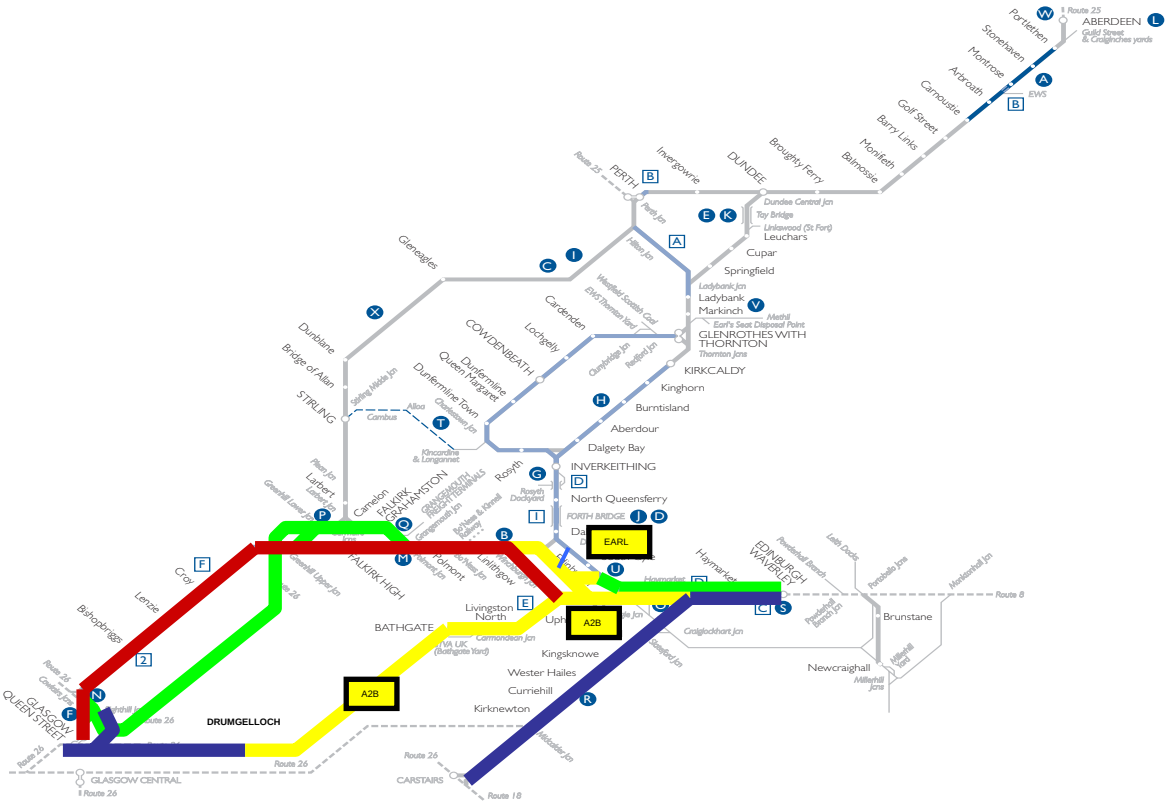
EDINBURGH WAVERLEY TO GLASGOW QUEEN ST :

PROPOSED ELECTRIFICATION

GRIP STAGE 1 REPORT



Final Report

May 2007

EDINBURGH WAVERLEY TO GLASGOW QUEEN ST ELECTRIFICATION

GRIP STAGE 1 REPORT

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EXECUTIVE SUMMARY

1) Transport Scotland commissioned Network Rail to undertake a study into the potential electrification of the Edinburgh to Glasgow (E&G) route in order to inform the development of their strategy for the Scottish rail network. Network Rail mobilised a project team of internal staff with appropriate expertise to progress this exercise in consultation with Transport Scotland.

2) Four different route groupings were considered for the purposes of this study. The Core Route was defined as the section of the E&G from Newbridge Junction (the boundary with the eastern end of the E&G that is to be electrified by the Airdrie to Bathgate project) to Glasgow Queen Street High Level. Three frequently used Diversionary Routes were also assessed. These were the North Lines between Haymarket Central and Princes St Gardens, the Falkirk Grahamston loop and the Greenhill Lower to Cowlairs via Cumbernauld line.

3) The study identified that there are a significant number of engineering works that would need to be progressed to achieve the required overhead line clearances, install the new overhead line equipment and alter existing infrastructure to achieve electrification compatibility. These works are summarised by engineering discipline in this report. No insurmountable engineering problems were identified that would prevent electrification of these Routes.

4) The estimated costs of these works, which are itemised within this report, total £264.9m. This comprises £124.9m for the Core Route and £39.6m, £34.9m and £65.5m respectively for the three Diversionary Routes. These estimates have been compiled using appropriate rates within Network Rail's national estimating database. They are to the specified GRIP Level 1 standard which is the normal practice for the Output Definition project phase. They include a 10% contingency allowance and are to +/- 50% quality.

5) The high level programme for the project indicates a likely completion date of March 2013. This is based on the assumption that the full package of works, i.e. the Core Route and Diversionary Routes 1, 2 and 3, is implemented. Implementation of the Core Route only would reduce the 3 year construction programme by around 1 year.

1) INTRODUCTION

1.1 Transport Scotland are developing a rolling stock strategy for the Scottish rail network. One of the options that is being considered in this strategy is the potential electrification of the Edinburgh to Glasgow Queen Street (E&G) corridor and the conversion of the existing DMU operated E&G services to EMU operation.

1.2 Transport Scotland have commissioned Network Rail to provide technical input to their evaluation of the issues associated with the electrification of the core E&G route and the associated diversionary routes in order to inform the development of their rolling stock strategy.

1.3 The purpose of this report is therefore to advise on the issues associated with electrifying these routes using the 25kV overhead line system. A summary of the specific issues to be addressed in this exercise, as specified in Transport Scotland's remit to Network Rail, is attached as Appendix 1 to this report.

1.4 Network Rail mobilised a project team of appropriate internal staff to progress this exercise. Regular project team meetings have taken place with representatives of Transport Scotland during the course of the exercise to review progress and address any emerging issues.

1.5 As Transport Scotland's remit was by necessity high level, a number of issues arose during the course of the exercise where assumptions had to be made on the treatment of particular issues. These issues and their agreed treatment were captured in an Assumptions Log that was reviewed and updated on a regular basis at these project team meetings. A copy of the final version of this Assumptions Log is attached as Appendix 2 to this report.

1.6 This exercise has been progressed to GRIP Level 1 which is the Output Definition project phase. The key outputs contained in this report are therefore a summary of the key issues by engineering discipline, a high level programme and estimates to +/- 50% quality.

2) GEOGRAPHIC SCOPE OF THE PROPOSAL

2.1 For the purposes of this exercise it has been assumed that the following electrification works will be carried out by other projects :

Airdrie to Bathgate

The Airdrie to Bathgate project will be completed prior to the implementation of this proposal. The project encompasses the electrification of the section of the existing E&G route from Newbridge Jcn (38m 59ch) to Haymarket East Jcn (45m 73ch).

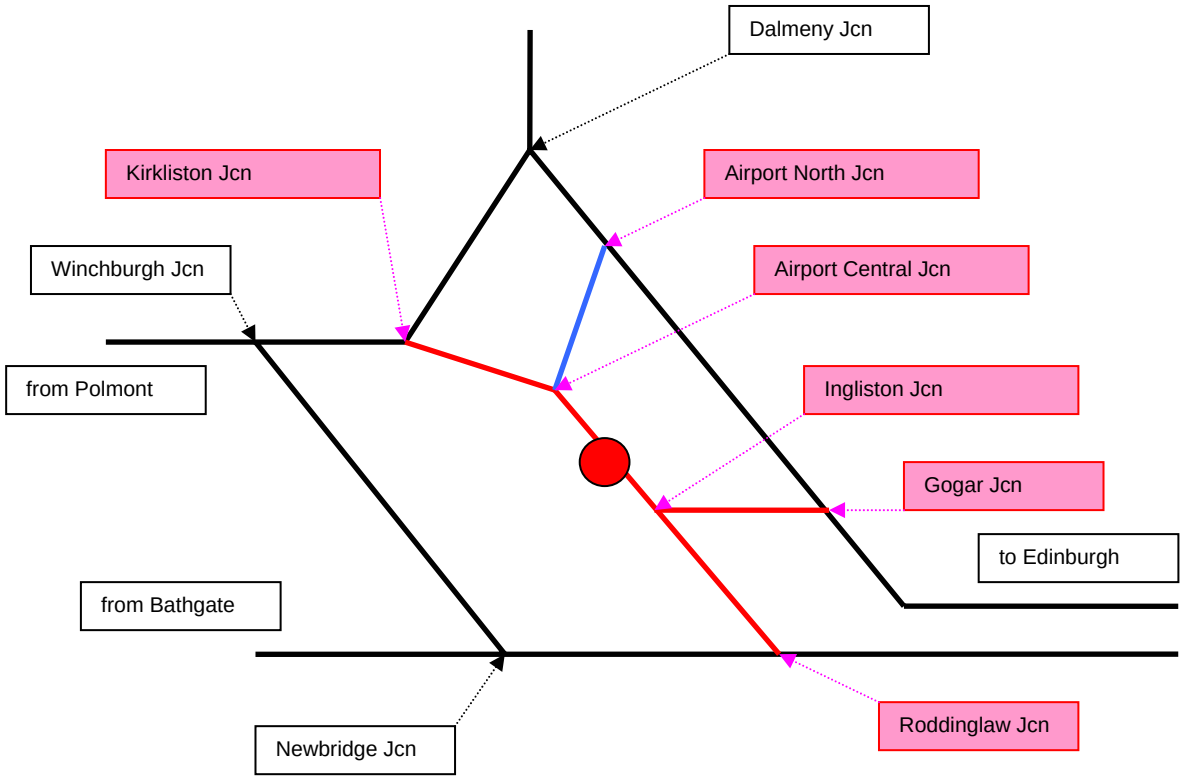
The project will not electrify the North Lines between Haymarket Central Jcn (45m 35ch), the location of the ladder junction between the South Lines and the North Lines, and Prices Street Gardens (0m 35ch) via Platforms 1 and 2 at Haymarket Station and Haymarket North Tunnel.

