, the timetable used as the basis to refresh the demand forecasting.

11. Existing FSR rolling stock diagrams were used to assess which services were likely to be operated by Class 158 (2 car) and Class 170 (3 car) diesel multiple units (DMUs). An estimate of operating costs was then calculated using the assessed increase in vehicle miles operated, along with traincrew requirements. The FSR rolling stock diagrams were also used to estimate the number of additional DMUs required over the current base to operate the service. In addition, the requirement for limited infrastructure work at Invergowrie and Arbroath was identified and capital costs estimated.

### *Start Up Options*

12. A short term 'start up' timetable was developed by examining the resource requirements for the full timetable option. In the core start up option, services which clearly only made use of existing resources were retained. Not unexpectedly, resources were not available in this core option to deliver a morning peak service between Arbroath and Dundee. Three alternative options were developed to address this issue. However, two of these required changes to existing national or regional services, and the third required an additional unit, which may not be available.

13. Operating costs and demand forecasts were developed for each start up option to provide the evidence to underpin the economic evaluation. It was assumed that all options required the same infrastructure enhancements as the full long term option.

## Appraisal

14. An appraisal was carried out qualitatively against the Planning Objectives developed for the study, and quantitatively using a Transport Economic Efficiency analysis which monetises costs and benefits.

15. A comparison of the key elements for each option is shown in the following table:

| | Option 1 - Start Up | Option 2 - Blair Atholl | Option 3 - Extra Stops | Option 4 - Additional Unit | Option 5 - Full Timetable |
|---|---|---|---|---|---|
| BCR | 1.4 | 1.6 | 1.5 | 2.0 | 1.6 |
| NPV (£m) | 6.2 | 9.1 | 7.5 | 20.6 | 28.4 |
| Planning Objective Score | 9 | 5 | 11 | 14 | 18 |
| Journeys (000s) | 131 | 171 | 163 | 241 | 318 |
| Revenue (£000s) | 626 | 823 | 778 | 1,125 | 1,501 |
| Cost (£000s) | 1,482 | 1,545 | 1,482 | 1,931 | 3,293 |
| Subsidy (£000s) | 856 | 722 | 704 | 806 | 1,792 |

**Note:** Revenue, cost and subsidy are in 2009/10 prices and assume the service is in steady state, taken to be 2018 levels, where there is no passenger ramp up.

### Conclusion

16. The table shows that, in the Start Up period:

- Option 1 provides a positive BCR. However, the lack of a morning peak service from its key stations is unlikely to drive a change in travel behaviour encouraging ad-hoc, rather than regular, use. We believe this service, although deliverable does not represent good value for money when compared with the other start up options.
- Option 2 performs well economically, but conflicts with regional objectives impacting regional and local services in the morning peak. This is reflected in the low score against the planning objectives.
- Option 3 also has a good BCR, but may conflict with national objectives by adding stops to an express service between Aberdeen to Glasgow in the morning peak.
- Option 4 is the best performing start up option when assessed qualitatively and quantitatively. However this option requires an additional DMU to resource morning peak services between Perth and Arbroath and we believe there is currently no spare rolling stock available to the ScotRail franchisee.

17. The positive economic assessments of all of these options show that latent demand does exist for an improved service level at the stations north of Dundee. We believe even limited additional services would prove attractive to passengers and that, where it is possible to extend some Dundee terminating services to Arbroath at marginal cost, this should be explored.

18. The full long term option (shown above as Option 5) does not currently deliver as strong a BCR as start up option 4, although it better meets the planning objectives and has larger patronage. We believe that this is because both costs and benefits for this option have been estimated prudently. Given the amount of changes that are likely to take place between now and a likely start date, assumed to be December 2017 (after EGIP has been completed), we would expect the franchisee to deliver a more refined option with reduced costs and increased benefits.

## Recommendation

19. The study recommends a phased approach to implementing TERS services:

- In the short term, seek to widen the benefit of the new Dundee to Glasgow services which will be introduced in December 2011, by extending them through to start and terminate at Arbroath;
- When a suitable DMU becomes available, Option 4 should then be implemented. This provides cost effective morning and evening peak services across Dundee and Perth. A DMU could be made available as early as the December 2012 through refinements to the HML timetable being used to pick up the calls of the morning Blair Atholl to Perth commuter service. If this did not prove viable, the next opportunity to obtain the required rolling stock is likely to be in the next franchise; and
- Implement the full service when further rolling stock becomes available and the other timetable interfaces are sufficiently stable to optimise the efficiency of the operation. The earliest opportunity for this phase is likely to be following completion of EGIP in late 2016.

# 1 Introduction

1.1 Steer Davies Gleave is delighted to have been given this opportunity to present TACTRAN with a refresh of the 2009 Tay Estuary Rail Study (TERS) business case.

1.2 The key objective of this work is to provide TACTRAN, Transport Scotland and rail industry stakeholders with the confidence that TERS remains a viable and deliverable scheme and complements the planned Highland Main Line and Aberdeen to Edinburgh / Glasgow service improvements.

### Background

1.3 Since publication of the Extended Tay Estuary Rail Study (TERS) STAG type appraisal in June 2009, TACTRAN has continued to engage with the rail industry to progress the study outputs towards delivery. Transport Scotland could not support further development of the TERS scheme until their own proposals for Highland Main Line (HML) were finalised. The TERS scheme recognised the political importance of HML and therefore developed a flexible timetabling approach to fit around the HML scenarios which were being considered in early 2009.

1.4 In November 2010 the Scottish Government announced HML proposals to increase the number of daily services between Inverness and Edinburgh / Glasgow from 9 to 11 per day in each direction. There remains a long term aspiration to a full hourly service and faster journey times, as proposed by STPR.

1.5 The TERS work undertaken in early 2009 was based upon the assumption that Highland Main Line would run a service between Glasgow and Inverness every two hours and that a new off peak service would run in the alternate hours between Glasgow and Perth (Priced Option 11 of the ScotRail Franchise Extension Agreement). This provided an hourly service throughout the day between Glasgow and Perth which TERS could build upon.

1.6 The current HML proposal provides two extra services per day between Glasgow and Perth, and Transport Scotland has now confirmed that Priced Option 11, for increased services between Glasgow and Perth, will not be called off. The first phase of HML is scheduled to commence at the December 2011 timetable change and as such First ScotRail (FSR) has recently submitted bids to Network Rail for timetable paths. Following small line speed improvements, a further minor adjustment is due for the December 2012 timetable change. Therefore, the December 2011 timetable bid now provides a firm base against which TERS can develop an optimised timetable and use this to refine demand forecasts, performance assessment and operating cost estimates.

1.7 Factors other than HML and Priced Option 11 services which have changed since the 2009 study and influence TERS are:

- The twice hourly service between Edinburgh and Dundee which commenced in December 2008 has now bedded in and patronage data is available to assess. This is likely to improve the accuracy of demand forecasts between Dundee and Perth and Glasgow;

- The Dundee Central Waterfront Redevelopment has presented firm delivery timescales with the V&A museum, offshore renewable energy employment opportunities, retail and leisure businesses now all confirmed;
- Rail patronage in Scotland has continued to grow throughout the economic downturn, albeit at a slower rate than before. This will only have a small impact on the business case appraisal but significantly helps the start up costs of a TERS service in the short term; and
- Network Rail has issued a draft of its Scotland Route Utilisation Strategy Generation Two which forecasts more optimistic growth levels than STPR in the medium term.

1.8 Follow up meetings with Transport Scotland and Network Rail have also identified the following issues which would benefit from further clarification:

- Further analysis of the performance impact of a TERS service terminating at Arbroath station and in particular clearing down line before the next train arrives in the signalling section;
- Network Rail has offered views as to how operating cost and demand forecasts should be estimated; and
- Transport Scotland has reiterated the precedence of HML over TERS and requires demonstrable evidence that the services do not conflict.

## Approach

1.9 This update document is not a full STAG type report, as the June 2009 document was. The intention is that it brings key elements of the earlier appraisal up to date and has sufficient detail to be able to be read as a standalone document. As such it covers the following areas:

- Chapter 2 covers the context in terms of developments on the railway and the policy fit;
- Chapter 3 refines this into relevant policy objectives against which the developed timetable options can be assessed;
- Chapter 4 describes the development of the timetable options; testing of the timetable robustness using performance modelling and the development of appropriate infrastructure and operating costs;
- Chapter 5 describes the demand forecasting methodology;
- Chapter 6 describes the appraisal of the options developed in Chapter 4 leading to;
- The development of a preferred option in Chapter 7.

# 2 Context

## Constraints and Opportunities

### *High-level regional overview*

2.1 The TACTRAN region has a unique geography and population distribution. The Stirling, Perth and Dundee cities support a dense urban population while a significant proportion of the population is dispersed across communities and settlements within the wide rural hinterland to the north and west of the region.

2.2 The geography of the region results in the following issues:

- routes to the south need to cross congested areas of the national network;
- the most direct route from the eastern part of the region to the south is constrained by two estuarial crossings;
- the rail link between Perth and Edinburgh is rather indirect; and
- large areas of the north and west of the region are a considerable distance from the trunk road & rail network.

2.3 The TACTRAN area covers a number of key transport corridors between the Central Belt and the rest of Scotland, which provide for a number of inter and intra regional movements.

2.4 Some of the main constraints to travel in the region include: the remoteness and rural nature of large areas of the region (in particular, to the north and west); growing traffic congestion in the three main cities and the resultant impacts on the economy and environment; background traffic growth and changes to commuting patterns which exacerbate congestion in the cities as well as key sections of the strategic road network.

2.5 As a result of increasing mobility and a growing local economy traffic on the TACTRAN road network has been increasing on average by around 1.6% per annum over the last 10 years[1]. Congestion, however, only affects some key areas of the network including certain single carriageway sections on the trunk roads, as well as particular areas within Dundee (and to a lesser extent, Stirling and Perth) during the peak periods. Travel patterns also continue to change: a trend of greater mobility has occurred across the region in places where the economy is growing.

2.6 There has been an increase of 9,000 jobs in the region since 1998 with around 2,000 in Perth and Kinross, around 2,250 in Stirling and more than 4,500 in Dundee. Consequently, there is an increased level of in-commuting to Dundee and, given Stirling's proximity to the Central Belt, there is an increase in out-commuting from Stirling. The RTS identifies that approximately 69% of all journeys to work in TACTRAN are made by the car, and rail accounts for approximately 2%. An opportunity exists to encourage a shift in the number of commuting trips by car to rail.

[1] TACTRAN Regional Transport Strategy

2.7 The TACTRAN RTS indicates that "employment levels in TACTRAN are forecast to increase, leading to increased prosperity and increased demand for commuter travel".

2.8 Collectively, proposed development areas are not expected to have a material influence on the transport issues affecting the wider region. In reference to this study however, and within the wider context of improving air quality and reducing congestion, they may indicate where patronage of rail services/ stations could be expected to increase.

2.9 The key driver of demand is believed to be the fact that rail is not currently a viable transport option for large areas of current land use. This demand will be enhanced through demographic and land use changes. Changes to housing provision in the form of new developments will increase the number of trips produced in specific areas and potential demand at stations in which these developments fall should be captured.

2.10 It has already been seen that Dundee has experienced growth in commuting trips into the city. This is likely to be further increased with the new commercial developments and the V&A Museum at the Central Waterfront and commercial developments at City Quay east of the Tay Bridge. Development at Ninewells is likely to attract additional trips to the area and may increase usage at stations particularly if a new station is opened at Dundee West.

***Rail-specific***

2.11 The existing rail network between Glasgow and Aberdeen has sections where the available capacity is already fully utilised as well as sections where capacity exists to accommodate additional services.

2.12 The area is served by relatively good inter urban rail services with at least hourly connections between Aberdeen, Dundee, Perth, Glasgow and Edinburgh. The journey times of the express services have been shortened through removal of stops at many intermediate stations. The reduced journey times has made these services more competitive with other transport modes and patronage levels are good and continue to grow. National policy remains focused on reducing the journey times between the main urban centres.

2.13 At the southern end of the route, all stations between Dunblane and Glasgow have frequent levels of service throughout the day. A positive change has recently taken place as Transport Scotland and First ScotRail will be providing additional services between Glasgow, Perth and Dundee. These will be introduced at the December 2011 timetable change and complement new services between Inverness and Edinburgh and Glasgow.