The 4 trains per hour EMU operated Airdrie to Bathgate project requires the electrification of the centre bore of the Mound Tunnel. An assessment is currently underway to determine the optimum way to progress these works to achieve the required completion date.

Edinburgh Airport Rail Link (EARL)

The new routes constructed by the EARL project that connect with the E&G route will be electrified as part of the EARL project. These routes comprise the new alignment from the new Roddinglaw Jcn on the existing E&G route via the Airport to the new Kirkliston Jcn, the existing line between the new Kirkliston Jcn and the existing Winchburgh Jcn on the existing E&G route and the new spur line from the new Gogar Jcn on the existing North Lines to the new Ingliston Jcn.

These routes are illustrated in the schematic diagram overleaf.



2.2 The extent of the existing infrastructure that is to be electrified under this proposal was therefore specified as :

Core Route

Glasgow Queen St High Level / Cowlairs South Jcn / Croy /
Greenhill Upper Jcn / Falkirk High / Polmont Jcn / Linlithgow / Newbridge Jcn

Diversionary Route 1

New Gogar Jcn / North Lines / Haymarket Central Jcn /
Haymarket Station Platforms 1 &2 / Haymarket North Tunnel.

Diversionary Route 2

Greenhill Upper Jcn / Greenhill Lower Jcn / Carmuirs West Jcn /
Carmuirs East Jcn / Falkirk Grahamston / Polmont Jcn

Diversionary Route 3

Cowlairs South Jcn / Springburn / Gartcosh / Cumbernauld /
Greenhill Lower Jcn

2.3 The map attached as Appendix 3 illustrates the Routes covered under each of the above groupings together with the Routes assumed to be electrified by other projects as described in Section 2.1 above

2.4 The only depot infrastructure considered for wiring under this proposal was specified as the stabling facility at the west end of the route at Eastfield. No account is taken of any additional electrification required to allow EMU's to access Shields Depot. This is assumed to remain as the main maintenance facility for EMU stock in Scotland for the purposes of this exercise.

2.5 The series of maps attached as Appendix 4 illustrate the individual tracks to be electrified under this proposal. The total extent of the additional track miles to be electrified, based on the above specification, is tabulated below.

Routes	Single Track Miles	Single Track Kilometres
Core Route (incl Eastfield Depot)	84.3	135.7
Diversionary Route 1	9.9	16.0
Diversionary Route 2	17.5	28.1
Diversionary Route 3	37.0	59.5
Totals	148.7	239.3

The table attached as Appendix 5 provides a bottom up analysis of the above totals by Route.

2.6 Potential synergy infill electrification initiatives were identified during the course of this exercise. In each of these cases a comparatively small amount of additional wiring would provide an opportunity to extend the scope of the proposed electrically operated services. These opportunities are :

Cowlairs West Jcn to Sighthill West Jcn (0 miles 740 yards)

Electrification of this double track section would allow E&G services to terminate at Springburn in the event of a planned or unplanned blockage between Cowlairs and Glasgow Queen Street High Level. This would also provide a direct link to Parkhead feeder station for emergency feeding purposes.

Gartsherrie South Jcn to Garnqueen North Jcn (1 mile 460 yards)

If Diversionary Route 3 were electrified, electrification of this double track section would allow the existing Motherwell to Cumbernauld service to change over from DMU to EMU operation and allow the potential for its integration with Argyle Line services to realise resource efficiencies.

Gartsherrie South Jcn to Gartcosh Jcn (1 mile 480 yards)

If Diversionary Route 3 were electrified, electrification of this single track section would allow a more direct access route for Empty Coaching Stock (ECS) workings to and from Shields Depot than the alternative existing route via Carstairs.

The associated additional electrified track mileage that would have to be wired under each of these opportunities is also tabulated in Appendix 5.

2.7 Extension of electrification beyond the Routes assessed in this exercise from Carmuirs West Jcn and East Jcn to Dunblane / Alloa would be a logical next step in order to further expand the scope of network benefits that could be realised by a comprehensive electrification strategy.

However, it is recognised that the additional infrastructure costs that this would entail are a significant order of magnitude higher than those for the three minor initiatives identified above. In particular, it is known that the clearances in Kippenross Tunnel are tight and an additional feeder station would be required north of Carmuirs. This would therefore have to be considered as a separate exercise, however an assessment is provided in the following section of this report of the scope to accommodate these potential future extensions within the feeding strategy that is recommended for this proposal.

3) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : OVERHEAD LINE

3.1 Power Requirements

3.1.1 The remit from Transport Scotland and associated Assumptions Log specify that the electrification of the Core Route shall only be designed to support the operation of the E&G services in 3 and 6 car formations at a frequency of 4 trains per hour. Electrification of the proposed Diversionary Routes would provide alternative routes for the E&G services, but in this study it is assumed that no other existing services are to be converted to EMU operation to run on these routes. However, the proposals contained in this report could accommodate the additional load arising from the possible conversion of the Glasgow to Cumbernauld service without any subsequent requirement for additional reinforcement of the supply network.

3.1.2 The proposed EMU operated E&G service is similar in frequency and stopping pattern to that proposed by the Airdrie to Bathgate project, although they operate at a higher line speed (100mph maximum) compared to the Airdrie to Bathgate services (80mph maximum). The power requirements for the E&G electrification have therefore been calculated from the power requirements calculated for the route from Drumgelloch to Haymarket, adjusted as required to make allowances for the longer route length and higher speed. As a worst case scenario, the power requirements ignore the effect of regenerative braking which would reduce the overall power consumed.

3.1.3 Based on the above, the estimated power requirement for the E&G core route from Glasgow Queen St to Haymarket at peak times is in the region of 10MW. Because of the longer route length, the power requirement would increase slightly if some of the diversionary routes were in operation, but this would not impact on the rating of any of the proposed new OHLE infrastructure.

3.1.4 Between Haymarket and Waverley, the electrified E&G service will impose a negligible loading increase on the existing feeder station at Portobello. Our assessments have indicated that this increase can be accommodated within the capacity of the existing equipment.

3.2 Feeding Areas

3.2.1 The Core Route cannot be provided with power from the existing electrification at both ends within the permitted voltage limits. The length of the route and the necessary interfaces with other electrified areas dictates that the power must be provided by more than one feeder station.

3.2.2 As stated in 2.1, it is assumed that the Airdrie to Bathgate project will electrify the section of the E&G route from Newbridge Junction to Haymarket. It is proposed that these 'existing' power supply arrangements at the east end of the route are extended to Winchburgh. The power requirements for the E&G route between Winchburgh and Haymarket will then be provided from the 'existing' feeder station feeding from Bathgate to Haymarket. This will result in approximately one third of the anticipated load for the E&G route being provided by this feeder. This can be accommodated within the working rating of the proposed new feeder station at Bathgate. A new mid-point Track Sectioning Cabin (TSC) complete with neutral sections will be provided in the Winchburgh area as the boundary between the two feeding areas.

3.2.3 The remaining route from Winchburgh to Glasgow is suitable for a single new feeder station located towards the centre of the route to be covered. This will locate the new feeder station in the Greenhill area. An alternative option has also been developed to provide the new feeder station at the east end of the route to ease the potential requirement to provide as few restrictions as possible on the operation of the depot at Eastfield. This alternative option is outlined further in Section 3.10.

3.3 Proposed Switching Stations

3.3.1 Preliminary discussions took place with Scottish Power during July 2006 at which they indicated that grid connection points towards the centre of the route are available from their existing network at the Bonnybridge or Grangemouth substations. These substation locations would allow a connection to the existing railway network in the Greenhill or Polmont areas respectively for the electrification of the Core Route. The Bonnybridge / Greenhill combination would provide the most central source of power on the route and is an ideal location to provide connections to Diversionary Routes 2 and 3 if these are also to be electrified. The proposed new Greenhill feeder station would be a twin circuit 18MVA connection.

3.3.2 The feeder station will be installed with the ability to accept regenerative braking from trains. This is a straightforward exercise utilising the latest generation of protection relays to ensure that circuit breakers do not trip during normal operation.

3.3.3 Intermediate TSC's will also be installed in the Polmont, Gartshore and Cowlairs areas. This will allow the electrification design to follow the established guidelines of providing a TSC approximately every 10 to 15km. The locations of the TSC's has been selected to allow extensions to accommodate the Diversionary Routes and connections to depots etc with minimal additional work.

3.4 Interfaces with Existing Electrified Network

3.4.1 East End

At the east end of the E&G route the proposal will tie into the 'existing' electrification at Newbridge Junction. The TSC at Newbridge Junction will be extended by two new track feeder circuit breakers to encompass the section of the E&G route between Newbridge and Winchburgh. The Airdrie to Bathgate project is making passive provision for these circuit breakers and OLE connections in their design.

The schematic plan attached in Appendix 6 illustrates these proposed arrangements.

3.4.2 West End

At the west end of the E&G route the new feeder station at Greenhill will normally feed to the terminus at Glasgow Queen St High Level. In the core route lines identified, the Glasgow end of the E&G route has no requirement to tie into the existing electrification.

The schematic plan attached in Appendix 7 illustrates these proposed arrangements.

3.5 Emergency Feeding Arrangements

3.5.1 First Emergency Feeding Arrangements

In a first emergency situation one of the two transformers at a feeder station is unavailable. In first emergency situations the remaining transformer is designed to support all of the prospective load with no reduction in train performance. With approximately 7MW of load and either of the 18MVA transformers at Greenhill, the transformers will have enough capacity to accommodate the load under first emergency conditions.

3.5.2 Second Emergency Feeding Arrangements

In a second emergency situation none of the incoming circuits at a feeder station are available and the power for the route would have to be provided from adjacent feeder stations. At these adjacent feeder stations it is assumed that all incoming connections are fully operational. Under second emergency feeding full train performance and full timetable running is not guaranteed.

At the east end of the route, overhead line power can be provided from the new Airdrie to Bathgate feeder station or the existing Portobello feeder station as operational circumstances require.

At the west end of the route, the Core Route has no natural connection to the existing electrified network. It does, however, pass within 0.6km of the current limit of electrification at Springburn station. To avoid the requirement for a second new feeder station in the Glasgow area to support the west end of the route, it is therefore proposed that a cable connection will be installed between the gap in the electrified networks between Springburn and Cowlairs.

This cable has to provide a feed and return path for current. For the Core Route a single cable connection will be installed. If diversionary routes are also to be electrified, a double cable connection will be installed. This connection will be used to provide power under second emergency conditions from the existing feeder station at Parkhead. Under normal feeding arrangements the load at Parkhead will not increase and the additional load can be supported within the existing transformer ratings if both transformers are available.

To provide the alternate feeding connection from Parkhead some works are required at Parkhead and on the Springburn branch. An extra circuit breaker will be provided at Parkhead and a cable route installed to connect it to the existing track feeder connections at Bellgrove. The return conductor on the Springburn branch will be extended from its existing terminus to the limit of electrification. The booster transformers at Bellgrove will be replaced with 300A units and additional booster transformers will be installed in the Springburn area. Neutral sections will be installed at Bellgrove to provide flexibility to the OLE system in feeding arrangements.

With higher currents being transmitted in the OLE through this connection these works will minimise the OLE lost during fault conditions and improve the immunisation of S&T cables on the Springburn branch.

The feeding distances under second emergency feeding would be acceptable to allow trains to run.

3.6 Electrification of Diversionary Routes

3.6.1 Diversionary Route 1

Diversionary Route 1 consists of electrifying the lines from the proposed Gogar Junction for the EARL branch through Haymarket Station and Haymarket North Tunnel to tie into the existing electrification just before the Mound Tunnel. Neutral sections would need to be installed in the vicinity of Haymarket East Junction.

Between Haymarket and the Mound Tunnel the diversionary route would be added to the existing electrical section. From Haymarket to Gogar Junction the amount of new electrification on these lines plus the probable addition of the EARL branch would dictate the provision of two additional circuit breakers at the Haymarket TSC. This would allow faults on the diversionary route to be interrupted safely without interrupting supplies to the main lines. The Airdrie to Bathgate project team are currently quantifying the additional cost (if any) of providing the required additional space at the new Haymarket TSC to allow the fitting of these circuit breakers at a later date with a view to seeking the necessary project variation as soon as possible.

3.6.2 Diversionary Route 2

It is proposed that the route from Greenhill to Polmont via Carmuirs will be electrified as additional electrical sections. These sections will be protected by dedicated circuit breakers at Greenhill and Polmont. Although longer than the Core Route, Diversionary Route 2 will still be a single electrical section for each line and no intermediate sectioning is required. A fault on the Diversionary Route can be safely interrupted by these additional circuit breakers without interrupting power to the Core Route.

3.6.3 Diversionary Route 3

It is proposed that the lines from Springburn to Greenhill via Cumbernauld will be electrified with additional electrical sections. It is proposed that:

Springburn to Gartcosh will be fed from the existing Parkhead FS ;

Gartcosh to Greenhill will be fed from the new Greenhill FS.

To reduce the amount of OLE that would potentially be disconnected during a fault, the Springburn branch will be converted from a single to a double track circuit breaker feed. The TSC at Cowlairs will be extended to accommodate additional circuit breakers for connections to the Springburn branch and the Springburn to Gartcosh lines. A neutral section will be required in the Cowlairs Chord to separate the different power supplies.

Additional circuit breakers and neutral sections will be installed at Greenhill for the Greenhill to Gartcosh lines. A new midpoint TSC would be installed at Gartcosh with neutral sections to separate the different power supplies, no other intermediate sectioning is required.

If Diversionary Route 3 is electrified, the cost of providing the cable described in Section 3.5.2 above to provide Second Emergency Feeding supplies can be avoided.

3.7 Overhead Line Design Issues

3.7.1 Open Route

The majority of the proposed routes can be electrified using standard products from the currently approved OLE design ranges. The basic OLE design will use auto-tensioned equipment supported on single track cantilevers which are mounted in the cess, except in particular areas as described below.

No problems are anticipated in interfacing the proposed new equipment to the existing equipment in the existing electrified network. However, a single type of OHLE design must be used to ensure compatability at critical interface points such as Newbridge and Winchburgh Junctions.

3.7.2 Junctions

Run offs for controlled de-wirement, of typical length of three spans of OLE are proposed at junctions to protect against potential wrong routing. These run offs will be installed at facing junctions only.

3.7.3 Multi-Track Areas

OLE supported on headspans or portals is proposed in areas where there are more than two tracks and the track separation does not permit the use of cantilevers between the tracks.

3.7.4 Signal Locations

At locations where signal sighting is problematic, additional design and the use of structures such as twin track cantilevers would allow signal sighting compliance without the need for major signalling alterations. An allowance for a proportion of such locations has been made within the project estimate.

3.7.5 Stations

It is proposed that the cantilever structures will be replaced by portals or headspans through stations to improve the segregation between station and OLE equipment. The location and numbers of these portals or headspans will be designed to accommodate any future platform extensions necessary to achieve the implementation of the strategy for the route. It should be noted in this regard that the long west end bays at Edinburgh Waverley and the platforms at the new Edinburgh Airport station will accommodate formations of 8 no 23metre vehicles.

At Glasgow Queen St station the new OLE system must be designed to be unobtrusive and in sympathy with the existing building. Existing building supports should be used to minimise the amount of new steelwork introduced.

3.7.6 Viaducts

The use of portal structures at viaducts is proposed to reduce the loadings on the structure. For those viaducts that are listed structures, approval of OLE equipment will have to be obtained from the relevant planning authorities and a longer design and approval period must be allowed for in such cases.

3.7.7 Cuttings

Along the route there are several cuttings (for example Eastfield, Croy and Winchburgh) with severely restricted lateral clearances. These will pose technical issues for the installation of OLE as installation of conventional structure foundations may not be possible. Conventional contact wire arrangements can be used, however the technical issues to be resolved will centre around the method of providing them with adequate support and additional design and construction time will be required to ensure that an adequate anchor is achieved. Installation of OLE has been successfully completed in similar areas in Roade Cutting, south of Rugby on the West Coast Main Line.

3.7.8 Tunnels

Tunnels along the route have been assessed for electrification clearances using a 4200mm minimum contact wire height by superimposing a pantograph profile onto the existing tunnel gauging profiles to highlights areas of concern. The results of this desk top assessment are reported in the next section of this report.

The preferred solution at all of the tunnels where works are required to achieve an acceptable electrification clearance is to lower and re-align the track before considering conducting major civil works on the tunnel structures. Special reduced clearances will only be used where it can be demonstrated that civil works cannot achieve the required clearances.

While the tunnels on the route may pose technical challenges to the installation of OLE equipment, the clearances are such that all are possible to wire. Restricted clearances combined with high line speeds may require innovative solutions not yet used in the UK.

Mound Tunnel has more restricted clearances than any of the tunnels on the Core Route. A solid conductor rail solution is currently being considered for the wiring of this Tunnel under the Edinburgh Waverley Phase 1 and Airdrie to Bathgate projects. This is an ideal arrangement for restricted clearances and is approved on the continent for line speeds up to 250km/h, and it is anticipated that at worst a similar solution will be required for the other tunnels on the route. On tunnels with less restricted clearances an underbridge arm and catenary wire arrangement will be used.

3.8 Immunisation

3.8.1 Immunisation of S&T lineside circuits will be achieved by installation of a return conductor and booster transformer system. Because of the distances involved, the return conductor can be terminated outside Queen St High Level tunnel. The anticipated restricted clearances through the tunnel would otherwise make fitting difficult.

Return conductors will be insulated where the proximity of the conductors would affect the segregation. Return conductors through stations shall also be insulated.

3.9 Electrical Control Arrangements

3.9.1 All of the new works will be operationally controlled from the existing ECR at Cathcart where it is anticipated that the enhancement works at Airdrie to Bathgate and E&G route will be installed on a new communications subsystem. The existing master station has the capacity to accommodate this additional sub system.

3.9.2 Currently the master station supports 52 outstations. This represents 46% of the available capacity. The enhancement projects at Airdrie to Bathgate and E&G electrification are likely to add a further 12 outstations, increasing capacity to 57%. While the number of outstations is 46% of capacity the current digital output signals is 10% of capacity, digital inputs at 13% of capacity and circuit breaker controls at 8% of capacity.

3.9.3 In conclusion, the existing master station has sufficient capacity to accommodate the new inputs and outputs that arise as a consequence of the above projects. Network Rail is currently assessing a proposal to re-locate the ECR as part of the Scotland Management Control Centre concept, however this proposal does not affect this conclusion.

3.10 Alternative Feeding Option

3.10.1 The above feeding strategy proposes to feed Eastfield Depot from a dedicated circuit breaker at the TSC in the Cowlairs area. This would provide a robust power supply with the ability to connect to two separate sources of power. It does not, however, guarantee a permanent power supply to the Depot as simultaneous isolations could interrupt both sources.