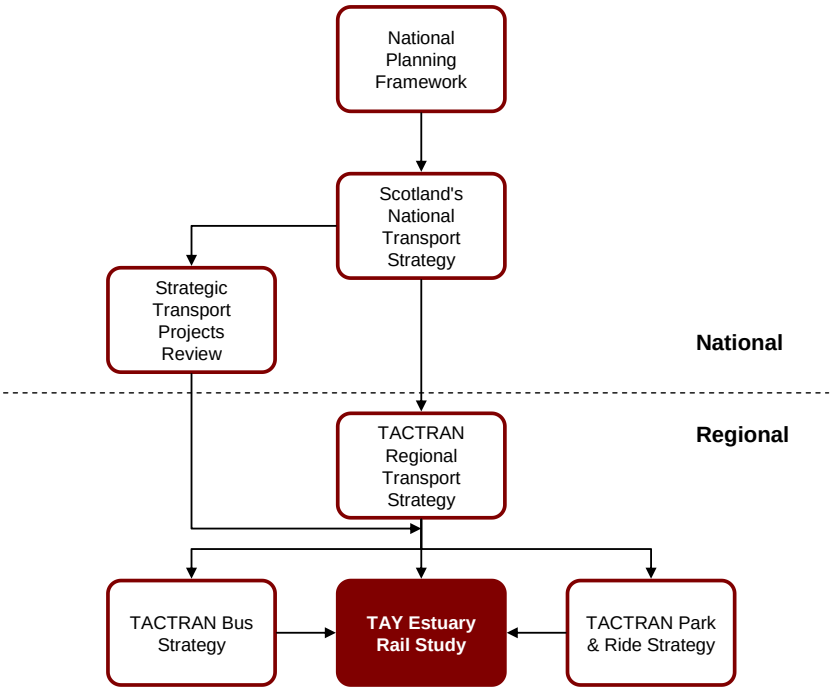
2.14 North of Dunblane the only intermediate stations receiving regular rail services throughout the day are Carnoustie and Arbroath. Accordingly rail is not perceived as a viable public transport option at communities such as Invergowrie, Broughty Ferry and Monifieth, despite having access to a rail station.

## Planning and Policy framework

2.15 The Tay Estuary Rail Study sits beneath the Regional Transport Strategy for the TACTRAN area which in turn takes into account national transport and planning policy. Figure 2.1 illustrates where this study sits in relation to other national and

regional strategies and policy documents. The study is informed by the national planning and transport policies and strategies in the hierarchy as well as the TACTRAN Regional Transport Strategy. There are also key linkages with other regional studies such as the Regional Bus Strategy and the TACTRAN Park & Ride Strategy.

**FIGURE 2.1 POLICY CONTEXT**




***National Planning Framework 2***

2.16 The National Planning Framework 2, published in June 2009, is a non-statutory planning policy document which looks at Scotland from a spatial perspective and sets out an achievable long-term vision to 2030. The key aims are:

- **Contribute to a wealthier and fairer Scotland** by supporting sustainable economic growth and improved competitiveness and connectivity;
- **Promote a greener Scotland** by contributing to the achievement of climate change targets and protecting and enhancing the quality of the natural and built environments;
- **Help build safer, stronger and healthier communities**, by promoting improved opportunities and a better quality of life; and
- **Contribute to a smarter Scotland** by supporting the development of the knowledge economy.

***Scotland's National Transport Strategy***

2.17 Scotland's National Transport Strategy, published in December 2006, presented a number of high level transport objectives, which were developed from those set out in the most recent Transport White Paper 'Scotland's Transport Future' (2004).

2.18 These objectives are supported by three strategic outcomes which will have wider benefits and will contribute to the delivery of a number of other key priorities including health improvement, social inclusion and regeneration:

- Improve journey times and connections, to tackle congestion and the lack of integration and connections in transport which impact on high level objectives for economic growth, social inclusion, integration and safety;
- Reduce emissions, to tackle the issues of climate change, air quality and health improvement which impact on high level objectives for protecting the environment and improving health; and
- Improve quality, accessibility and affordability, to give people a choice of public transport, where availability means better quality transport services and value for money or an alternative to the car.

*Strategic Transport Projects Review (STPR)*

2.19 The STPR is focussed on delivering a strategic transport network which will benefit the whole of Scotland and deliver on the priorities set out in the Government Economic Strategy, the National Transport Strategy, the National Planning Framework and the Scottish Climate Change Bill. It identifies improvements on the national rail and road network in Scotland to meet the challenges faced from 2012 and beyond. The priorities are based on the strategic outcomes of the National Transport Strategy as outlined above.

*Corridor and node objectives*

2.20 The STPR sets out a number of objectives for specific corridors and urban or strategic nodes. There are three corridors and two urban/strategic nodes with relevance to the TERS study area and their objectives are summarised in Table 2.1.

**TABLE 2.1 STPR CORRIDOR AND NODE OBJECTIVE**

| **Urban Node: Dundee** |
|---|
| To reduce the conflict between longer distance and local traffic;<br><br>To improve bus/rail interchange opportunities;<br><br>To improve the public transport accessibility and competitiveness to Dundee West;<br><br>To promote continuing reduction in accident rates and severity rates across the strategic transport network; and<br><br>To promote journey time reductions, particularly by public transport, between Aberdeen and the Central Belt primarily to allow business to achieve an effective working day when travelling between these centres. |
| **Strategic Node: Perth** |
| To contribute to reducing the emissions per person kilometre;<br><br>To promote continuing reduction in accident rates and severity rates across the strategic transport network; and<br><br>To promote journey time reductions, particularly by public transport, between the Central Belt and Aberdeen/Inverness primarily to allow business to achieve an effective working day when travelling between these centres. |

| Corridor 5 – Dundee to Aberdeen |
|---|
| To improve the public transport competitiveness between Aberdeen and Dundee (and hence onwards to the central belt);<br><br>To contribute to reducing both overall emissions and emissions per person kilometre through providing for alternatives to road freight movement on the corridor;<br><br>To promote continuing reduction in accident rates and severity rates across the strategic transport network; and<br><br>To promote journey time reductions, particularly by public transport, between the Central Belt and Aberdeen primarily to allow business to achieve an effective working day when travelling between these centres. |
| **Corridor 9 – Glasgow to Perth** |
| To address current and forecast rail overcrowding into Glasgow;<br><br>To improve the efficiency and reliability of the operation of the southern sections of the M80 on approach to Glasgow, particularly for priority vehicles;<br><br>To reduce the severity of accidents to the national average; and<br><br>To promote journey time reductions, particularly by public transport, between the Central Belt and Aberdeen/Inverness primarily to allow business to achieve an effective working day when travelling between these centres. |
| **Corridor 11 – Perth to Dundee** |
| To promote continuing reduction in accident rates and severity rates across the strategic transport network; and<br><br>To promote journey time reductions, particularly by public transport, between the Central Belt and Aberdeen primarily to allow business to achieve an effective working day when travelling between these centres. |

*Relevant investment packages*

2.21 The 29 investment packages have been developed using a three tiered approach:

- Maintain and safely operate existing assets
- Make better use of existing capacity
- Targeted infrastructure improvements

2.22 This approach is consistent with the approach that has been adopted in the Tay Estuary Rail Study. In addition to HML (project 17), STPR projects numbers 2, 6, 7, 8, 10, 12 and 15 have relevance to the study area and their impacts are considered in the option development process. However, Project 23 has a significant fit with this study and it is critical that all options appraised do not conflict with its proposed impacts.

*Project 23. Rail service enhancements between Aberdeen and the Central Belt*

2.23 Improving public transport competitiveness between Aberdeen and the Central Belt and providing enhanced opportunities to move freight by rail. It would involve:

- Recasting of the passenger timetable on the Aberdeen – Dundee – Edinburgh/Glasgow corridors;
- Providing one express train per hour to Glasgow (2hr 15min journey time); and
- Providing one express train per hour to Edinburgh (2hr journey time).

2.24 Works would be implemented in two phases. Phase 1 would include line speed enhancements, additional passing loops for freight trains and upgraded signalling along the entire length of the line to reduce headway times. It would also require more powerful rolling stock. Phase 2 will replace the single track section at Usan with a twin track railway and provide a new bridge over Montrose Basin.

2.25 Modest improvements are required to implement improved passenger services but more work is required to implement the freight side of the intervention. Potential overall emissions reductions make the full package of improvements worthwhile.

***Scotland Route Utilisation Strategy (RUS) Generation Two***

2.26 Network Rail have published their Scotland RUS (Generation Two) for consultation last October and noted continued growth in rail demand in the area. However, the TERS proposal was not considered within the draft. Following consultation between Network Rail and TACTRAN during the consultation period, it is anticipated that positive references to the TERS proposals will be included within the final Scotland RUS (Generation Two) document.

***TACTRAN Regional Transport Strategy (RTS)***

2.27 The RTS sets out six overarching objectives for the region (below), within which sit 18 sub-objectives. The overarching objectives are:

- Economy: To ensure transport helps to deliver regional prosperity;
- Accessibility, Equity and Social Inclusion: To improve accessibility for all, particularly for those suffering from social exclusion;
- The Environment: To ensure that the transport system contributes to safeguarding the environment and promotes opportunities for improvement;
- Health and Well-Being: To promote the health and well-being of communities;
- Safety & Security: To improve the real and perceived safety and security of the transport network; and
- Integration: To improve integration, both within transport and between transport and other areas.

***Regional Sub-Strategies***

2.28 Both the TACTRAN Bus Strategy and Park & Ride strategy have some overlap with TERS in relation to improved integration. For example, the Bus Strategy includes the following objective regarding integration between public transport modes:

- To increase connectivity between road based passenger transport services and between different modes of transport.

2.29 In the case of the Park & Ride strategy, there is specific recognition of rail in achieving Park & Ride actions. This is found in actions NPR10 and EPR5:

- **NPR 10**: Support the development of new rail stations at Dundee West and Bannockburn through the Tay Estuary Rail Study and/or other opportunities and ensure the provision of parking space is sufficient to match the anticipated parking demand; and
- **EPR 5**: Support the provision of additional car parking at Dunblane and/ or Bridge of Allan and at other station locations where demand warrants. All car parking issues at stations to be taken forward in consultation with Network Rail.

2.30 Both actions are set as high priority in the strategy and also relate back to the STPR investment packages. The development of a strategic park and ride site at Bannockburn is included in Investment Package 8: Strategic Park & Ride/Park & Choose Strategy.

# 3 Planning objectives

3.1 The planning objectives generated for the 2009 TERS study continue to remain valid. These objectives were developed from the issues discussed in Chapter 2 and reflect the objectives of the RTS and wider national and regional strategies. The objectives of TERS were determined as:

***Economy***

- Ec1: Ensure that rail provides and supports economic growth by connecting key business & employment sectors where possible.
- Ec2: Improve the efficiency, reliability and integration of rail services in the Tay Estuary, study area specifically where this will benefit key business and employment sectors.

***Accessibility***

- Acc1: Increase accessibility to key service destinations in the TACTRAN area (e.g. employment, health and education sites) and to/from key external destinations by rail without compromising wider inter-regional rail connectivity.

***Environment/Health & Well-Being***

- Env1: Contribute to national greenhouse gas emission reductions through rail-based interventions where possible.
- Env2: Contribute to the management of air quality in the TACTRAN area, particularly the AQMA's across the Dundee City Council area and Perth.

***Safety and security***

- Sec1: Maintain or improve real and perceived levels of safety and personal security on the rail network.

***Integration***

- Int1: Ensure that rail is fully integrated with relevant land-use and planning projects.
- Int2: Ensure the rail network is integrated with the wider public transport network.

***Policy fit***

3.2 The planning objectives were developed from an analysis of the higher level objectives set by the TACTRAN RTS and national transport planning objectives. The five common themes of economy, accessibility (and social inclusion), environment, safety and integration run strongly down the policy hierarchy and this has been continued through to developing the objectives set for this study. Whilst rail-specific, they are designed to contribute strongly to the higher level objectives set under these themes.

3.3 These objectives were agreed with stakeholders at the consultation meeting held with members of the TACTRAN Rail Forum on 23rd January 2009.

3.4 The table below illustrates the fit between the Tay Estuary Rail Study planning objectives and the higher level objectives set in the Regional Transport Strategy, the Strategic Transport Projects Review and Scotland's National Transport Strategy.

**TABLE 3.1 FIT OF TERS PLANNING OBJECTIVES WITH WIDER OBJECTIVES**

| Theme | Scotland's National Transport Strategy | Strategic Transport Projects Review Corridor and Node Objectives | TACTRAN Regional Transport Strategy | Tay Estuary Rail Study |
|---|---|---|---|---|
| **Economy** | Promote economic growth by building, enhancing managing and maintaining transport services, infrastructure and networks to maximise their efficiency. | Promote journey time reductions, particularly by public transport, between Aberdeen and the central belt primarily to allow business to achieve an effective working day when travelling between these centres.<br><br>Address current and forecast rail overcrowding into Glasgow. | Ensure transport helps to deliver regional prosperity. | Ec1: Ensure that rail provides and supports economic growth by connecting key business & employment sectors where possible.<br><br>Ec2: Improve the efficiency, reliability and integration of rail services in the Tay Estuary study area, specifically where this will benefit key business and employment sectors. |
| **Accessibility Equity and Social Inclusion** | Promote social inclusion by connecting remote and disadvantaged communities and increasing the accessibility of the transport network. | Improve public transport accessibility and competitiveness to Dundee West.<br><br>Improve public transport competitiveness between Aberdeen and Dundee (and hence onwards to the central belt). | Improve accessibility for all, particularly for those suffering from social exclusion. | Acc1: Increase accessibility between key destinations in the TACTRAN area and to/from key external destinations by rail without compromising wider inter-regional rail connectivity. |

| Theme | Scotland's National Transport Strategy | Strategic Transport Projects Review Corridor and Node Objectives | TACTRAN Regional Transport Strategy | Tay Estuary Rail Study |
|---|---|---|---|---|
| **Environment Health and Well Being** | Protect our environment and improve health by building and investing in public transport and other types of efficient and sustainable transport which minimise emissions and consumption of resources and energy. | Contribute to reducing emissions per person kilometre. | To ensure that the transport system contributes to safeguarding the environment and promotes opportunities for improvement. | Env1: Contribute to national greenhouse gas emission reductions through rail-based interventions where possible. |
| | | | To promote the health and well-being of communities. | Env2: Contribute to the management of air quality in the TACTRAN area, particularly the AQMA's across the Dundee City Council area and Perth. |
| **Safety & Security** | Improve safety of journeys by reducing accidents and enhancing the personal safety of pedestrians, drivers, passengers and staff. | Promote continuing reduction in accident rates and severity rates across the strategic transport network. | To improve the real and perceived safety and security of the transport network. | Sec1: Maintain or improve real and perceived levels of safety and personal security on the rail network. |
| **Integration** | Improve integration by making journey planning and ticketing easier and working to ensure smooth connection between different forms of transport. | Improve bus/rail interchange opportunities. | To improve integration, both within transport and between transport and other areas. | Int1: Ensure that rail is fully integrated with relevant land-use and planning projects.<br><br>Int2: Ensure the rail network is integrated with the wider public transport network. |

# 4 Option Development

## Introduction

4.1 The TERS work undertaken in early 2009 was based upon the expectation that Highland Main Line (HML) would run a service between Glasgow and Inverness every two hours and that a new off peak service would run in the alternate hours between Glasgow and Perth (Priced Option 11 of the ScotRail Franchise Extension Agreement). This provided an hourly service throughout the day between Glasgow and Perth which TERS could build upon.