3.10.2 An alternative feeding proposal was therefore developed to address this issue. Discussions with Scottish Power have identified that there are existing power supplies at Port Dundas / Cowlairs and Lambhill / Bishopbriggs that could supply a feed to the OHLE network. Both of these locations are close enough to Eastfield to connect the depot directly to the new feeder station. The non-central location of the feeder station at Cowlairs increases the feeding distances, but the associated voltage limits would still be within acceptable limits.

3.10.3 The feeding arrangements for this alternative option are also shown in Appendices 6 and 7.

3.10.4 It is recommended that the final location of the feeder station should be decided in future project stages when the depot operation constraints on the new electrification arrangements are understood in greater detail. At this stage it is considered that there are no appreciable differences in costs between the options.

3.11 Other Issues

3.11.1 <u>Lineside Switches</u>

At strategic points on the route, crossovers, TSCs and within electrical sections lineside switches shall be provided for sub-sectioning. Motorised switches shall be installed in areas where bi-directional working is permitted and in areas where access for operation is difficult. In all other areas manual switches shall be fitted.

All TSCs will be fitted with bypass switches to facilitate maintenance activities.

3.11.2 Vegetation Clearance

Vegetation clearance, especially in restricted areas, must be completed to ensure that all vegetation is 2.75m minimum away from the OLE. An allowance has been made within the estimate for vegetation work along the route to achieve electrification clearances.

3.11.3 Screening

Throughout the route screening will be used to shield non OLE equipment (structures, bridges, non railway equipment) and people working on the equipment from the proximity of the OLE.

3.11.4 Utility Diversions

On the existing route there will be multiple instances of utility services crossing the railway. If installed too low the clearance between the overhead line equipment and the utility service may be insufficient. They also pose a danger to the operation of the electrified railway because they would cause trips if the wires fell on top of the OLE. To avoid this it is recommended that most of the services crossing above the railway (electricity circuits up to 33kV and telephone circuits) are replaced with cable or diverted to avoid the railway.

At this stage it is not possible to quantify the number of such services that may be affected and an allowance is included within the estimate for a small number of diversions.

3.11.5 Fencing

The type and integrity of the fencing along the route will have to comply with the latest electrification standards. As the fencing on the route is already to a very high standard, the associated works are only minor in nature.

3.11.6 Testing and Commissioning

Once the new route and feeder station is constructed, energised and section proved it will be required to undergo short circuit and load bank testing to prove that the S&T lineside cables are adequately immunised.

The energisation of the OLE will be preceeded by a campaign of information and advice to schools, local authorities, emergency services as required by Network Rail company standards.

3.11.7 Potential Future Extension of Electrification to Dunblane / Alloa

The electrification of the lines on Diversionary Route 2 in the Carmuirs area will be designed to easily accommodate a potential future northwards extension to Stirling. An additional feeder station would be required for this extension as the proposed feeder stations at Greenhill or Glasgow would not be able to support the route adequately under second emergency feeding arrangements.

A feeder station at Greenhill could normally feed to Stirling, Dunblane and Alloa, a maximum distance of 28km, with no increase in the rating of the equipment. Two new TSC's would be required for sectioning purposes in the Larbert and Stirling areas.

4) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : STRUCTURES

4.1 Summary of Issues

4.1.1 The principal structures issue arising from the proposal to electrify the Core Route and the Diversionary Routes is the determination of the optimum method of achieving the necessary clearance enhancements required for the installation of the overhead wiring system at each affected structure.

4.1.2 Other issues also arise in the installation of masts on existing listed structures, general considerations relating to the deployment of new rolling stock and any necessary extension of platforms to accommodate longer train lengths. Whilst the first of these may be significant, the associated difficulties with achieving an acceptable resolution are likely to be less than those related to the provision of electrical clearance.

4.1.3 Details of the new EMU rolling stock that would operate on the route and the associated platform length requirements have not yet been determined. In accordance with Transport Scotland's remit and the associated Assumptions Log, the impact of the proposals on platform lengths has therefore not been addressed in this exercise

4.2 Evaluation of Electrical Clearances

4.2.1 A desk top assessment was carried out of the current available clearances at each of the existing overbridge structures on each of the Routes to determine whether the required electrical clearances could be achieved. Where they could not be achieved, an assessment was also made of the extent of the necessary physical works that would be required at each individual structure to achieve the required clearances.

4.2.2 This assessment was carried out using the most recent current structural clearance data contained in Network Rail's database for overbridge structures on each of the Routes. Clearance assessments were based on whether a minimum contact wire height of 4200mm could be achieved with an acceptable passing clearance from the vehicle pantograph to the adjacent structure.

4.2.3 Acceptable passing clearances were taken as 80mm to brick or masonry structures or 150mm to metal structures. These dimensions were increased to 150mm and 200mm respectively in the desk top assessment to take account of the dynamic movement of the contact wire.

Generic descriptions of the typical types of work required on individual structures are provided in the following sections.

4.3 Provision of Electrical Clearances : Overline Bridges

4.3.1 The works required at individual overline bridges vary significantly. A few structures are already suitable for installation or even direct fixing of the overhead line equipment without any additional works. These tend to be the most recently constructed highway structures or station footbridges.

4.3.2 At a number of structures sufficient clearance currently exists for the installation of overhead line equipment, but the existing parapet details will have to be revised. The requirement for enhanced parapets reflects the electrocution hazards associated with 25kV equipment in addition to those more generally associated with the passage of trains. These can normally be addressed by the raising of parapets and the installation of coping on which it is difficult to gain a foothold. Current masonry or steelwork details may also require to be treated to remove existing footholds, particularly on the exterior or rail side of the structure. This work is generally straightforward, relatively inexpensive and can typically be undertaken under the existing Rules of the Route access opportunities.

4.3.3 A number of options exist at overbridge structures where the existing clearance is insufficient for the installation of overhead line equipment. For arched structures in particular, reconstruction is generally required due to foul clearances at the ends of the vehicle pantograph swept envelopes. It is, however, frequently possible to re-use the existing abutments of these structures from the level of the arch springing downwards in order to minimise the reconstruction costs. The arch itself would typically be replaced by pre-cast concrete units with a square profile to provide haunch clearance for the pantograph and the return conductor and raised vertical clearance for the contact wire.

4.3.4 The cost of this work is substantial and dependent on the size of the structure and the nature of any road and utility diversions needed to allow the work to take place. In many cases it is possible to phase the works in order that it may be undertaken under Rules of the Route access or with minimal disruption to rail traffic. The road access would normally remain unusable throughout the period of the reconstruction works, typically three to four months.

4.3.5 In some cases, particularly for flat steel or concrete decked structures, it is possible to jack up the existing deck and support it on raised abutments. The cost of this work is also substantial and is again dependent on the size of the structure, the presence of utilities and and the need or otherwise to provide an alternative road access during the works. It is usual to phase the works in order that it may be undertaken under Rules of the Route access opportunities or with minimal disruption to rail traffic.

4.3.6 In a relatively small number of cases the most cost effective solution is to lower the rail level beneath the structure to achieve the necessary clearances. This is likely to be the case only where the structure or the utilities crossing it are particularly complex or sizeable. The vertical profile of the rail approaches to the structure will also require to be re-profiled, often over several hundred metres unless the line speed is low or the magnitude of the track lowering required is minimal. For this reason, it is unlikely that the works will be able to be undertaken under the normal Rules of the Route access windows. This solution is also liable to leave a legacy of formation drainage problems due to the creation of a dip in the vertical track profile.

4.3.7 No allowance has been made to address potential vehicle incursion issues at existing overbridge structures which are currently being addressed as part of a national campaign. Where individual structures have been assessed as requiring re-construction appropriate protection against vehicle incursion will be incorporated as part of the new superstructure design.

4.4 Provision of Electrical Clearances : Tunnels

4.4.1 The Routes under consideration for electrification under this study include a number of tunnels. The tracks within Haymarket South Tunnel were electrified as part of the Edinburgh to Carstairs electrification project some fifteen years ago. It is also assumed, as outlined in Section 2.1, that the centre bore of the Mound Tunnel will be electrified for the Airdrie to Bathgate scheme in advance of the proposed Edinburgh to Glasgow electrification project proceeding.

The assessed extent of the physical works required on each of the other tunnels on the Routes is summarised below.

4.4.2 Core Route : Queen Street (High Level) and Falkirk High Tunnels

The tracks through both of these Tunnels are assessed as having sufficient electrical clearance for the installation of overhead line equipment. Both have slab track formation which will allow this equipment to be installed at a reduced clearance when compared with conventional ballasted track as there is no requirement to provide tolerances for future track movements.

Both Tunnels are wet in places and the placing of the new overhead line supports will have to take account of this. An allowance has therefore been allowed in the project estimate for alterations to existing or installation of new drip trays.

4.4.3 Core Route : Winchburgh Tunnel

This tunnel is assessed as having sufficient electrical clearance to allow installation of overhead equipment through most of its length. Tight clearances within the tunnel are localised and it is envisaged that the required work at the affected locations can be undertaken to the tunnel fabric rather than to the track to achieve the necessary easement.

These works will, however, still be significant in nature. Detailed site investigations involving extensive coring will have to be carried out to confirm the precise scope of these works which are expected to be a combination of grouting, rock bolting, brickwork, the provision of sprayed concrete linings and improved track alignment fixity to allow the new overhead line equipment to be installed at a reduced clearance.

It is anticipated that the proposed package of works can be implemented during a period of short blockades, probably of around 48 hours duration. This compares with a three to four month closure that would have been required had it proved necessary to install slab track. The disruptive possessions required may also be capable of integration with the possessions required for the significant re-modelling of Winchburgh Junction that is being undertaken as part of the EARL project.

Copies of some representative tunnel profiles are attached as Appendix 8.

4.4.4 Diversionary Route 1 : Haymarket North Tunnel

This tunnel has insufficient clearance for overhead line equipment throughout most of its length. At these locations a significant track lowering will be required and the track will have to be re-instated to a fixed alignment to allow the equipment to be installed at an acceptable reduced clearance.

It is therefore proposed that the additional clearances required are achieved by the installation of slab track, in a similar manner to the works on the adjacent Haymarket South Tunnel referred to above. A deep level drain is also proposed as part of these works to address the long standing drainage problem in the Tunnel.

The cost for this work will be very substantial, and the associated access required will necessitate closure of the Tunnel to rail traffic for a period of 3 to 4 months. The additional track and signalling facilities being provided at Haymarket Station as part of the Edinburgh Waverley Phase 1 project will allow the associated disruptive impact of this major blockade on existing services to be minimised.

Copies of some representative tunnel profiles are attached as Appendix 8.

4.4.5 Diversionary Route 2 : Carmuirs Twin Tunnels

These Tunnels are single bore structures with insufficient clearance for the installation of the new overhead line equipment. Unlike the double track tunnels where there is generous clearance in the centre of the tunnel to provide support arrangements for the overhead line, clearance to achieve an acceptable support arrangement for the overhead line will be difficult to achieve. A track lowering in the order of 150 to 200mm is therefore assessed as necessary to achieve acceptable clearances.

The tunnels are comparatively short (40m in length) and may be suitable for single line working while the works are being undertaken. Whilst the cost for this will be significant, it should be possible to complete the works in weeks rather than the months required for a longer structure.

Copies of some representative tunnel profiles are attached as Appendix 8.

4.5 Installation of Overhead Line Equipment

4.5.1 The installation of overhead equipment is likely to rely on direct support from a structure at a number of locations. The typical associated general arrangements are described below.

4.5.2 On viaducts, portals are generally secured to the spandrel walls to carry the wiring on the structure. Standard designs for this type of arrangement are well established. In the last 15 years variations of these designs have been approved for installation at listed structures including the Royal Border Bridge at Berwick and Dunglass, Linhouse and Slateford Viaducts in East and Central Scotland. The routes under consideration for electrification under this exercise include the listed viaduct structures at Newbridge, Linlithgow and Castlecary. Although no approach has yet been made to the relevant planning authorities, it is assumed that an acceptable design can be agreed.

4.5.3 On retaining walls, it may be necessary to build supports into the face of the structure. This has been successfully achieved elsewhere on the network, and it is anticipated that this arrangement can be repeated where necessary on this project.

4.5.4 In rock cuttings specialist designs may be required for mast and gantry foundations. The route has a number of such cuttings, most significantly those at Bishopbriggs, Croy and Winchburgh. Subject to careful positioning of the footings at these locations and given sufficient time to optimise designs, it is not envisaged that these will impact unduly on the installation of the required overhead line equipment.

4.6 Conclusions

4.6.1 The tables in Appendices 9 to 12 summarise the outputs from the structural clearance assessments referred to above. They identify the structures where it is assessed that the necessary electrical clearances currently exist together with the assessed extent of the necessary works to achieve electrical clearances on structures where these do not currently exist.

4.6.2 A summary of the outputs from these assessments is provided in the table below.

	Core Route	Diversionary Route 1	Diversionary Route 2	Diversionary Route 3
Clear : No Works Required	5	0	5	16
Clear : Parapet Protection Works	31	1	9	6
Foul : Track Lowering Works	2	2	1	0
Foul : Re-construction	13	3	7	11
Other Works	3	0	0	0
Total No of Structures	54	6	22	33

5) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : SIGNALLING

5.1 Summary of Issues : Core Route

5.1.1 At the west end of the Routes, the Queen Street, Eastfield, Cadder, Gartshore, Gartsherrie and Garnqueen signalling interlockings are all Solid State Interlockings (SSI's) that have been constructed to current standards. They are therefore, in general, already to acceptable electrification standards. The only significant exception to this is the current double rail configuration track circuit bonding arrangements. Queen Street also has a mixture of AzL 70/30 and AzL 90 axle counters. The AzL 90 is a one off installation with a Site Specific Safety Case and will need to be replaced with an electrification compatible equivalent.

5.1.2 Greenhill is an early GEC Geographical interlocking which was commissioned in two stages. The older part of Greenhill interlocking is generally not to AC Immune standards. It generally has low voltage AC signal heads, non immune type point machines (HW1000) and many aspect control line relays that are also of the non immune type. That part of Greenhill which was renewed later (called the Greenhill Extension) which covers the Scottish Central Route is more compliant with electrification standards, being near identical in design to the lineside equipment supplied at Motherwell for the West Coast Electrification.

5.1.3 Polmont, Boness, Linlithgow, Winchburgh and Newbridge are all GEC Geographical interlockings with AC Immune Point Machines, Line Circuits and Signal Heads. The bonding configuration is a mixture of single rail on plain line and double rail in S&C.

5.1.4 Haymarket is an Interfaced SSI with similar lineside arrangements as that from Polmont to Newbridge. All equipment is, in general, to electrification standards.

5.1.6 Edinburgh Waverley is a full SSI installation similar to Queen Street. All equipment is to electrification standards.

5.2 Physical Works Required

5.2.1 As described above, the signalling equipment on the Core Route and the majority of the Diversionary Routes is therefore already largely "electrification compatible". There are, however five specific packages of work that will need to undertaken as described below : -

1) The double rail track circuit configuration needs to be changed to single rail. Large numbers of Insulated Block Joints (IBJ's) will therefore need to be recovered.

2) The Safety Case for the AzL 90 axle counter arrangement at Queen Street will need to be reviewed and replacement with an electrification compatible alternative will probably be required as a consequence. It is currently anticipated that this replacement will have been carried out prior to the implementation of this project under Network Rail's signalling renewals programme.

3) 18 non immune point machines In the Greenhill area need to be changed to a current AC Immune type (HW2000).

4) Non immune line relays in the Greenhill area need to be changed for AC Immune types.

5) The Low Voltage signal heads In the Greenhill area the need to be changed or checked to ensure that their tail cables are short enough for them to be electrification compatible.

5.2.2 A strategy of maintenance delivered point machine conversion and relay changing could be considered for the Greenhill area. This would then be identical to the strategy used in the late 1980's to undertake a similar task in the Peterborough Station area in a cost effective manner as part of the East Coast Main Line Electrification project.

Alternatively, it may be more cost effective to bring forward the planned S&C renewals at Greenhill Junction to coincide with the timescales for the electrification project. All point machines and relays provided under this renewal would be to electrification standards.

5.3 Other Issues

5.3.1 A number of other issues will also have to be addressed in the subsequent development of this project. These are summarised below.

1) Any new Neutral Sections in the existing auto signalled sections in the Polmont and Greenhill areas will require the protecting signals to be converted to non interlocked controlled type signals.

2) Signal sighting is likely to be a major issue due to the high speeds on the route. An allowance has been made in the estimate meantime for a number of signal relocations.

3) 650V power cables are sectioned in electrified areas by means of a 1:1 transformer to prevent unacceptable induced voltages. A number of such transformers may need to be installed at a number of locations.

4) SSI data links need to be reviewed for adequate provision of Data Link Isolating Transformers (DLIT's) etc.

5) Provision of an electromagnetic Screening Cable by Telecoms will be needed to protect signalling cables.

6) Cable routes may need to be relocated within the masts in certain places to give optimum arrangements in respect of traction derived interference.

7) Gapping of point rodding at Ground Frames along the route will also be required.

8) Non AC Immune Aster type jointless track circuits exist on Diversionary Route 2 between Polmont and Grangemouth Junction and on Diversionary Route 3 at Greenhill Lower. These are currently being converted to medium voltage AC immune track circuits under the signalling renewals programme and it is anticipated that all conversions will have been carried out prior to the implementation of this project.

6) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : TELECOMMUNICATIONS

6.1 Summary of Issues

6.1.1 The potential adverse effects propagated in telecomms cables as a result of the introduction of a new AC traction electrification system are an excessive touch potential which creates an occupational safety hazard and induced noise which could cause degraded speech levels in safety critical voice and data circuits.

6.1.2 The mitigating measures that are proposed to control these effects are outlined below.

6.2 Screening Conductor

6.2.1 To provide immunity to the effects of electromagnetic induction into telecoms cables it is proposed to provide a sacrificial compensating cable in close proximity to the signalling & telecoms cables. This sacrificial cable is called a screening conductor and its purpose is to shield any nearby cables. The screening conductor comprises of a single, pvc-sheathed, stranded aluminium conductor with cross sectional area of 150mm² which is earthed approximately every kilometre.

6.2.2 Provision of screening conductor on the Core Route and all Diversionary Routes 1, 2 & 3 will require approximately 125km of screening cable, 260 joints or branching joints and 134 earth farms. These figures include for provision of screening conductor and associated joints and earth farms on adjacent branch lines which will not be electrified. There are a small number of locations on the route with lengths of parallel cabling where it may be necessary to provide parallel screening conductors in both routes. Tolerance has been allowed within the estimated 125km of screening provision to accommodate these areas.

6.3 Troughing Route

6.3.1 In 25kv AC electrified areas utilising separate return conductor and booster transformers the ideal position of the troughing route to provide the greatest protection to copper cables by the screening conductor is directly under the return conductor at 1.98m from the running rail and 0.6m below the top of the running rail. The area to be electrified already has a troughing route fitted throughout, however it has not been universally provided within these distances and there will be a requirement to reroute lengths of the troughing route as part of the proposed works.

6.3.2 This is not a particular concern where the troughing extends beyond the 1.98m, however where the existing troughing route is elevated for long lengths there may be a requirement to provide a new route and move all S&T cables to the new route. An allowance has therefore been included in the project estimate for a small amount of re-routing of existing cable routes.