4.2 The 2009 study identified a preferred long term option of an hourly Glasgow – Arbroath service. However, this requires infrastructure improvements between Perth and Glasgow because present capacity is restricted such that a single timetable path has to be shared for services running to Perth, Inverness and Dundee. This means a Glasgow to Arbroath service cannot run in the same hour as a Glasgow to Inverness service.

4.3 Two different timetable options were derived which worked around this constraint:

- An extension to Arbroath of the Glasgow – Perth service in the hours when Glasgow – Inverness services do not operate; and
- A "shuttle" between Perth and Arbroath which permits interchange at Perth for Glasgow services.

4.4 A "hybrid" option exists which combines both to permit a reasonably regular direct service between Arbroath and Glasgow with the "shuttle" to Perth used to provide the hourly local service frequency in the hours which the direct train to Glasgow cannot operate.

4.5 The HML timetable for introduction in December 2011 is different from that assumed by the study in 2009. It not only provides additional services between Glasgow and Perth, but also Perth and Dundee. First ScotRail (FSR) recently submitted bids to Network Rail for timetable paths for these new services and the bid timetable is used as the base against which new TERS timetable options can be developed and their value tested.

4.6 It is recognised that FSR are making almost full use of the DMU resources available and that it will be difficult to obtain rolling stock to operate new services until franchise renewal in 2014 at the earliest and more likely, in 2017, upon completion of EGIP. Therefore, in addition to a long term TERS timetable option, we have developed a number of alternative 'start up' options which are designed to be deliverable in the short term, with the aim of using resources which are currently available to FSR.

## Methodology

4.7 The timetables from the 2009 study were overlaid onto the FSR timetable bid for December 2011. It was then apparent that the improved Glasgow, Perth and Dundee services being introduced with HML provide an opportunity to deliver a

generally hourly Arbroath to Glasgow service with interchange at Perth in the hours which Glasgow to Inverness services operate.

4.8 To further guarantee the implementability of this long term timetable option, the performance impacts of the option was tested in RailSys and, once validated, the timetable used as the basis to refresh the demand forecasting. Existing FSR rolling stock diagrams were use to assess which services were likely to be operated by Class 158 (2 car) and Class 170 (3 car) diesel multiple units (DMUs) and, indeed, where coupled units could not be avoided for use elsewhere on the system. Estimate of operating cost were then calculated using the assessed increase in vehicle miles operated along with traincrew requirements. The FSR rolling stock diagrams were also used to estimate the number of additional DMUs required over the current base to operate the service.

4.9 The start up timetables were then developed by examining the resource requirements for the full timetable options. Services which clearly only made use of existing resources were retained and alternatives examined for resourcing peak services which were not being provided by current resources.

## Timetable development

### *December 2011 Passenger Timetable*

4.10 The base case for the timetabling work is the proposed December 2011 timetable, which has been supplied (in confidence) by ScotRail for this work. This enhances services between Glasgow, Perth and Dundee and it is assumed that Priced Option 11 has not been called off and will not be implemented in future.

4.11 The new services to be introduced in December 2011 are:

- 08:06 Glasgow QS – Dundee;
- 09:06 Glasgow QS – Dundee;
- 12:10 Glasgow QS – Perth (- Inverness);
- 15:10 Glasgow QS – Perth (- Inverness);
- 19:10 Glasgow QS – Dundee;
- 12:15 Dundee - Glasgow QS ;
- 15:15 Dundee - Glasgow QS ; and
- 19:37 Perth – Glasgow QS (originates Inverness).

4.12 In addition a number of services are to be modified in December 2011:

- 16:11 Glasgow QS – Inverness diverted to Dundee;
- 17:12 Glasgow QS – Perth extended to Dundee;
- 06:12 Perth – Glasgow QS starts back at Dundee; and
- 11:37 Perth – Glasgow QS retimed Perth dep 10:53 (originates Inverness).

4.13 Examining other operators timetables identified the following conflicts with the original TERS clockface timetable proposal:

- 14:30 Edinburgh – Aberdeen is to be operated from May 2011 by East Coast as a through service from London King's Cross. This train stops additionally in Fife compared to the previous ScotRail operation, and therefore impacts north of Dundee on a proposed TERS service.

- The proposed TERS 14:25 Perth – Arbroath appears to be in conflict with a freight service between Grangemouth and Aberdeen (4A13) north of Dundee. Flexing this service would result in a 25 min later arrival at its destination which is deemed to be unacceptable.

4.14 These both prevent mid-afternoon TERS services running as before, because they need to be looped and overtaken at Dundee.

***TERS timetable***

4.15 The resulting steady state timetable is shown in Figure 4.1. It is generally clockface with the exception of gaps of 11.xx and 19.xx northbound from Perth and 12.xx and 15.xx southbound from Arbroath; there are also a couple of 90-minute gaps north of Dundee in the middle of the afternoon.

4.16 The reasons for these gaps are:

- The 11.xx northbound slot is not available because the 10.28 Edinburgh – Aberdeen service is operated by East Coast. As a result this train makes more stops in Fife than is the case when the equivalent service is operated by FSR and it therefore arrives and departs Dundee later. There is then insufficient margin between this train and the following 10.41 Glasgow – Aberdeen to permit operation of a stopping service to Arbroath.
- The 19.xx northbound slot is not available because both Cross Country and East Coast operate services to Aberdeen at this time of day and there is no margin available.
- The 12.xx southbound service could run, but because the 11.xx northbound slot is not available, no resources can get to Arbroath to operate this service.
- The 15.xx southbound service could run in principle but would have to be off pattern (later) as a result of the 14.50 Aberdeen – London East Coast service operating in the normal path. However at this time of day the northbound service has also had to be adapted resulting in two 90-minute gaps; these are caused by a freight train occupying the normal 14.xx northbound path, and the 14.28 Edinburgh – Aberdeen service being operated by East Coast which, after extra stops in Fife, occupies the normal 15.xx northbound path. As a result there can only be resources at Arbroath for either a 15.xx or 16.xx southbound departure, and the latter appears preferable.

**FIGURE 4.1 LONG TERM TERS TIMETABLE WITH DEC 2011 BASE**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glasgow Queen St | | | 07:06 | | 08:06 | 09:06 | 10:10 | 11:06 | 12:10 | | 13:06 | | 14:06 | 15:10 | | 16:10 | 17:11 | 18:11 | 19:10 |
| Stirling | | | 07:33 | | 08:35 | 09:34 | 10:35 | 11:34 | 12:35 | | 13:34 | | 14:34 | 15:36 | | 16:39 | 17:45 | 18:41 | 19:37 |
| Bridge of Allan | | | | | 08:39 | | 10:41 | 11:40 | 12:41 | | 13:40 | | 14:40 | 15:41 | | 16:44 | 17:49 | 18:46 | 19:41 |
| Dunblane | | | 07:39 | | 08:43 | 09:41 | 10:43 | 11:42 | 12:43 | | 13:42 | | 14:42 | 15:45 | | 16:49 | 17:54 | 18:50 | 19:46 |
| Gleneagles | | | | | 08:55 | 09:53 | 10:55 | 11:53 | | | 13:53 | | 14:53 | | | 17:02 | 18:06 | 19:02 | 19:58 |
| Perth | | | 08:06 | | 09:12 | 10:09 | 11:14 | 12:09 | 13:11 | | 14:09 | | 15:09 | 16:11 | | 17:18 | 18:23 | 19:19 | 20:14 |
| *Inverness* | | | *10:28* | | | | *13:25* | | *15:23* | | | | | *18:28* | | | | *21:43* | |
| Perth | 06:43 | 07:32 | | 08:23 | 09:16 | 10:16 | | 12:16 | | 13:22 | 14:16 | | 15:16 | | 16:22 | 17:19 | 18:25 | | 20:15 |
| Invergowrie | 07:00 | 07:49 | | 08:40 | 09:34 | 10:34 | | 12:34 | | 13:39 | 14:34 | | 15:34 | | 16:39 | 17:37 | 18:44 | | 20:33 |
| Dundee arr | 07:07 | 07:56 | | 08:47 | 09:43 | 10:43 | | 12:41 | | 13:46 | 14:46 | | 15:41 | | 16:46 | 17:44 | 18:54 | | 20:38 |
| *Dundee dep* | *07:08* | *07:57* | | *08:48* | *09:47* | *10:48* | | *12:47* | | *13:47* | | *15:17* | | | *16:47* | *17:49* | *18:56* | | *20:47* |
| Broughty Ferry | 07:14 | 08:03 | | 08:54 | 09:53 | 10:54 | | 12:53 | | 13:53 | | 15:23 | | | 16:53 | 17:55 | 19:03 | | 20:53 |
| Monifieth | 07:18 | 08:07 | | 08:58 | 09:57 | 10:58 | | 12:57 | | 13:57 | | 15:27 | | | 16:57 | 17:59 | 19:09 | | 20:57 |
| Carnoustie | 07:24 | 08:13 | | 09:04 | 10:03 | 11:04 | | 13:03 | | 14:03 | | 15:33 | | | 17:03 | 18:05 | 19:19 | | 21:03 |
| Arbroath | 07:31 | 08:20 | | 09:11 | 10:10 | 11:11 | | 13:10 | | 14:10 | | 15:40 | | | 17:10 | 18:12 | 19:26 | | 21:10 |
| | | | | | | | | | | | | | | | | | | | |
| Arbroath | | 06:01 | 07:45 | 08:40 | 09:40 | | 10:36 | 11:40 | | 13:41 | 14:40 | | 16:33 | 17:40 | 18:40 | | 19:40 | 21:40 | |
| Carnoustie | | 06:08 | 07:52 | 08:47 | 09:47 | | 10:43 | 11:47 | | 13:48 | 14:47 | | 16:40 | 17:47 | 18:47 | | 19:47 | 21:47 | |
| Monifieth | | 06:17 | 08:01 | | 09:53 | | 10:49 | 11:53 | | 13:54 | 14:53 | | 16:46 | 17:53 | 18:53 | | 19:53 | 21:53 | |
| Broughty Ferry | | 06:23 | 08:07 | 08:54 | 09:57 | | 10:53 | 11:57 | | 13:58 | 14:57 | | 16:50 | 17:57 | 18:57 | | 19:57 | 21:57 | |
| Dundee arr | | 06:30 | 08:14 | 09:00 | 10:03 | | 11:00 | 12:03 | | 14:04 | 15:03 | | 16:57 | 18:03 | 19:03 | | 20:03 | 22:03 | |
| *Dundee dep* | *05:45* | *06:32* | *08:18* | *09:02* | *10:05* | | *11:02* | *12:05* | *13:10* | *14:05* | *15:05* | | *17:05* | *18:10* | *19:05* | | *20:05* | 22:07 | |
| Invergowrie | | 06:39 | 08:23 | 09:09 | 10:12 | | 11:09 | 12:12 | 13:17 | 14:12 | 15:12 | | 17:12 | 18:17 | 19:12 | | 20:12 | 22:12 | |
| Perth | 06:11 | 06:57 | 08:40 | 09:27 | 10:30 | | 11:27 | 12:30 | 13:35 | 14:30 | 15:30 | | 17:30 | 18:35 | 19:30 | | 20:30 | 22:30 | |
| *Inverness* | | | | | | *09:18* | | | | | | *14:47* | | | | *17:22* | | | |
| Perth | 06:12 | 07:02 | 08:41 | 09:38 | | 10:53 | 11:38 | 12:38 | 13:38 | 14:38 | 15:37 | 16:53 | 17:37 | 18:37 | | 19:37 | 20:37 | | |
| Gleneagles | 06:29 | 07:16 | 08:55 | 09:53 | | 11:08 | 11:53 | 12:53 | 13:53 | 14:53 | 15:52 | 17:08 | 17:52 | 18:52 | | 19:51 | 20:52 | | |
| Dunblane | 06:45 | 07:29 | 09:07 | 10:04 | | 11:20 | 12:04 | 13:04 | 14:04 | 15:04 | 16:05 | 17:20 | 18:05 | 19:05 | | 20:05 | 21:05 | | |
| Bridge of Allan | 06:48 | 07:32 | 09:10 | 10:08 | | 11:23 | 12:08 | 13:08 | 14:08 | 15:08 | 16:09 | 17:23 | 18:09 | 19:09 | | 20:09 | 21:09 | | |
| Stirling | 06:54 | 07:38 | 09:15 | 10:13 | | 11:28 | 12:13 | 13:13 | 14:13 | 15:13 | 16:14 | 17:29 | 18:14 | 19:14 | | 20:14 | 21:14 | | |
| Glasgow Queen St | 07:34 | 08:18 | 09:45 | 10:45 | | 12:08 | 12:45 | 13:45 | 14:45 | 15:45 | 16:45 | 18:09 | 18:45 | 19:45 | | 20:46 | 21:45 | | |

Proposed TERS service added to Dec 2011 base

### *Timetable resources*

4.17 The draft FSR diagrams supporting the December 2011 timetable bid were reviewed and the TERS services overlaid. Rolling stock resources were (either class 158 or 170) allocated to operate each TERS service in a manner which fits with the earlier inbound working.