6.4 Earthing and Bonding

6.4.1 The new screening conductor requires to be earthed approximately every kilometre. Generally the earth farm positions coincide with a location near to screening conductor joints; as the joints provide an earth tap point to electrically connect the screening conductor to an earth wire that can be connected to an earth electrode.

6.4.2 There are certain locations instances where earth farms should not be positioned. Common such locations are within 100m of traction feeder stations, substations, track paralleling huts and track section cabins and within 50m of any earth farms connected to a telecoms apparatus room, active trackside equipment housing, REB, relay rooms or return conductor to return rail connection points (red bonds).

6.4.3 Many of these conditions will exist within the vicinity of the screening joint and therefore the screening conductor earthing system will need to be designed around these areas resulting in the earth farms in a number of locations being less than 1Km apart.

6.4.4 In addition to the separate earthing system provided for the screening conductor, the existing lineside infrastructure will require to be bonded dependant on its particular location with reference to the overhead line equipment on other infrastructure.

6.5 Fixed Telecom Network and GSM-R

6.5.1 Network Rail are currently rolling out new Telecommunications infrastructure consisting of new copper and fibre cables, transmission equipment, trackside cabinets. REB's, radio masts and, where applicable, new and renovated cable routes. The design work for the Core Route is complete and installation works are about to get underway with a planned completion date of November 2007.

6.5.2 Although the majority of the new FTN equipment is electrification compatible and will replace existing equipment which is not when the cut over from the existing National Radio Network (NRN) is achieved, there is an issue with the associated cabling. As the line is currently not electrified, the FTN design has been undertaken based on a network with maximum space between transmission nodes of 13km. On electrified routes the design rules stipulate that the maximum space between transmission nodes should be no more than 10km dependant upon the number of parallel tracks, the proximity of OHLE feeder stations and the fitment of booster transformers and return conductors.

6.5.3 There will therefore be a requirement to cut in additional access nodes at a number of locations where the FTN is being constructed with transmission nodes and there are continuous copper cable lengths in excess of 10km. The number of such locations can only be confirmed once the design of the power supply network has progressed further, and a provision for the likely associated expenditure is included in the project estimate meantime. Discussions are continuing with the FTN team to assess to what extent these works can be mitigated through appropriate passive provision.

6.6 Existing Infrastructure

6.6.1 A GEC 12 Channel FDM system currently carries operational circuits between Glasgow Queen Street to Stirling and Falkirk Grahamston. It is planned that the existing infrastructure supporting Telecommunication circuits will be decommissioned after migration of services to the Fixed Telecoms Network. This would result in de-commissioning of the existing 12 Channel FDM systems on the route. It is assumed that migration to the FTN will be completed prior to electrification, thereby avoiding the need to alter this equipment.

6.6.2 Inductive loops are installed at manned stations to improve facilities for passengers with impaired hearing. Historically these systems do not operate correctly in electrified areas causing uncomfortable and unacceptable noise to users. An allowance has therefore been included in the project estimate for the necessary rectification works.

6.6.3 An existing leaky feeder antenna system is currently installed on the roof of Queen Street Tunnel. The feeder will have to be moved to accommodate the overhead line structures. This will require provision of a new feeder throughout the length of the tunnel and provision of new fixing arrangements.

6.6.4 Some existing cable routes at Queen Street station may also have to be re-located so that they can be maintained without a requirement to take isolations. Similar considerations may also apply to some of the existing platform mounted equipment.

7) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : TRACK

7.1 The track on the existing Core Route is maintained to a high standard with a high quality of track geometry. With the exception of the station approaches at either end, the ruling speed is 100mph over most of the Route due to the favourable vertical and horizontal profile. There are localised speed restrictions at Newbridge Viaduct of 90mph (due to pier stability considerations) and Winchburgh Tunnel of 85mph (due to aerodynamic considerations as a result of the particularly tight six foot at this location).

7.2 No changes to the current track categories of the Routes being considered for electrification under this proposal are envisaged. Although the characteristics of the new EMU stock is not yet confirmed, it is expected to have a lighter axle load than the current Class 170 stock that operates on the Routes with a consequential benefit in reduced energy and track damage and lower track access charges.

7.3 The extent of the track works required under this project therefore mainly arise as a consequence of works required under other asset headings. These works have been outlined in the preceding Sections and can be summarised as follows :

- installation of slab track to provide the required structural clearances for overhead line equipment installation in Haymarket North and Carmuirs Tunnels ;
- enhanced track fixity works to provide structural clearances to localised areas within Winchburgh Tunnel and at a small number of other overbridge structures to reduce track tolerances and permit the use of reduced clearances ;
- track lowering works to provide acceptable structural clearances at a number of overbridge structures ;
- removal of insulated block joints where required to provide an acceptable track circuiting arrangement for immunisation purposes ;
- alterations to existing track drainage to accommodate the placing of OHLE masts.

7.4 At this stage, therefore, a high level provision has been made within the cost estimates for the anticipated level of track works under each of these headings. Further evaluation of the work required at individual structures where track fixity or track lowering solutions are proposed will be required once detailed surveys and site investigations have been carried out. This will allow a value engineering process to be followed to arrive at the optimum whole life cost solution.

8) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : PLANT

8.1 The electrification of the Routes addressed in this study does not drive a requirement for any significant changes to the existing signalling equipment. The loads on the existing signalling power supply points will therefore be no greater than that currently experienced and no requirement for power supply reinforcement arises.

8.2 The electrification of the route will, however, bring requirements for additional earthing and bonding of lineside power supplies, stations, signal centres, telecoms masts, structures, fences, bridges etc. The bonding of these services and structures will require to be undertaken in accordance with current standards. The unit rate used to compile the project estimate contains an allowance for these works.

9) SPECIFIC ISSUES BY ENGINEERING DISCIPLINE : STATIONS

9.1 There are no canopies or other structures at stations that will need to be re-located or otherwise altered as a consequence of the proposed electrification of the Routes considered in this study.

9.2 The most significant issue that will arise at stations is the requirement to provide earth bonding to all of the station furniture at these locations to address the touch potential issue highlighted in Section 6.4.4. An allowance for the associated costs has been included in the project estimates provided.

10) INTERFACES WITH OTHER MAJOR PROJECTS

10.1 Edinburgh Waverley Infrastructure Works

10.1.1 Scope

The Edinburgh Waverley Infrastructure Works project includes the re-modelling of the existing west end station throat to provide additional capacity to accommodate the additional services that are planned to operate to the west of Edinburgh. These services will be the additional 2 trains per hour that will operate from Bathgate on completion of the Airdrie to Bathgate project and additional services from Fife. The authorised project does not currently include any extension of the existing electrified network at the west end of Edinburgh Waverley station.

Physical works are currently in progress and the works at Edinburgh Waverley are programmed to be completed by December 2007. The associated works to convert the entire Edinburgh signalling centre control area to IECC operation with the capacity to accommodate the control of other planned enhancements in the area will continue for a further 12 months beyond this date.

10.1.2 Extent of Interface

The remit for this study specifically excluded any wiring works to the two tracks in the centre bore of the Mound Tunnel where only the two tracks that go through the single track outer bores are currently wired. It also excluded any wiring in the west end bays (Platform numbers 12 to 18 inclusive) at Edinburgh Waverley station.

The Airdrie to Bathgate project requires the Mound Tunnel works to be undertaken to provide a sufficient number of electrified routes at the west end of the station to cater for the enhanced number of electric services that will operate in and out of the station on completion of the project. The Airdrie to Bathgate project also requires, as a minimum, the electrification of Platform numbers 12 to 15 inclusive to provide platform capacity to accommodate the new electrified services (assumed to be contained to Platform numbers 12 and 13) with a sufficient margin of additional capacity (assumed to be Platform numbers 14 and 15) to be able to cope with any service disruption.

10.1.3 Recommendation

Discussions are currently in hand on the possible variation of these additional works that are required for the Airdrie to Bathgate project into the contract for the Edinburgh Waverley Infrastructure Works project. This is also assessing the scope for wiring all of the west end bay platforms required for the Edinburgh to Glasgow proposals (Platform numbers 12 to 18 inclusive) as part of this variation rather than just the platforms required for the Airdrie to Bathgate proposals (Platform numbers 12 to 15 inclusive).

The disruptive access negotiated for the Edinburgh Waverley Infrastructure Works project present an opportunity to progress these works at a significantly lower capital cost than would be the case if they were progressed as a stand alone project. It is therefore recommended that the opportunity to progress the works as a variation in scope to this project should be progressed accordingly.

10.2 Airdrie to Bathgate

10.2.1 Scope

The Airdrie to Bathgate project encompasses the electrification of the section of the existing E&G route from Newbridge Junction (mileage 38 miles 1300 yards) in the west to Haymarket East Junction (mileage 45 miles 1600 yards) in the east, a distance of some 7 miles 300 yards. The project does not encompass the wiring of the North Lines between Haymarket Central Junction to the west end of Mound Tunnel. It also does not encompass the wiring of the centre bore of the Mound Tunnel or the wiring of any of the west end bays at Edinburgh Waverley station. As outlined above, a proposal is currently being considered to vary this work into the current Edinburgh Waverley Infrastructure Works project.

The associated Private Bill that would confer powers to construct the project is currently being considered by the Scottish Parliament. Physical works are scheduled to commence during 2007, and the project is scheduled to be completed during 2010.

10.2.2 Extent of Interface

A new feeder is proposed at Bathgate to meet the additional power requirements of the Airdrie to Bathgate project. A number of areas have been identified where passive provision should be allowed in the design to accommodate the possible extension of electrification to cover the Core Route and associated Diversionary Route. These are described in the preceding Sections 3.2.2 and 3.6.1.

10.2.3 Recommendation

Development work on the Airdrie to Bathgate should continue to make passive provision for the subsequent electrification of the E&G route as far as practically possible.

10.3 Edinburgh Airport Rail Link (EARL)

10.3.1 Scope

The Edinburgh Airport Rail Link (EARL) project encompasses the construction of a diversionary route to the existing E&G route over a distance of approximately 4 miles 1380 yards from Roddinglaw (mileage 41 miles 960 yards) on the existing E&G route via the Airport to a new junction at Kirkliston (mileage 37 miles 280 yards) on the existing Dalmeny to Winchburgh line.

Two spur lines on and off this new alignment are also proposed to allow services from Edinburgh to Fife, Perth, Inverness and Aberdeen to also serve the Airport. The first of these is from a new junction at Gogar on the Fife Lines (mileage 5 miles 690 yards) to a junction at Ingliston, immediately to the south of the Airport station. The second of these is from a junction at Airport Central, immediately to the north of the runway tunnel, to Airport North on the Fife Lines (mileage 8 miles 1320 yards).

The new EARL infrastructure is currently being designed for diesel operation only from the introduction of services, although passive provision for future electrification has been specified within the design remit.

Under the current EARL timetable proposals, 2 of the 4 E&G services per hour would be diverted via the Airport. The prior electrification of the new EARL infrastructure is therefore an essential enabler for the E&G electrification proposal.

The associated Private Bill that would confer powers to construct the project is currently being considered by the Scottish Parliament. Physical works are scheduled to commence during 2007, and the project is scheduled to be completed during 2011.

10.3.2 Extent of Interface

The E&G electrification project must interface with the EARL electrification at Winchburgh and Roddinglaw Junctions. The proposed electrical route for EARL, if connected to the E&G route at both ends, would by-pass the protection that it is proposed to provide in the new TSC at Newbridge that will be provided under the Airdrie to Bathgate project. The EARL electrification must therefore be treated as a branch line fed from one end only.

There are no neutral sections on the E&G route between Roddinglaw and Winchburgh so no neutral sections have to be provided on the EARL connection. Passive provision will be made at Winchburgh for a circuit breaker to feed EARL or a motorised switch at both ends will allow quick isolation of a fault on the EARL branch and allow power to be restored to the main E&G route.

10.3.3 Recommendation

Scott Wilson, the design consultants for the EARL project, are currently providing an estimated cost for the additional works required to electrify the new EARL infrastructure at the time of construction. The proposed specification for the above interface issues has been provided to inform this exercise.

10.4 Edinburgh Tram

10.4.1 Scope

Two Lines are to be provided under the Edinburgh Tram proposals. Line 1 is a Northern Loop from the City Centre to Granton and Leith and Line 2 is a branch from the Loop in the Haymarket Area to the Airport and Newbridge.

Line 1 runs in close proximitv to the existing rail network between Haymarket station and the east end of Haymarket Depot where the junction with Line 2 is located. Line 2 runs parallel to the existing rail network over a distance of approximately 4 miles from this point to Edinburgh Park station. It then heads north towards the Airport, but heads south thereafter to again parallel the existing rail network over a distance of approximately 1 mile between Ratho and Newbridge.

The associated Private Bills that confer powers to construct both Lines were approved by the Scottish Parliament in March 2006. Physical works are scheduled to commence during 2007, and the project is scheduled to be completed during 2011.

10.4.2 Extent of Interface

As the parallel working section outlined above will be electrified by the Airdrie to Bathgate project, this project will be responsible for driving out appropriate technical solutions for the interface issues. The most critical section is considered to be the Baird Drive area at Murrayfield where clearances between the heavy rail and the tram networks are extremely tight. Although the Airdrie to Bathgate project is only electrifying the South Lines in this area, the design will have to allow passive provision for the subsequent electrification of the North Lines as part of the Diversionary Route 1 package.

10.4.3 Recommendation

Continue to ensure that the appropriate level of passive provision is made for the E&G electrification proposals, particularly the wiring of the North Lines out to the new Gogar Jcn.

There is an emerging concern that the current Tram proposals that are being developed in this area do not make adequate provision for these subsequent electrification works which will cause unnecessary re-work and abortive costs.

10.5 Borders Railway

10.5.1 Scope

The Borders Railway project encompasses the re-instatement of the former Waverley Route from Edinburgh to Carlisle from Newcraighall (the terminus of the current Edinburgh CrossRail services) to Tweedbank (to the south of Galashiels), a distance of some 25 miles.

The associated Private Bill that confers powers to construct the project was approved by the Scottish Parliament in early 2006. Physical works are scheduled to commence during 2007, and the project is scheduled to be completed during 2011.

10.5.2 Extent of Interface

There is no significant interface between this project and the E&G electrification proposals. The Edinburgh CrossRail service will be suspended during 2007 while the Edinburgh Waverley throat re-modelling works are being carried out and replaced by an alternative Edinburgh to Newcraighall shuttle service which will connect at Edinburgh Waverley with destinations to the west of Edinburgh.

11) INTERFACES WITH PLANNED NETWORK RAIL RENEWALS

11.1 A review has been carried out of the proposals currently contained in Network Rail's current engineering renewal workbanks to assess whether there are any synergies that can be exploited with the works proposed within this report on the Core Route and the Diversionary Routes. These renewal proposals are summarised in the tables contained within Appendix 13 by engineering discipline. Comments are also provided on any identified potential interfaces.

11.2 It should be noted that renewals within these tables that are scheduled for implementation beyond 2008/09 fall within Control Period 4. As such, funding for these renewals cannot be guaranteed until the output from the Office of Rail Regulation's current Access Charges Review is complete. This Review will establish Network Rail's funding for this Control Period which will in turn determine the availability of funding for proposed renewals.

11.3 The main potential synergies that have been identified from this review are tabulated below.

Item	Synergy
2006/07 Structures Renewal Programme Core Route : O/B130 Cathedral St Glasgow	Scope to incorporate parapet protection works to electrified line standards.
2006/07 Structures Renewal Programme DR3 : O/B 55 Greenhill Road	Scope to incorporate clearances to electrified line standards.
2008/09 Signalling Renewal Programme : Queen St Station Axle Counters	Replacement of non-standard axle counters with electrification compatible units.
2009/11 S&C Renewal Programme : Greenhill Upper Junction	Replacement of non-standard point machines with electrification compatible units.

11.4 Network Rail will ensure that the subsequent development of each of these items and any new items that arise as a result of engineering inspections will make provision for subsequent electrification as far as practically possible.

12) MAINTENANCE IMPLICATIONS

12.1 Electrification of the Routes examined in this study would significantly increase the extent of the electrified track network in Scotland. Currently there are 730 of electrified track miles in Scotland. This would rise by approximately 85, 95, 110 or 145 miles depending which combination of the Core Route and Diversionary Routes is selected for implementation.

12.2 Maintenance costs for overhead line equipment are primarily driven by the need to undertake examinations of the various pieces of equipment to the laid down periodicities. There is therefore a linkage between these maintenance costs and the electrified track mileage. It is therefore proposed that for the purposes of this study the current cost per track mile for overhead line maintenance are extrapolated to provide an assessment of the additional maintenance costs. This cost can be refined once the outline design is complete and the specific new assets to be maintained can be quantified.

12.3 The main overhead line maintenance depot in Scotland is located at Shields on the south side of Glasgow. This is due to be re-located to the new maintenance super depot that is planned at Cowlairs on the north side of Glasgow, at the west end of the Core Route. This would be ideally located to provide the necessary accommodation needed for the maintenance of these routes

12.4 The other main factor that will influence the final level of additional maintenance costs will be the quality of the access opportunities that are available for maintenance purposes. The main influence on this is expected to be the hours of operation of the depot facility at Eastfield, and options for providing as close to a guaranteed regular power supply as possible to this facility while still providing regular maintenance access opportunities on the remainder of the Routes are described in Section 3.10.

12.5 The outline design phase of the project should ensure that good lineside accesses are available to the location of new booster transformers and neutral sections to ease their future maintenance. It will also be good design practice to ensure that the Dedicated Earthing Points (DEP's) are similarly situated to minimise the time taken to take isolations. A provision has been allowed in the project estimate accordingly to allow for the creation of new access locations.

12.6 Electrification of the Routes considered in this study will require isolations to be taken for certain types of renewal and maintenance work that can currently proceed without any such requirement. Examples of this the use of track relaying plant and drain cleaning using Vactor units. The associated additional costs arising cannot be quantified at this stage, and it is proposed that these are firmed up during the next stage of the project's development.

13) PROGRAMME

13.1 A high level programme has been produced for the electrification of the Routes covered by this study. A copy of this programme is attached as Appendix 14. This has been prepared on the assumption that Network Rail would be responsible for production of the Form A documents that would be used as the basis for tendering for the detailed design and build for the works.

13.2 Key high level dates from this programme are :

Option Selection Tendering	06/07 to 09/07
Production of Form A Documents	10/07 to 09/08
Design and Build Tendering	01/09 to 10/09
Production of Form B Documents	01/10 to 10/10
Implementation Works	01/11 to 03/13

13.3 The above dates are based on the assumption that the full package of works, i.e. the Core Route and Diversionary Routes 1 to 3 are all implemented. Implementation of the Core Route only would reduce the above 3 year construction programme by around 1 year.

13.4 There are also gaps in the above programme where time needs to be allowed for the negotiation of the necessary commercial agreements between Transport Scotland and Network Rail. If it were possible to develop a suite of templated agreements that minimised the length of time required for these negotiations and the seeking of the necessary internal authorities, these timescales could be reduced.