4.18 This detail allows accurate estimates of total vehicle miles to be developed, which also account for instances where existing services are strengthened. For example: the existing 07.02 Perth to Glasgow departure is currently formed of 2 x class 170 units. In the TERS timetable these sets now start back at Arbroath, departing at 06.01. In resource terms this means that 6 vehicles incur 38 additional miles. Total vehicle miles for the full and truncated service options are presented in Table 4.1.

4.19 The new rolling stock diagrams identified a need for two additional class 158 units and one class 170 unit to operate both the full and truncated timetables. These trains are required to form the 06.43, 07.32 and 08.23 departures from Perth to Arbroath and subsequently form the 07.45, 8.40 and 9.40 departures from Arbroath to Perth and Glasgow.

4.20 From discussions with FSR, it was recognised that the new December 2011 timetable has used all of the spare capacity in existing traincrew rosters. In general new traincrew shifts would be required to staff most of the TERS services. 12 drivers and guards were estimated as being required to provide this cover Monday to Saturday for the specified hours of operation.

4.21 The additional mileage operated by the train fleet will require 25 to 30 additional "B" maintenance examinations for both the class 158 and 170 fleets per annum. The material cost of these is included in the assumed rate per vehicle mile, however labour is not. It is unlikely this level of increase in workload could be accommodated within existing depot staffing levels, so we have added the cost of

3 additional maintenance staff for each option where the annual FSR fleet mileage increases by more than 1m.

4.22 Cleaning requirements are driven more by the fleet size than the number of services operated. As the increase in fleet size of 3 DMUs is proportionally small, it was felt reasonable to assume sufficient resources were present in the existing traincare teams.

## Short term timetables

4.23 The resource analysis supporting the timetable was reviewed to identify timetables which could operate using rolling stock currently available to FSR.

***Resource opportunities***

*AM Peak*

4.24 No significant additional services can be run in the early morning or am peak – all units stabled at Dundee and Perth depart prior to 07:00 and there is little opportunity to use them to operate additional TERS services.

4.25 The only option identified is for the 07:02 Perth – Glasgow to start back at Dundee, or even Arbroath. In doing so it could also replace the current 06:14 Carnoustie – Dundee service which is the one train that serves all stations between Carnoustie and Dundee. However, it should be noted that the 07:02 is formed of 2 x 3-car Class 170, and is therefore overlength for many platforms. It is presumed possible that 3 cars could remain locked out of public use until arrival at Perth.

4.26 Running this service would require 2 x 170 to work empty coaching stock (ECS) from Perth to Arbroath, replacing 2 x 158 running ECS from Dundee to Carnoustie.

*Off Peak*

4.27 In the off peak more opportunity exists to make use of spare time in current resources. There are choices that could be made as to the preferred use of the units, the main difference being the opportunity to run more trains between Glasgow and Perth/Dundee in one option, as opposed to an additional service to Arbroath in the other.

4.28 In the first scenario the following trains could be run:

- 08:06 Glasgow – Dundee could be extended to Arbroath
- 09:06 Glasgow – Dundee could be extended to Arbroath
- 11:06 Glasgow – Arbroath additional
- 13:06 Glasgow – Dundee additional
- 10:36 Arbroath – Glasgow additional
- 12:05 Dundee – Glasgow could start back at Arbroath
- 13:40 Arbroath – Glasgow additional

4.29 The above would fill all but one of the off peak gaps between Glasgow and Perth (14:06 ex Glasgow) and leave two in the opposite direction (09:38 and 13:38 ex Perth). It would also enable the 10:48 Glasgow – Dunblane to be short terminated at Stirling and the 12:13 Dunblane – Glasgow to start from Stirling.

4.30 In the second off peak scenario the following trains could be run:

- 08:06 Glasgow – Dundee could be extended to Arbroath
- 09:06 Glasgow – Dundee could be extended to Arbroath
- 11:06 Glasgow – Arbroath additional
- 13:25 Perth – Arbroath additional
- 10:36 Arbroath – Perth additional
- 12:05 Dundee – Glasgow could start back at Arbroath
- 13:40 Arbroath – Glasgow additional
- 15:15 Dundee – Glasgow could start back at Arbroath

4.31 The above would leave two of the off peak gaps between Glasgow and Perth (13:06 and 14:06 ex Glasgow) and leave three in the opposite direction (09:38, 11:38 and 13:38 ex Perth) but would provide an additional service between Dundee and Arbroath and vice versa(VV).

4.32 A high level assessment of demand impact along with a review of the inherent flexibility of the service determined that providing the additional Dundee to Arbroath service was slightly more advantageous than filling a further Glasgow – Perth gap.

*PM Peak/Evening*

4.33 In the evening there are also opportunities for additional services, with choices to the preferred use of the units. The main difference being the opportunity to run an additional train between Perth/Dundee and Arbroath and VV, or additional evening trains between Dundee and Glasgow and VV.

4.34 Certain later services can be regarded as optional according to the likely demand/cost, but units must remain balanced.

4.35 If a 19.40 Arbroath – Glasgow and 20:10 Glasgow – Dundee both run, the 19:49 Glasgow – Dunblane can be curtailed at Stirling and the 21:13 Dunblane – Glasgow to start back from Stirling.

***Option 1 - Basic Start Up Option Timetable***

4.36 The preferred 'start up' option timetable uses a combination of additional am, off and pm peak services as discussed above. The key drawback of this timetable is the lack of a morning peak service between Arbroath and Dundee serving Broughty Ferry and Monifieth. The timetable is summarised in Figure 4.2 below.

**FIGURE 4.2 TERS START UP SERVICE TIMETABLE**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glasgow Queen St | 07:06 | 08:06 | 09:06 | 10:10 | 11:06 | 12:10 | | 15:10 | 16:10 | 17:11 | 18:11 | 19:10 |
| Stirling | 07:33 | 08:35 | 09:34 | 10:35 | 11:34 | 12:35 | | 15:36 | 16:39 | 17:45 | 18:41 | 19:37 |
| Bridge of Allan | | 08:39 | | 10:41 | | 12:41 | | 15:41 | 16:44 | 17:49 | 18:46 | 19:41 |
| Dunblane | 07:39 | 08:43 | 09:41 | 10:43 | 11:42 | 12:43 | | 15:45 | 16:49 | 17:54 | 18:50 | 19:46 |
| Gleneagles | | 08:55 | 09:53 | 10:55 | 11:53 | | | | 17:02 | 18:06 | 19:02 | 19:58 |
| Perth | 08:06 | 09:12 | 10:09 | 11:14 | 12:09 | 13:11 | | 16:11 | 17:18 | 18:23 | 19:19 | 20:14 |
| *Inverness* | *10:28* | | | *13:25* | | *15:23* | | *18:28* | | | *21:43* | |
| Perth | | 09:16 | 10:16 | | 12:16 | | 13:22 | | 17:19 | 18:25 | | 20:15 |
| Invergowrie | | 09:34 | 10:34 | | 12:34 | | 13:39 | | 17:37 | 18:44 | | 20:33 |
| Dundee arr | | 09:43 | 10:43 | | 12:41 | | 13:46 | | 17:44 | 18:54 | | 20:38 |
| *Dundee dep* | | *09:47* | *10:48* | | *12:47* | | *13:47* | | *17:49* | *18:56* | | *20:47* |
| Broughty Ferry | | 09:53 | 10:54 | | 12:53 | | 13:53 | | 17:55 | 19:03 | | 20:53 |
| Monifieth | | 09:57 | 10:58 | | 12:57 | | 13:57 | | 17:59 | 19:09 | | 20:57 |
| Carnoustie | | 10:03 | 11:04 | | 13:03 | | 14:03 | | 18:05 | 19:19 | | 21:03 |
| Arbroath | | 10:10 | 11:11 | | 13:10 | | 14:10 | | 18:12 | 19:26 | | 21:10 |
| | | | | | | | | | | | | |
| Arbroath | | 06:01 | | 10:36 | 11:40 | 13:41 | 14:40 | | 18:40 | | 19:40 | 21:40 |
| Carnoustie | | 06:08 | | 10:43 | 11:47 | 13:48 | 14:47 | | 18:47 | | 19:47 | 21:47 |
| Monifieth | | 06:17 | | 10:49 | 11:53 | 13:54 | 14:53 | | 18:53 | | 19:53 | 21:53 |
| Broughty Ferry | | 06:23 | | 10:53 | 11:57 | 13:58 | 14:57 | | 18:57 | | 19:57 | 21:57 |
| Dundee arr | | 06:30 | | 11:00 | 12:03 | 14:04 | 15:03 | | 19:03 | | 20:03 | 22:03 |
| *Dundee dep* | *05:45* | *06:32* | | *11:02* | *12:05* | *14:05* | *15:05* | | *19:05* | | *20:05* | *22:07* |
| Invergowrie | | 06:39 | | 11:09 | 12:12 | 14:12 | 15:12 | | 19:12 | | 20:12 | 22:12 |
| Perth | 06:11 | 06:57 | | 11:27 | 12:30 | 14:30 | 15:30 | | 19:30 | | 20:30 | 22:30 |
| *Inverness* | | | *09:18* | | | | | *14:47* | | *17:22* | | |
| Perth | 06:12 | 07:02 | 10:53 | | 12:38 | 14:38 | 15:37 | 16:53 | | 19:37 | 20:37 | |
| Gleneagles | 06:29 | 07:16 | 11:08 | | 12:53 | 14:53 | 15:52 | 17:08 | | 19:51 | 20:52 | |
| Dunblane | 06:45 | 07:29 | 11:20 | | 13:04 | 15:04 | 16:05 | 17:20 | | 20:05 | 21:05 | |
| Bridge of Allan | 06:48 | 07:32 | 11:23 | | 13:08 | | 16:09 | 17:23 | | 20:09 | | |
| Stirling | 06:54 | 07:38 | 11:28 | | 13:13 | 15:13 | 16:14 | 17:29 | | 20:14 | 21:14 | |
| Glasgow Queen St | 07:34 | 08:18 | 12:08 | | 13:45 | 15:45 | 16:45 | 18:09 | | 20:46 | 21:45 | |

Proposed TERS start up service added to Dec 2011 base

4.37 The lack of a southbound morning peak service is felt to be very restrictive to regular travellers and additional options to provide such a service have been examined. These have the impact of requiring changes to the December 2011 timetable or an additional Class 158 resource. This analysis has resulted in a further three options being developed as follows.

***Option 2 - Blair Atholl***

4.38 This option requires the Blair Atholl to Perth section of the 07.12 Blair Atholl - Edinburgh service to be withdrawn and the set used to form an additional 06.43 Perth – Arbroath and then the 08.18 Dundee to Glasgow which would start back at Arbroath at 07.45.

4.39 As a replacement, the 06.55 Perth to Edinburgh would start back at Blair Atholl at 06.07 and in addition to this, an additional stop would be provided in the 06.47 service from Inverness, stopping at Blair Atholl around 08.20.

4.40 An unfortunate consequence of this service change is that the 06.29 from Edinburgh to Dundee would have to terminate at Perth so as to form the 07.59 Perth to Edinburgh (rather than continue at 07.48 to Dundee), thus replacing the element currently formed by the 07.12 Blair Atholl starter. This results in the loss of a morning peak service from Perth to Dundee, which is contrary to the objective of trying to improve local services.

***Option 3- Additional Stops in the Aberdeen to Glasgow service***

4.41 Option 3 sees two extra stops added into the 06.33 Aberdeen – Glasgow. This should cost 4.5 minutes for both stops, but assuming we can use the 1.5 minutes

pathing time shown between Arbroath and Dundee, this should only cost 3 minutes extra, and it is assumed that this in north of Dundee. The stops are at Monifieth 07.40 and Broughty Ferry 07.44.

4.42 It is recognised that adding additional stops and lengthening journey times of regional express services is contrary to current Transport Scotland policy.

***Option 4 - Additional Unit***

4.43 The last option assumes an additional class 158 unit can be acquired. This is used to operate the 06.29 Edinburgh – Dundee via Perth, so that the class 170 currently assigned to this service can operate the 08.18 Dundee – Glasgow starting back at Arbroath at 07.45 as in Option 2. Assuming this unit is stabled overnight at Perth, it could also provide an 06.43 from Perth to Arbroath. The additional unit would then work through to Arbroath at 08.18 from Dundee and form an 08.57 from Arbroath to Perth. We have the assumed that the unit is not used again until the evening peak, forming the 16.22 Perth to Arbroath and 17.40 Arbroath to Glasgow. A timetable simplifier is presented in Figure 4.3.

4.44 We have accounted for this unit's full cost in the appraisal. There may be an opportunity for it to generate additional benefit in the off-peak, either on a TERS service or elsewhere on the network. There may be an opportunity to develop these services when the core service becomes established.

**FIGURE 4.3 TERS START UP SERVICE TIMETABLE WITH ADDITIONAL CL158**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glasgow Queen St | | | 07:06 | 08:06 | 09:06 | 10:10 | 11:06 | 12:10 | | 15:10 | | 16:10 | 17:11 | 18:11 | 19:10 |
| Stirling | | | 07:33 | 08:35 | 09:34 | 10:35 | 11:34 | 12:35 | | 15:36 | | 16:39 | 17:45 | 18:41 | 19:37 |
| Bridge of Allan | | | | 08:39 | | 10:41 | | 12:41 | | 15:41 | | 16:44 | 17:49 | 18:46 | 19:41 |
| Dunblane | | | 07:39 | 08:43 | 09:41 | 10:43 | 11:42 | 12:43 | | 15:45 | | 16:49 | 17:54 | 18:50 | 19:46 |
| Gleneagles | | | | 08:55 | 09:53 | 10:55 | 11:53 | | | | | 17:02 | 18:06 | 19:02 | 19:58 |
| Perth | | 07:47 | 08:06 | 09:12 | 10:09 | 11:14 | 12:09 | 13:11 | | 16:11 | | 17:18 | 18:23 | 19:19 | 20:14 |
| *Inverness* | | | *10:28* | | | *13:25* | | *15:23* | | *18:28* | | | | *21:43* | |
| Perth | 06:43 | 07:48 | | 09:16 | 10:16 | | 12:16 | | 13:22 | | 16:22 | 17:19 | 18:25 | | 20:15 |
| Invergowrie | 07:00 | 08:05 | | 09:34 | 10:34 | | 12:34 | | 13:39 | | 16:39 | 17:37 | 18:44 | | 20:33 |
| Dundee arr | 07:07 | 08:13 | | 09:43 | 10:43 | | 12:41 | | 13:46 | | 16:46 | 17:44 | 18:54 | | 20:38 |
| *Dundee dep* | *07:08* | *08:15* | | *09:47* | *10:48* | | *12:47* | | *13:47* | | *16:47* | *17:49* | *18:56* | | *20:47* |
| Broughty Ferry | 07:14 | 08:21 | | 09:53 | 10:54 | | 12:53 | | 13:53 | | 16:53 | 17:55 | 19:03 | | 20:53 |
| Monifieth | 07:18 | 08:25 | | 09:57 | 10:58 | | 12:57 | | 13:57 | | 16:57 | 17:59 | 19:09 | | 20:57 |
| Carnoustie | *07:24* | 08:31 | | 10:03 | 11:04 | | 13:03 | | 14:03 | | 17:03 | 18:05 | 19:19 | | 21:03 |
| Arbroath | 07:31 | 08:38 | | 10:10 | 11:11 | | 13:10 | | 14:10 | | 17:10 | 18:12 | 19:26 | | 21:10 |
| | | | | | | | | | | | | | | | |
| Arbroath | | 06:01 | 07:45 | 08:57 | | 10:36 | 11:40 | 13:41 | 14:40 | | 17:40 | 18:40 | | 19:40 | 21:40 |
| Carnoustie | | 06:08 | 07:52 | 09:04 | | 10:43 | 11:47 | 13:48 | 14:47 | | 17:47 | 18:47 | | 19:47 | 21:47 |
| Monifieth | | 06:17 | 08:01 | 09:10 | | 10:49 | 11:53 | 13:54 | 14:53 | | 17:53 | 18:53 | | 19:53 | 21:53 |
| Broughty Ferry | | 06:23 | 08:07 | 09:14 | | 10:53 | 11:57 | 13:58 | 14:57 | | 17:57 | 18:57 | | 19:57 | 21:57 |
| Dundee arr | | 06:30 | 08:14 | 09:20 | | 11:00 | 12:03 | 14:04 | 15:03 | | 18:03 | 19:03 | | 20:03 | 22:03 |
| *Dundee dep* | *05:45* | *06:32* | *08:18* | *09:23* | | *11:02* | *12:05* | *14:05* | *15:05* | | *18:10* | *19:05* | | *20:05* | *22:07* |
| Invergowrie | | 06:39 | 08:23 | 09:30 | | 11:09 | 12:12 | 14:12 | 15:12 | | 18:17 | 19:12 | | 20:12 | 22:12 |
| Perth | 06:11 | 06:57 | 08:40 | 09:52 | | 11:27 | 12:30 | 14:30 | 15:30 | | 18:35 | 19:30 | | 20:30 | 22:30 |
| *Inverness* | | | | | *09:18* | | | | | *14:47* | | | *17:22* | | |
| Perth | 06:12 | 07:02 | 08:41 | | 10:53 | | 12:38 | 14:38 | 15:37 | 16:53 | 18:37 | | 19:37 | 20:37 | |
| Gleneagles | 06:29 | 07:16 | 08:55 | | 11:08 | | 12:53 | 14:53 | 15:52 | 17:08 | 18:52 | | 19:51 | 20:52 | |
| Dunblane | 06:45 | 07:29 | 09:07 | | 11:20 | | 13:04 | 15:04 | 16:05 | 17:20 | 19:05 | | 20:05 | 21:05 | |
| Bridge of Allan | 06:48 | 07:32 | 09:10 | | 11:23 | | 13:08 | | 16:09 | 17:23 | 19:09 | | 20:09 | | |
| Stirling | 06:54 | 07:38 | 09:15 | | 11:28 | | 13:13 | 15:13 | 16:14 | 17:29 | 19:14 | | 20:14 | 21:14 | |
| Glasgow Queen St | 07:34 | 08:18 | 09:45 | | 12:08 | | 13:45 | 15:45 | 16:45 | 18:09 | 19:45 | | 20:46 | 21:45 | |

Proposed TERS start up service added to Dec 2011 base

***Option 5 – Full timetable***

4.45 Through the remainder of the report, the full TERS option has been described as Option 5.

## Performance Modelling

4.46 The performance impact of the new full TERS timetable has been modelled using an updated version of the RailSys model used in the 2009 study.

4.47 RailSys has been used iteratively during the timetable development process to validate the work in progress to check compliance with Network Rail's planning rules for this section of route. We can therefore have confidence the resulting timetables are robust and operable.

4.48 Performance simulations have also been undertaken, specifically focussing on key areas of concern or risk. The conclusions of the 2009 performance modelling will remain substantially valid for the new timetable, due to the relatively small number of differences between this and the 2009 preferred option timetables. The previous performance modelling analysed the impact of proposed new services on the network as a whole, and identified the approaches to Glasgow Queen St as the key performance impact.

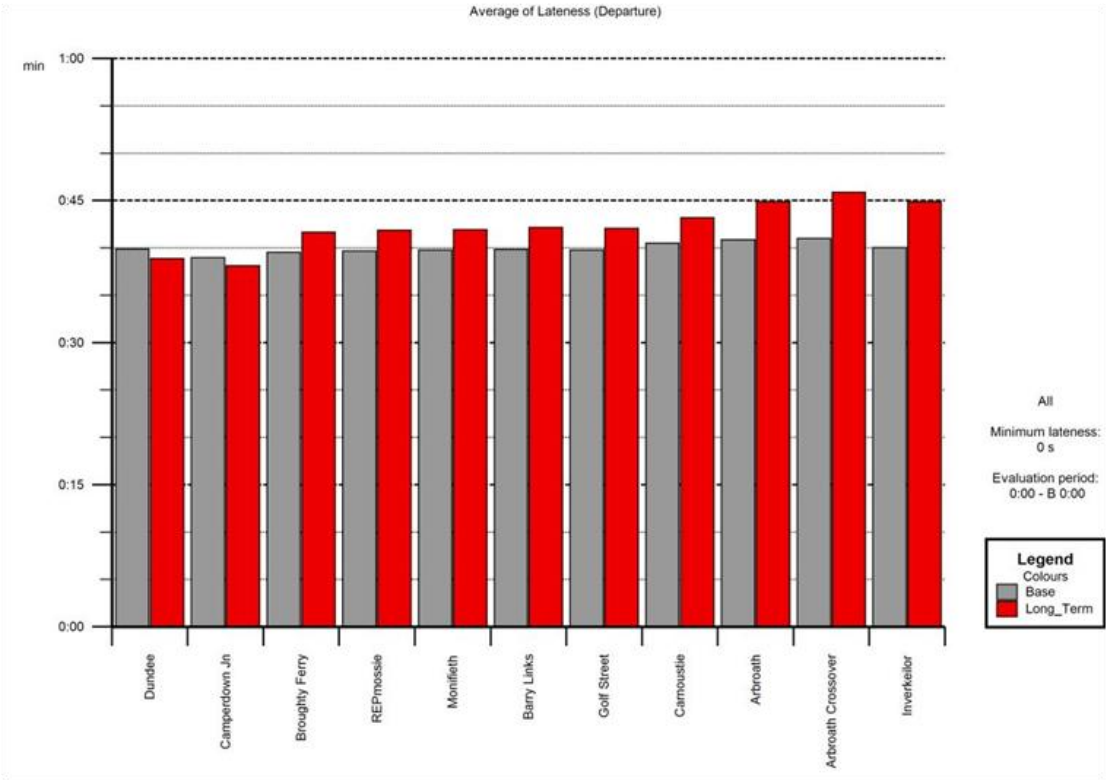
4.49 Turning back services at Arbroath requires empty stock movements from the Down Main line to cross the Up Main line to access the Up Relief Siding. Such a move could be a potential risk to the performance and robustness of the timetable. Therefore, a localised study focussing on the turn-back operation at Arbroath was identified as being of more value than a further route wide analysis.

4.50 The existing RailSys model covers the infrastructure from both Glasgow Queen Street and Haymarket, to Inverness via Aberdeen. A partial network has been created covering the infrastructure from Hilton Junction to Inverkeilor to focus on the Arbroath area, as well as including the key areas of Perth and Dundee. This modelling is to compare the relative performance of a December 2011 base timetable, which does not have services turning back at Arbroath, against the proposed full TERS timetable, which does.

4.51 The simulation is not intended to predict exact values of delay or lateness for the proposed timetable, as this is beyond the capabilities of the software tool. However this test gives an indication of any change in performance between the base and the proposed timetables.

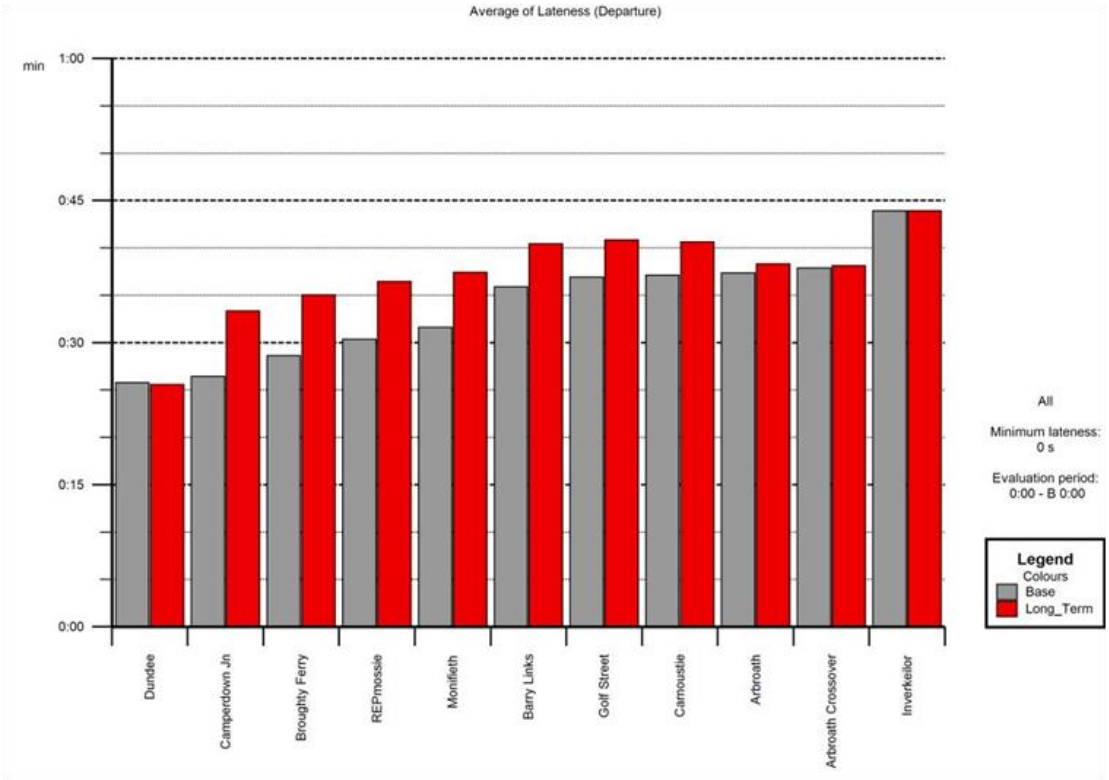
4.52 The proposed timetable does exhibit additional average lateness per train in comparison to the Base Timetable between Dundee and Arbroath as seen in Figures 4.4 and 4.5. However the difference is slight with the greatest increase northbound at Inverkeilor with an increase from 40 to 45 seconds per train at the exit boundary for the study. A gradual increase in lateness is seen from Dundee towards the model boundary at Inverkeilor.

**FIGURE 4.4 COMPARISON OF AVERAGE DEPARTURE LATENESS PER TRAIN – NORTHBOUND**




4.53 For Southbound trains, Figure 4.5 shows that although existing services enter the model at Inverkeilor with the same delay as the base, after Arbroath the average delay increases on the approach to Dundee. For example at Monifieth the lateness has increased from 32 seconds to 37 seconds. Arbroath sees a marginal increase in average lateness of 1 second. Due to recovery time and extended dwell times over and above the minimum at Dundee, the increase in arrival lateness southbound appears to be absorbed at Dundee.

**FIGURE 4.5 COMPARISON OF AVERAGE DEPARTURE LATENESS PER TRAIN – SOUTHBOUND**




4.54 This analysis gives confidence that the TERS timetable will not have an intolerable impact on performance in the Perth, Dundee and Arbroath areas. Few additional services are introduced south of Perth, giving confidence the timetable as a whole is deliverable.

### Operating Costs

4.55 Estimates of operating cost have been developed for each full and start up service option. The key drivers of the cost of operating a new service are:

- Capital lease costs for additional rolling stock, where required;
- Heavy and light maintenance of rolling stock (labour and materials);
- Cleaning of rolling stock;
- Fuel cost;
- Variable track access charges; and
- Traincrew (drivers and guards).

4.56 Key metrics were calculated for each element using the process described (for the long term option) in paragraphs 4.17 to 4.21. Unit costs were agreed with FSR and applied to the metrics allowing an estimate to be calculated for each timetable option.

4.57 The key metrics for each option are presented in Table 4.1 showing the additional vehicle miles, DMUs and staff required as well as the total cost estimate.

**TABLE 4.1 TIMETABLE METRICS USED TO CALCULATE OPERATING COSTS**

| | Units | | Annual Vehicle Miles (000s) | | Staff | | | Cost (£000s in 2009/10 prices) |
|---|---|---|---|---|---|---|---|---|
| | Cl 158 | Cl 170 | Cl 158 | Cl 170 | Drivers | Guards | Maint | |
| Option 1 - Start Up | 0 | 0 | 357 | 254 | 8 | 8 | 2 | £1,358 |
| Option 2 - Blair Atholl | 0 | 0 | 357 | 254 | 8 | 8 | 2 | £1,358 |
| Option 3 - Extra Stops | 0 | 0 | 357 | 322 | 8 | 8 | 2 | £1,416 |
| Option 4 - Additional Unit | 1 | 0 | 500 | 320 | 9 | 8 | 2 | £1,770 |
| Option 5 - Full Timetable | 2 | 1 | 576 | 786 | 12 | 12 | 3 | £3,018 |

4.58 Due to the relatively small number of additional DMUs required in the full service options, it was assumed that cleaning could be undertaken using existing staff available in the franchise. 3 new maintenance staff were assumed when annual vehicle miles were greater than 1m and 2 for an increase in mileage between 0.5m and 1m. The number of traincrew was estimated from the rolling stock diagrams based on the assumption that there was little or no spare capacity in existing rosters following introduction of HML services in December 2011.

4.59 The operating costs are slightly higher than those estimated in the 2009 study. This is entirely due to the greater level of analysis to inform the estimates arising from the availability of draft FSR rolling stock resource diagrams. Given these assumptions the operating costs can be regarded as conservative, as they do not allow for fine tuning of rolling stock and driver diagrams, which a commercial operator would inevitably be able to achieve. We can therefore have a high degree of confidence in the accuracy of these estimates.

## Infrastructure development

4.60 Limited infrastructure works at two locations are required to permit TERS services to operate in a safe, reliable, manner which does not impact the performance of other services. The new start up options continue to require provision of a CCTV tail light camera at Arbroath.

4.61 Enhancement of Invergowrie station is required if (as has been assumed) TERS services are to stop there.

### *Arbroath*

4.62 The railway infrastructure at Arbroath has undergone significant rationalisation over the past 20 years. There is currently one train per day from Dundee which terminates and turns back at Arbroath. The train on arrival at Arbroath and after passengers have disembarked is signalled from Signal AH26 to Signal AH8 and then

to the North (Dens) Siding. The train is the signalled from Signal AH1 to the Up Main when ready to depart. The timetables developed for this study will use the same means of turning services back at Arbroath.

4.63 Since the closure of the South Signal Box the signaller at Arbroath cannot accept another down train from Carnoustie until the tail lamp of the previous train has been observed after passing the Signal Box. Provision of a Tail Lamp Camera would allow the signaller to clear back (and accept another train) after observing the tail lamp of a train arriving in Platform 2. A Down train from Carnoustie could therefore be signalled up to Signal AH48 when a train is stopped at Platform 2. Signal AH48 is motor operated and is fitted with TPWS Train Stop Sensor (TSS).

4.64 The CCTV tail light camera will help mitigate the performance impact of this operation on the express services in this section of route. This modification to the existing infrastructure is therefore a pre-requisite before running any proposed new services and turning back at Arbroath. Costs for the provision of a Tail Lamp Camera and associated cable route and signal box works are estimated as £204k including 44% optimism bias – see Table 4.2 below. Timescales for delivery are estimated as 12 months from commencement of design to commissioning. All works can be undertaken through rules of the route possessions.

4.65 The £204k includes the cost of reinstating the first 200m of the 800m long siding. This is sufficient to accommodate a six car class 170 DMU. There is no known operational requirement to undertake works to the full length of the siding.

**TABLE 4.2 CAPITAL COST ESTIMATE – TAIL LIGHT CCTV CAMERA**

| Construction Costs | Quantity | Unit | Rate | Total | Comments |
|---|---|---|---|---|---|
| CCTV camera & monitor | 1 | No. | 60,000 | 60,000 | |
| Modifications to Signal Box | 1 | sum | 2,500 | 2,500 | |
| Cable route | 200 | m | 45 | 9,000 | |
| Upgrading of North Siding | 200 | m | 100 | 20,000 | |
| **Total Base Cost Arbroath SB** | | | | **91,500** | |

| Non Construction Costs | % of Base | Unit | Rate | Total | Comments |
|---|---|---|---|---|---|
| Contractor preliminaries | 20.00% | | | 18,300 | |
| GRIP stages 1-4 development | 10.00% | | | 9,150 | |
| GRIP stage 5 design | 10.00% | | | 9,150 | |
| Project Management | 15.00% | | | 13,725 | |
| Possession management | 0 | shifts | £ 2,000 | - | |
| TOC Compensation | 0.00% | | | - | |
| **Total Non Construction Cost** | | | | **50,325** | |
| **Sub Total** | | | | **141,825** | |
| **Risk and Optimum Bias** | 44.00% | | | **62,403** | |
| **TOTAL** | | | | **£204,228** | 2009/10 prices |

***Invergowrie***

4.66 The current station is only served a few times per day and does not have appropriate facilities to safely accommodate an hourly rail service. In particular the platforms are only of two car length and First ScotRail has special dispensation to stop three car units here only because of the very low patronage. If the volume

of services increase, so will the patronage (it is forecast to rise to 36,000 journeys per annum) and therefore the risk of an incident increases to unacceptable levels.

4.67 The key issue at Invergowrie is the short platform lengths of 64m and 70m for the Up and Down lines respectively. This is sufficient to safely accommodate Class 156 and 158 diesel multiple units which are consist of two carriages. However due to the need to interwork rolling stock diagrams with Edinburgh and Inverness services, it is likely that some services calling at Invergowrie will be formed of Class 170 diesel multiple units. These have a length of just over 71m with the endmost passenger doors approximately 5m from the front and rear of the set and drivers door 1.5m.

4.68 Train stop boards at stations are provided with a minimum of 2m tolerance but with some safety margin on top of this required.

4.69 Two options were reviewed in conjunction with First ScotRail:

- Use Selective Door Operation (SDO) to avoid the need to lengthen platforms; and
- Lengthen the platforms to accommodate three car units in the most cost effective manner.

***Selective Door Operation (SDO)***

4.70 Existing DMU rolling stock operated by First ScotRail is not equipped with automatic SDO. However a system is in operation at Beauly on the Far North Line where passengers enter and egress the train through a single door under the local control of the train guard. This system is causing operational problems because of the time taken to embark all passengers through a single set of doors. Patronage at Beauly is comparable with that forecast for Invergowrie. This option has therefore been discounted for use on all services because of the performance impact on the route if there are extended dwell times at Invergowrie. There is also a safety issue with large numbers of people congregating to board at a single location rather than being spread along the platform.

***Platform Lengthening***

4.71 Opportunities to lengthen the platforms by the short distance required to safely accommodate a Class 170 unit were reviewed and a proposal developed to provide an Up platform of length 75m and a Down of 77m, by infilling three of the four existing end of platform ramps and tying these into the existing platform surfacing.

4.72 First ScotRail has confirmed this would allow a drivers stop board to be placed at approximately 72 or 73m along the platform. Finalisation of the stop board positions would require a sighting inspection. Network Rail has also confirmed its acceptance in principle of this proposal subject to safety case verification. Maintenance access to the lineside would be provided by new precast steps from the ends of the extended platforms.

4.73 Two additional lamp posts would be required to provide safe lighting levels at the platform ends. A 3m x 1m waiting shelter is proposed for the up platform as no facilities presently exist here. Both platforms have been resurfaced in the last five years and are in a safe condition.

4.74 In order to minimise cost, no other enhancements are proposed to the station. The previous estimate had provision for a modern customer information system, enhanced waiting shelters and enhanced lighting. The revised scheme provides facilities which are safe and gives shelter from the elements. This is an appropriate level of investment when the medium term aim is to relocate the station to a brand new facility 700m away.

4.75 A capital cost estimate has been developed for the revised scope of works and is shown in Table 4.3. The estimated cost is £239k including 44% optimism bias.

4.76 This solution would not be able to accommodate DMUs longer than 3 car length and in the case of the proposed 06.01 Arbroath to Glasgow service one of the class 170 units would have to be locked out of use until arrival in Perth. The proposed 17.12 Glasgow to Arbroath and 19.40 Arbroath to Glasgow services are both formed of 2 x Class 158 units. These would also be overlength however it is suggested that use could be made of local door operation by the guard for these two services. The costs of further extending the platforms at Invergowrie to 4 or 6 car length would not be justified by the patronage generated by these two services.

**TABLE 4.3 CAPITAL COST ESTIMATE – INVERGOWRIE STATION ENHANCEMENT**

| Station Construction Costs | Quantity | Unit | Rate | Total | Comments |
|---|---|---|---|---|---|
| Demolition of 3 No ramps | 76 | m2 | 70 | 5,320 | |
| Up Dundee end - New platform extension -crosswall build (8.6m length) | 18 | m2 | 660 | 11,880 | |
| Up Dundee end - New platform extension -crosswall build (5.7m length) | 28 | m2 | 660 | 18,480 | |
| Dn Dundee end - New platform extension -crosswall build (7.7m length) | 30 | m2 | 660 | 19,800 | |
| New lighting column | 2 | No | 1,500 | 3,000 | Improve existing lighting |
| Precast stairs to platform end | 3 | No | 2,500 | 7,500 | |
| Car stop signs | 4 | No | 1,000 | 4,000 | |
| Platform fencing | 23 | m | 100 | 2,300 | |
| Platform shelter & seating | 1 | No | 25,000 | 25,000 | 3m x 1m standard shelter |
| LLPA / CIS / CCTV / Help Points | 0 | item | 150,000 | 0 | Nil works |
| Overbridge | 0 | item | 250,000 | 0 | Renewal works through NR |
| **Total Base Cost - Invergowrie Station** | | | | **97,280** | |

| Non Construction Costs | % of Base | Unit | Rate | Total | Comments |
|---|---|---|---|---|---|
| Contractor preliminaries | 15.00% | | | 14,592 | |
| GRIP stages 1-4 development | 10.00% | | | 9,728 | |
| GRIP stage 5 design | 10.00% | | | 9,728 | |
| Project Management | 15.00% | | | 14,592 | |
| Possession management | 10 | shifts | £ 2,000 | 20,000 | |
| TOC Compensation | 0.00% | | | - | |
| Land | 0.00 | Ha | £30,000 | 0 | On railway land |
| **Total Non Construction Cost** | | | | **68,640** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sub Total** | | | | **165,920** | |
| **Risk and Optimum Bias** | 44.00% | | | **73,005** | |
| **TOTAL** | | | | **£238,925** | 2009/10 prices |

4.77 The capital cost estimates developed for infrastructure developments at Arbroath and Invergowrie are considered to be robust and in practice there may be scope to implement at a lower cost.

# 5 Demand Forecasting

## Outline Methodology

5.1 The basis of the demand forecasting work undertaken for this study was the ScotRail version of MOIRA; the industry standard tool for modelling the impact on demand and revenue of timetable changes. Whilst being the best tool available for this appraisal, MOIRA does have limitations when it comes to forecasting patronage at new stations and where existing stations receive a step change in the number of stopping services, for example, in the case of Broughty Ferry. In these cases forecasts have been created outside MOIRA using a trip rate-based model based on population catchment areas, which have been added to the MOIRA outputs prior to input into the appraisal process.

5.2 Demand forecasting focuses on the services which have the most potential and helps provide solid data to help identify the options with the most potential and produce the evidence to underpin the economic evaluation.

5.3 Demand, revenue, passenger miles and time savings output from MOIRA and the trip rate modelling feed directly into the economic appraisal. The base year for demand was 2009/10 and the price base is therefore Q3 2009.

## MOIRA

5.4 MOIRA forecasts were undertaken for the Dec 2011 Do Minimum timetable and all the option timetables against a Dec 2010 base timetable, using a demand and revenue base year of 2009/10. The Do Minimum and option timetables have been fully developed, so no additional assumptions needed to be made for entry into MOIRA. The impact of the timetable change was then taken as the difference between the impact of the option timetable against the base and the Do Minimum timetable against the same base. The timetable impact is assumed to apply on weekdays and Saturdays, but not Sundays.

## Demand and Revenue forecasts for new service options

5.5 In addition to the standard outputs from MOIRA, it was anticipated that MOIRA would significantly under-estimate the demand increase at existing stations where the current service is very limited. This is because MOIRA uses an elasticity-based approach for small timetable changes to forecast the (small) incremental demand change on top of the existing demand.

5.6 A revised approach was therefore required for estimating demand at Invergowrie, Broughty Ferry and Monifeith. A similar approach was used for smaller stations, such as Golf Street, Barry Links and Balmossie and new stations at the station sifting stage of the original study.

5.7 These forecasts were created by undertaking analysis of the potential catchment areas of these stations. This procedure was split into three main steps:

- GIS analysis to estimate the total 800m walk and 5 minute drive time catchments for each station and a comparator station, in this case Carnoustie;

- Calibration of appropriate trip rates from PDFH[2] v4.1 by comparison with the existing market at Carnoustie; and
- Application of trip rates to the populations to estimate demand at the stations.

5.8 Trip rate models are a fairly standard approach when forecasting demand at new stations, and we believe that Carnoustie is a reasonable comparator station for services into Dundee and beyond. However, it is important not to be over-optimistic and to double count benefit with this approach and we have considered and adjusted the trip rates derived in three ways:

- Any potential abstraction from other stations was identified, to ensure that losses at neighbouring stations (particularly Dundee) are consistently accounted for. This estimated that approximately 35% of 'new' demand at Invergowrie, Broughty Ferry and Monifeith is abstracted from existing trips to/from Dundee and so the demand uplift has been reduced accordingly.
- The proposed service at the stations was compared with that at Carnoustie. Trip rates were scaled down by 10% to reflect the fact that a proportion of demand will be to the north of Arbroath and journeys to these stations will have to interchange at Arbroath.
- For the long term option the service at the new stations is comparable with the service currently received by Carnoustie so no further factors have been applied. For the short term options, where the service frequency is reduced, the forecasts were scaled down according to standard PDFH assumptions using generalised journey times (GJTs) from MOIRA. This additional demand reduction varied between options from 18% to 52%.

5.9 It is recognised that demand for a new service will take some time to mature. A ramp up profile for the demand and revenue increase of 60% in the first year, 80% in the second year and the full demand and revenue in the third year after implementation of the service was assumed. This is consistent with current PDFH guidance.

5.10 As well as producing the revenue and demand uplift brought about by the new service, for appraisal purposes we also require changes to time savings and passenger miles. Time savings output from MOIRA were capped at 15 minutes for any single OD pair. For existing stations the time savings and passenger miles were calculated using the average change per journey for the relevant MOIRA option applied to the forecast journeys.

5.11 Revenue for these stations was forecast by multiplying the demand forecast by the average fare in the existing demand and revenue matrices, adjusted to reflect that a higher proportion (we have assumed 50%, based on MOIRA data for Carnoustie) of trips would be on local flows, particularly to Dundee.

### Base Year Results

5.12 Table 5.1 below presents a summary of the demand forecasting outputs for revenue and patronage on a 2009/10 base.

[2] Passenger Demand Forecasting Handbook. National Rail standard guidance on demand forecasting. Version 4.1 was current during the initial study and gave guidance on trip rates. The current version, v5, no longer includes this guidance.

**TABLE 5.1 FORECAST JOURNEYS AND REVENUE (2009/10 PRICES)**

| Option | From MOIRA | Catchment overlay | | | Total |
|---|---|---|---|---|---|
| | | Invergowrie | Broughty Ferry | Monifieth | |
| **Demand (000 jnys)** | | | | | |
| Start Up Option 1 – Start Up | 24 | 10 | 44 | 25 | **103** |
| Start Up Option 2 – Blair Atholl | 21 | 15 | 65 | 38 | **139** |
| Start Up Option 3 – Extra Stops | 24 | 14 | 59 | 34 | **131** |
| Start Up Option 4 – Additional Unit | 47 | 19 | 81 | 46 | **193** |
| Full timetable Option 5 | 86 | 21 | 92 | 53 | **252** |
| **Revenue (£000s)** | | | | | |
| Start Up Option 1 – Start Up | 112 | 47 | 208 | 108 | **475** |
| Start Up Option 2 – Blair Atholl | 95 | 69 | 308 | 160 | **632** |
| Start Up Option 3 – Extra Stops | 107 | 63 | 279 | 145 | **594** |
| Start Up Option 4 – Additional Unit | 199 | 86 | 380 | 197 | **862** |
| Full timetable Option 5 | 385 | 97 | 432 | 225 | **1,139** |

5.13 It should be noted that throughout forecasts that have been provided are the net impact relative to the December 2011 timetable and are for aggregate National Rail (rather than just ScotRail), which is consistent with the appraisal approach outlined in STAG. Therefore, this is new patronage and excludes patronage abstracted from other stations and services.

### Future Year Demand

5.14 The impact of timetable changes on demand and revenue has been forecast using a combination of MOIRA and a trip rate model for the 2009/10 base year, as described above.

5.15 Future year forecasts have been developed using a representation of the PDFH guidance on exogenous demand drivers, which includes changes to population, employment, the economy and competing modes. In addition we have adopted the approach used by Network Rail in the Scotland RUS (Generation Two) with the development of a second "continuing rail competitiveness" scenario in which the degree to which growth has outstripped forecast growth in the last few years is extended forward to the next 10 years. At present, this appears the more plausible scenario in this area and so this has been adopted as the central case throughout this report. Table 5.2 below describes the two forecast scenarios.

**TABLE 5.2 UNDERLYING DEMAND GROWTH FORECASTS**

| | Continuing Competitiveness | | Steady State | |
|---|---|---|---|---|
| From 2009/10 to | Jnys | Revenue | Jnys | Revenue |
| 2012/13 | 8.6% | 11.9% | 4.1% | 7.3% |
| 2018/19 | 31.6% | 43.9% | 16.1% | 27.0% |
| 2029/30 | 58.5% | 93.4% | 37.9% | 68.3% |

5.16 Consultation with Local Authorities along the corridor confirmed no additional demand drivers were forecast to those used in the socio-economic forecasts used. The planned developments throughout the corridor are understood to be included in for example DfT's TEMPRO dataset. However, the opening of the V&A Museum as the anchor tenant of the Dundee Waterfront development, due in late 2014, has not been included in the forecasts, and to that extent the forecasts can be regarded as conservative.

# 6 Appraisal

6.1 This chapter describes an appraisal of all five options described in Chapter 4. This appraisal has been undertaken in two parts: firstly qualitatively against the planning objectives and secondly quantitatively using a Transport Economic Efficiency (TEE) table which monetises costs and benefits where possible, including economic, environmental and safety benefits.

## Appraisal against Planning objectives

6.2 The following sections outline an appraisal of the five service options identified from the option development process.

6.3 Performance of the options against the study planning objectives is shown below in Table 6.1 on a seven point scale ranging from major negative ('---') to neutral ('n') to major positive ('+++'). As can be seen at this stage, Options 4 and 5 perform the best against the study planning objectives.

**TABLE 6.1 APPRAISAL OF OPTIONS AGAINST STUDY PLANNING OBJECTIVES**

| | Ec1 | Ec2 | Acc1 | Env1 | Env2 | Sec1 | Int1 | Int2 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Option 1- Start Up** | + | + | +++ | + | + | n | + | + | **9** |
| **Option 2 - Blair Atholl** | - | -- | ++ | ++ | ++ | n | + | + | **5** |
| **Option 3 - Extra Stops** | ++ | ++ | + | ++ | ++ | n | + | + | **11** |
| **Option 4 - Additional Unit** | ++ | +++ | +++ | ++ | ++ | n | + | + | **14** |
| **Option 5 - Full timetable** | +++ | +++ | +++ | +++ | +++ | n | + | ++ | **18** |

## Description against Planning objectives

***Economy - growth***

6.4 All five options present the opportunity for economic growth from improved connectivity to key business and employment sectors. Specifically, all options enhance services between the stations served and key business and employment sectors within and outwith the TACTRAN region. The effect on economic growth from the options however are variable, with options 2, 3, 4 and 5 providing a

greater number of services in the peak periods to key areas of employment but Option 1 providing no enhancements to current services in the AM peak. Whilst Option 2 provides the potential to support economic growth by increasing services, it is the expense of a key commuter service from Perth to Dundee.

6.5 Connecting populations to major centres such as Dundee, Perth, and further afield to Glasgow will help to stimulate economic activity across the TACTRAN region and the greatest example of this is from Option 5.

***Economy –efficiency, reliability and integration***

6.6 In terms of improving the efficiency, reliability and integration of rail services in the Tay Estuary study area, all options provide enhanced rail services, with Options 4 and 5 greatly enhancing the number of services within the area. This is partially offset, for all options, by the slight worsening in performance described in Chapter 4.

6.7 Whilst Option 1 seems to improve integration to business sectors by enhancing the integration of services to Arbroath, it also reduces the business and employment benefit by not providing additional AM peak services. Similarly, whilst Option 2 enhances services between Dundee, Glasgow, Perth and Edinburgh, it also withdraws a commuter service from Blair Atholl in the AM peak (although this is partly mitigated by the introduction of two additional services) as well as a service between Perth and Dundee from Edinburgh. Option 2 therefore loses two key commuter flows from both within and outwith the region.

### Accessibility

6.8 Options 1, 4 and 5 increase accessibility between key destinations in the TACTRAN area by providing additional services or stops to/from key external destinations by rail without compromising wider inter-regional rail connectivity. Options 2 and 3 however require stops from inter-regional services.

### Environment

6.9 All five options will contribute to national greenhouse gas emission reductions through encouraging modal shift to rail. Option 5 will achieve higher emissions reductions due to the greater number of services which will be provided throughout the day in comparison to other services, both within the Tay Estuary area, and further afield to Glasgow. Option 1 would achieve less of a reduction of greenhouses gases as the AM peak period services are not enhanced.

6.10 Benefits will also be accrued from each option as a result of air quality improvements associated with modal shift in the TACTRAN area. Option 5 will see a greater air quality benefit due to the largest increase in the number of services in the Tay Estuary area.

### Safety and Security

6.11 All options are expected to maintain or improve real and perceived levels of safety and personal security on the rail network.

## Integration

### *Policy integration*

6.12 As can be seen from previous chapters, all of these options offer a high degree of policy integration with national policy, through to fit with STPR schemes in the long term, and the TACTRAN Regional Transport Strategy.

### *Transport integration*

6.13 All options provide improved links to the wider rail network. Option 5 specifically provide the greatest links to destinations within the TERS study area and also further afield to Glasgow.

## Transport Economic Efficiency – TEE

6.14 The planning objectives cover the key areas of the Government objectives. In addition to the financial impacts of the options, the economic benefits have been captured through an analysis of the impacts on transport users, both directly of the service and other transport users, for which there is a knock-on effect.

6.15 The economic impact of improvements on rail users has been summarised in terms of savings in time, or more specifically generalised journey time. This encompasses journey time, an element representing service frequency and an element representing the need to interchange. Benefits to users basically fall into two sub-groups:

- Existing users, whose travel patterns do not change, but who enjoy a time saving; and
- Users diverted to rail from other routes, other modes, or from not travelling at all by an improvement in the (generalised) time – estimated using the standard 'rule of a half'.

6.16 In addition to the user benefits, there are economic impacts on other, non-rail, transport users which have been captured. These benefits have been calculated by estimating the reduction in car trips consistent with the increase in rail demand diverted from car. The reduction in car trips results in improvements in accident rates, noise and local emissions. In addition there is a benefit in Greenhouse Gas (GHG) emissions. All of these benefits have been monetised using standard factors, consistent with STAG guidance.

6.17 The benefits described above and the financial impacts (both cost and revenue) described elsewhere have been included in a TEE analysis, which is consistent with STAG. In particular:

### *Capital Costs*

6.18 Capital costs have been estimated in 2009/10 prices and inflated by 2.5% pa in real terms until the assumed construction of both Invergowrie and Arbroath in 2012.

6.19 The base cost derived from each capital cost estimate, i.e. the total excluding optimism bias, has been cross referenced with the out-turn costs of recent similar projects. The variances between actual out-turn cost and our estimates were +/- 15%. In accordance with the optimism bias guidance, we have therefore applied a 44% uplift rather than 66% in order to reflect higher levels of confidence in the base estimate. This is in accordance with HM Treasury Green Book Guidance.

*Appraisal Assumptions*

- Appraisal period of 60 years from 2012;
- Discounting at 3.5% for first 30 years and 3.0% thereafter;
- All values discounted to 2002 price base;
- Revenue and demand forecast until 2029 and then fixed for the rest of the appraisal period;
- Time savings and car miles removed forecast until 2029 and then fixed for the rest of the appraisal period;
- Values of time levels and growth consistent with STAG guidance;
- Factors for calculating non-user benefits consistent with STAG guidance;
- Operating costs assumed to rise by 1% per annum in real terms throughout the appraisal period; and
- An optimism bias of 1% has been applied to the operating costs, as these are based on existing diagrams and unit costs and are therefore prudent.

6.20 All five options described above have been appraised as if they were to open in December 2012, despite our view that this would only be possible for the Start Up options. This analysis has been done for two reasons:

- To confirm, in combination with the qualitative assessment shown above, the best performing start up option; and
- To allow the performance of the long term option to be compared on an equal basis to the the short term options.

6.21 Table 6.2 outlines the monetised costs and benefits for all five options. This table shows that, in economic terms, the additional unit more than covers its additional costs and is the best performing start up option.

6.22 The appraisal shows that the long term option does not perform quite as well as Option 4 with only one additional unit. This is because we have recognised that the environment of the next ScotRail franchise in which Option 5 would be delivered is likely to be different to the current, in terms of how the franchisee will manage delivery of Transport Scotland's contract specification. The short term options are based on the resource plans used in the current franchise whereas the long term option assumes a dedicated resource. This is prudent and very conservative as it is realistic to expect the next franchisee to find opportunities to interwork both rolling stock and traincrew in a more efficient manner. We have been cautious in this respect to in order to demonstrate the viability of the scheme without the need for it to rely on the same resourcing criteria as the current franchise.

6.23 Table 6.2 shows that even in these circumstances the performance is good, and that this could be refined upwards once it has received the same level of scrutiny as the start up options. This could be in three key areas:

- On the benefit side the demand forecasting approach does not capture the intangible benefit of the nearly clockface service that the long term option provides.
- On the cost side, the current long term timetable does not make the most efficient use of the additional 2 units above that required for Option 4. It is likely that a franchisee would be able to alter existing unit diagrams, probably

to reduce the units required by one. This is also true of the on-train staff requirement.

- A more regular through service would have other potential benefits elsewhere on the network, which have not been modelled here. In particular, they would allow for a more regular shortening of the Dunblane service at Stirling. As well as the cost savings that this facilitates, this can provide benefits in terms of faster and more consistent services to Dunblane and Bridge of Allan.

**TABLE 6.2 ANALYSIS OF MONETISED COSTS AND BENEFITS**

| £'000s 2002 prices and values | Option 1 - Start Up | Option 2 - Blair Atholl | Option 3 - Extra Stops | Option 4 Additional Unit | Option 5 - Full timetable |
|---|---|---|---|---|---|
| Noise | 51 | 68 | 60 | 83 | 122 |
| Local air quality | 58 | 77 | 67 | 93 | 136 |
| Greenhouse gases | 84 | 112 | 98 | 136 | 199 |
| Journey ambience | - | - | - | 0 | - |
| Accidents | 632 | 841 | 736 | 1,024 | 1,498 |
| Consumer users | 22,311 | 22,674 | 22,826 | 39,974 | 70,953 |
| Business users and providers | - | - | - | 0 | - |
| Reliability | - | - | - | 0 | - |
| Option values | - | - | - | 0 | - |
| **Present value of benefits (PVB)** | **23,136** | **23,772** | **23,788** | **41,311** | **72,908** |
| | | | | | |
| **Present value of costs (PVC)** | **16,896** | **14,688** | **16,307** | **20,729** | **44,496** |
| | | | | | |
| **OVERALL IMPACTS** | | | | | |
| **Net present value (NPV)** | **6,241** | **9,085** | **7,481** | **20,581** | **28,412** |
| **Benefit to Cost Ratio (BCR)** | **1.4** | **1.6** | **1.5** | **2.0** | **1.6** |

6.24 In addition a comparison of key elements for each option is shown in Table 6.3, below.

**TABLE 6.3 SUMMARY OF OPTIONS**

| | Option 1 - Start Up | Option 2 - Blair Atholl | Option 3 - Extra Stops | Option 4 - Additional Unit | Option 5 - Full Timetable |
|---|---|---|---|---|---|
| BCR | 1.4 | 1.6 | 1.5 | 2.0 | 1.6 |
| NPV (£m) | 6.2 | 9.1 | 7.5 | 20.6 | 28.4 |
| Planning Objective Score | 9 | 5 | 11 | 14 | 18 |
| Journeys (000s) | 131 | 171 | 163 | 241 | 318 |
| Revenue (£000s) | 626 | 823 | 778 | 1,125 | 1,501 |
| Cost (£000s) | 1,482 | 1,545 | 1,482 | 1,931 | 3,293 |
| Subsidy (£000s) | 856 | 722 | 704 | 806 | 1,792 |

**Note:** Revenue, cost and subsidy are in 2009/10 prices and assume the service is in steady state, taken to be 2018 levels, where there is no passenger ramp up.

6.25 This table shows that, economically, the additional unit option is the most attractive start up option with a Benefit: Cost ratio of 2.0, it is also the start up option which best meets the planning objectives. However, this is dependent on the feasibility of finding the additional unit and does not have the lowest subsidy.

6.26 Option 3 has the lowest subsidy and is the best of the start up options requiring no additional resources in terms of meeting the planning objectives, but has a reduced economic performance. The major stumbling block for this option is the acceptability to stakeholders of the impact on the important Aberdeen-Glasgow service. For this option, there may be a possibility of a partial trade off with other services, where Carnoustie stops can be removed from Aberdeen services in the hours where a TERS service operates. This is not currently part of the economic assessment.

6.27 The Blair Atholl option performs well economically, but poorly against the planning objectives, particularly with the loss of a key commuting service in the morning peak between Perth and Dundee. There may be scope for refinement of this option if the HML timetable is refined in December 2012.

6.28 The Long Term Option does not perform as well economically as Option 4, although clearly this option is the best in terms of planning objectives and total patronage. Our view is that this is a conservative estimate at this early stage of development and that there will be the potential for additional local cost savings and demand growth, as well as wider network benefits of shortening services to Dunblane at Stirling, while providing more consistent and faster services to Dunblane and Bridge of Allan at these times. These additional benefits could be realised by the franchisee closer to the date.

6.29 In order to support the robustness of these option appraisals, a number of sensitivity tests were undertaken on the best performing option, Option 4. These tests all yielded positive BCRs of great than 1 : 1, which re-emphasises the robustness of their case. These tests have been included in Appendix A.

# 7 Conclusion

7.1 This update to the 2009 TERS business case has identified new timetables which are deliverable and provide good levels of benefit through a step change in service provision, in particular for the residents of Invergowrie, Broughty Ferry and Monifieth.

7.2 Short and longer term solutions have been developed which provide positive NPVs and make good use of resources available to the ScotRail franchisee.

### Start up services

7.1 Option 1 provides a positive BCR. However, the lack of a morning peak service from its key stations is unlikely to drive a change in travel behaviour encouraging ad-hoc, rather than regular, use. We believe this service, although deliverable does not represent good value for money when compared with the other options.

7.2 Option 2 performs well economically, but conflicts with regional objectives, as the morning peak service between Arbroath and Dundee is resourced by removing the morning peak Perth to Dundee service and retiming a morning peak service from Blair Atholl. This is reflected in the low score against the planning objectives. There may be an opportunity to replace the current 07.12 Blair Atholl to Edinburgh service by an earlier departure from Inverness when adjustments are made to the timings of services between Inverness and Perth to reflect linespeed improvements presently being delivered. Timetable changes to reflect linespeed improvements are likely to take place in December 2012.

7.3 Option 3 also has a good BCR, but may conflict with national objectives. Adding an extra Monifieth and Broughty Ferry stop into the early Aberdeen to Glasgow service is cost effective, but unlikely to be a viable solution as it results in a longer journey time for passengers who board the train north of these stations. National priorities are to reduce journey times on express services between the principal cities.

7.4 Option 4 is the best performing start up option when assessed qualitatively and quantitatively. However this option requires an additional DMU to resource morning peak services between Perth and Arbroath and we believe there is currently no spare rolling stock available to the ScotRail franchisee. The full capital lease cost of the unit has been allocated in the appraisal calculation to TERS. The unit could be timetabled to provide more off peak services between Perth and Arbroath than shown in Figure 4.3. However, our calculations show this would require an additional driver and conductor meaning that the cost increase of the additional service outweighs the revenue generated. The option presented is therefore the most subsidy efficient. This does mean that the unit could be used to support other services on the network in the off peak.

7.5 The positive economic assessments of all of these options show that latent demand does exist for an improved service level at the stations north of Dundee. We believe even limited additional services would prove attractive to passengers and that, where it is possible to extend some Dundee terminating services to Arbroath at marginal cost, this should be explored.

### Full service

7.6 With the current timetable the full long term option does not currently deliver as strong a BCR as the best performing start up option. However it does better meet the planning objectives and generates larger patronage. We believe that this is because both costs and benefits for this option have been estimated prudently. Given the amount of changes that are likely to take place between now and a likely start date, assumed to be December 2017 (after EGIP has been completed), we would expect the franchisee to deliver a more refined option with reduced costs and increased benefits.

7.7 The full long term service also provides an opportunity to terminate Glasgow to Dunblane services at Stirling all day, rather than just when the new Glasgow to Dundee services run in the December 2011 timetable. This is actually better for Dunblane, Bridge of Allan and Stirling passengers as the timetable becomes standardised and reduced journey times to Glasgow and the north are available for most of the day. These service changes have not been included in the economic assessment.

7.8 In addition this option could more fully realise its potential if it were possible to make it fully clockface by overcoming the issues described with East Coast and Cross-Country services outlined in paragraph 4.16. Again, these service changes have not been included in the economic assessment.

7.9 We consider that this benefit combined with the largest number of passenger journeys generated as well as the highest qualitative score means the full service timetable will be preferred to the start up option in the longer term.

### Recommendation

7.10 The study recommends a phased approach to implementing TERS services:

- In the short term, seek to widen the benefit of the new Dundee to Glasgow services which will be introduced in December 2011, by extending them through to start and terminate at Arbroath;
- When a suitable DMU becomes available, Option 4 should then be implemented. This provides cost effective morning and evening peak services across Dundee and Perth. A DMU could be made available as early as the December 2012 through refinements to the HML timetable being used to pick up the calls of the morning Blair Atholl to Perth commuter service. If this did not prove viable, the next opportunity to obtain the required rolling stock is likely to be in the next franchise; and
- Implement the full service when further rolling stock becomes available and the other timetable interfaces are sufficiently stable to optimise the efficiency of the operation. The earliest opportunity for this phase is likely to be following completion of EGIP in late 2016.

# APPENDIX

**A**

**SENSITIVITY TESTS**

# A1 SENSITIVITY TESTS

A1.1 We have undertaken a number of sensitivity tests with which to test the robustness of the monetised TEE appraisal. It is most appropriate at the current time for this analysis to be applied to the output for Option 4. These tests confirm that the BCRs are robust, as they all remain above 1:1. They are described in outline below.

### Network Rail Scotland RUS (Generation Two) Optimism Bias

A1.2 In consultation and dialogue on the Scotland RUS (Generation Two), Network Rail noted that the levels of Optimism Bias applied in the previous TERS appraisal were not consistent with those used in the option appraisal in the RUS. We consider that both the capital and operating costs used in this work are at a much more developed stage than those used in the RUS – and are more prudent – and have applied appropriate levels of Optimism Bias. However, we have tested the RUS's levels of 40% for operating costs and 60% for capital costs as a sensitivity test.

A1.3 This test has the effect of reducing the BCR for Option 4 from 2.0 : 1 to 1.2 : 1.

### 30 year Appraisal Period

A1.4 It is standard practice for a 60 year appraisal period to be adopted where there is significant infrastructure work involved, for which a 60 year life is plausible. In this case there is relatively little infrastructure work and it might be argued that a 30 year appraisal is more appropriate.

A1.5 Using a 30 year appraisal period has the effect of reducing the BCR for Option 4 from 2.0 : 1 to 1.6 : 1.

### Lower Underlying Growth

A1.6 As described in paragraph 5.15, we have developed two future year growth scenarios for this work and have adopted the higher one, which appears more plausible and still conservative as it does not include the opening of the V&A Museum near Dundee station. As a sensitivity test we have tested using the lower growth rates, which use standard PDFH methodologies, with no local interpretation.

A1.7 This test has the effect of reducing the BCR for Option 4 from 2.0 : 1 to 1.6 : 1.

### Reduced Cost Long Term Option Variant

A1.8 We have explored the possibility of reducing the cost of the long term option (Option 5) by removing two off-peak round trips serving relatively small markets between Perth and Glasgow.

A1.9 This test has the effect of slightly increasing the BCR for Option 5 from 1.6 : 1 to 1.7 : 1. This gives further credibility to the view that this option can be more fully developed.

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