13.5 One of the key factors in producing a detailed optimised programme for these works will be the quality of the access opportunities that are available for the necessary construction works. The next Section of this report identifies a process for optimising these to ensure that physical works costs and compensation costs to affected train operators are kept as low as possible.

13.6 It is recommended that these opportunities are explored further in the next stage of the project's development to produce an optimised implementation strategy. An assessment of the high level procurement strategy and the optimum packaging of the works should also be undertaken at the same time.

14) RISK REGISTER

14.1 A Risk Management workshop was held to identify the key engineering, operational and commercial risks associated with the project. The session was attended by the Network Rail project team members and a number of Transport Scotland representatives.

Risk Identification was undertaken on the basis of a brainstorming session for all project risks which could affect the deliverability of the works. The identified risks were evaluated on the basis of a 5X5 matrix of probability v impact based on the workshop participants' assessments of the probability of the occurrence of each risk and their associated potential impact on the project.

14.2 A total of 45 risks were identified initially, however a subsequent review of the register consolidated the number down to 38. These risks and the associated ranking scores are tabulated in the attached Appendix 12 to this report.

From these 38 risks, 7 were ranked as key risks. These are detailed below together with a brief explanation of the associated issues.

14.3 Key Risk 1 : Failure to Complete Electrification by the end of 2011

Failure to complete the E&G Electrification by the end of 2011 could have a critical impact on the EARL scheme. Although the impact of this risk centres on the EARL scheme, the programme and related cost implications for the E & G project to meet this date could be substantial.

Key Risk 2 : Insufficient Gauging Clearance

Subsequent surveys may identify that some structures assessed as being clear based on the desk top assessments carried out are not clear. The impact of this risk materialising would be to extend the scope of the identified physical works required.

Key Risk 3 : Infrastructure Interface

Other interfacing projects such as Edinburgh Waverley Infrastructure Works, Airdrie to Bathgate or EARL may not proceed, preventing the assumptions on infrastructure that will be delivered by other projects being delivered. Any such failure or delay would result in delay to programme and additional costs.

Key Risk 4 : Lack of Network Rail and Contractor resources

Due to the volume of enhancement projects planned over the coming years, there may not be the required resource, both Network Rail and Contractor, to deliver the project. This risk is considered especially acute for signalling design resources.

Key Risk 5 : Earthing and Bonding

There is a risk that earthing and bonding carried out as part of the project may be inadequate and adverse impacts materialise once the new overhead line is energised. This would result in additional design and works at additional cost to the project.

Key Risk 6 : Availability of source records

Source records may be unavailable due to the high volume of project activity planned on the corridor over the coming years. Programme delay and / or additional costs may occur due to record unavailability.

Key Risk 7 : Track Lowerings unachievable

The project may not be able to achieve the track lowering or slue solutions that are proposed at some locations. This would require additional design to find an alternative solution which would have a higher capital cost.

14.4 In line with the current GRIP stage 1 status of the project, the risk register is in the early stages of development. As the project progresses, it is expected that the risks, mitigation measures and ownerships will be expanded upon.

15) ESTIMATED COSTS

15.1 A detailed bottom up estimate at current price levels has been produced for the physical works described in the preceding sections of this report. A copy of this estimate is attached in Appendices 16 to 19 for the Core Route and Diversionary Routes 1 to 3 respectively. This estimate has been prepared using Network Rail's nationally applied rates for GRIP Stage 1 quality estimates.

15.2 The estimated costs can be summarised as :

Core Route	£ 124.9m
Diversionary Route 1	£ 39.6m
Diversionary Route 2	£ 34.9m
Diversionary Route 3	£ 65.5m

	£ 264.9m

A more detailed summary of these costs is also attached as Appendix 20.

15.3 There are a number of caveats attached to these estimates. The most significant of these are summarised below.

1) Structure Sums Include Services Diversions.

2) Costs include Lift & Shift provisions.

3) All Telecomms work is Included in the Core Route totals.

4) An "Extra Over" allowance for working in difficult locations is included within the OLE Works estimate.

5) An Allowance has been made in the estimate for renewing a proportion of the cable route.

6) No Allowance has been made in the estimate for TOC Compensation as this is dependent on an access strategy that has not yet been agreed in consultation with affected train operators.
(Section 16 provides an initial assessment of these costs.)

7) An Allowance has been made for new materials on Track Lowering Works in accordance with current standards.

8) An Allowance has been made for side wall support in Haymarket North Tunnel in relation to the proposed slab track works.

9) The estimate has been calculated on September 2006 Base Date (3Q06).

These issues would be addressed in more detail and quantified where possible in the next stage of the proposal's development.

15.4 An assessment was also undertaken of the escalation that should apply to these costs to take account of the projected implementation timescales. This results in an increase in the total costs of £63.5m, based on the mid-point of delivery of the construction phase. A more detailed breakdown of the make up of this figure is attached as Appendix 21.

16) ACCESS REQUIREMENTS

16.1 Introduction

16.1.1 It is a requirement of Network Rail's and each Train Operator's Licence from ORR that any changes to advertised passenger train times are published at least 12 weeks in advance. This is achieved through the Informed Traveller concept, under which the timescales for booking major disruptive possessions have been progressively extended.

16.1.2 This imposes a discipline to properly plan such works and identify the scope for co-ordinating major items of work within the same geographical area in order to minimise overall disruption. The desire to minimise the level of compensation payable to affected train operators is another strong incentive to adopt this approach.

16.1.3 There are a number of disruptive possessions for major Switch and Crossing (S&C) renewals that are currently planned to take place in future years on the routes addressed in this study. Each of these presents a potential opportunity to progress some of the physical works identified in this report at the same time in order to achieve a quicker and a more cost effective implementation. These opportunities are summarised in Section 16.2 below.

16.1.4 The 2009 Timetable Year, defined as mid-December 2008 to mid-December 2009, is the next available opportunity for any new major disruptive possessions to be negotiated with affected train operators. Network Rail is currently co-ordinating possession plans for this year based on the proposals that are contained within the current engineering renewal work banks and planned enhancements.

16.1.5 These proposals have to be formally submitted in May 2007. An early objective in the next stage of the development of this project would therefore be to identify if there are any advance works that it may be appropriate to progress within these timescales and make retrospective submissions where possible. Sections 16.3 and 16.4 below summarises our initial assessment of these potential opportunities

16.2 Current Planned Disruptive Access Opportunities

16.2.1 A number of major renewals are currently programmed over the likely implementation period of this project. Details of the most significant of these together with the potential for enhancing the project scope to incorporate enabling works for this project is provided in the tables overleaf.

Item	**Proposed Work / Opportunity**
2008/09 S&C Renewal Programme	<u>Newbridge Junction (Core Route)</u> Newbridge Junction is currently a single lead junction. As part of an advance works package for the Airdrie to Bathgate project, the junction is to be renewed as a double junction. This will include the installation of OHLE masts as appropriate.
2009/10 S&C Renewal Programme	<u>Carmuirs East Junction (Diversionary Route 2)</u> The specification for this renewal is still to be finalised. While it would be desirable to provide higher speeds on the routes to both Larbert Junction and Carmuirs West Junction, the site constraints may prevent this and a like for like renewal is more likely. While the length of the required blockade is still to be finalised, it may be possible to extend the scope of the renewals to encompass the installation of overhead line bases and masts in the area around the Junction. <u>Cadder East (Core Route)</u> No significant synergies.
2010/11 S&C Renewal Programme	<u>Princes St Gardens (Diversionary Route 1)</u> The specification for this renewal is still to be finalised. Current speeds through the ladders where weaving moves between the North Lines and the South Lines take place is limited to 20mph, and the opportunity to enhance these as part of this renewal will be examined. The existing ladders are fully wired in both directions, however the blockade required for the renewal may present an opportunity to incorporate some of the works required to provide OHLE through Haymarket North Tunnel, assuming it is decided that Diversionary Route 1 should be included in the scope of the project.

Item	**Proposed Work / Opportunity**
2010/11 S&C Renewal Programme	Cumbernauld (Diversionary Route 3) Linlithgow (Core Route) No significant synergies.
2011/12 S&C Renewal Programme	Eastfield (Core Route) The opportunity to improve junction and loop entry / exit speeds will be examined as part of the development of this proposal. Boness Junction (Core Route) Roughcastle (Core Route) Cadder West (Core Route) No significant synergies.
2012/13 S&C Renewal Programme	Greenhill Upper Junction (Core Route) The specification for this renewal is still to be finalised. However, it is currently proposed that by recovering the infrequently used Up Side Loops it will be possible to provide a higher turnout speed on the route to Greenhill Lower Junction than the current 70mph diverging speed and eliminate the existing switch diamonds. This would provide a journey time reduction on this route and provide a capacity benefit by allowing local services to clear the main line quicker. While the length of the required blockade is still to be finalised, it may be possible to extend the scope of the renewals to encompass the installation of overhead line bases and masts in the area around the Junction. Cowlairs West (Core Route) Greenfoot (Diversionary Route 3) The opportunity to improve junction and loop entry / exit speeds will be examined as part of the development of these proposals.

Item	**Proposed Work / Opportunity**
2013/14 S&C Renewal Programme	Gartshore (Core Route) Queen Street HL Station (Core Route) Carmuirs West Junction (Diversionary Route 2) The opportunity to improve junction and loop entry / exit speeds will be examined as part of the development of these proposals.
2014/15 S&C Renewal Programme	Cowlairs South (Core Route) The opportunity to double the Cowlairs Chord line in conjunction with this renewal will be examined as part of the development of this proposal. Cowlairs East (Core Route) Cowlairs Turkey (Core Route) The opportunity to improve junction and loop entry / exit speeds will be examined as part of the development of these proposals.
2015/16 S&C Renewal Programme	Cadder East (Core Route) Cadder West (Core Route) The opportunity to improve junction and loop entry / exit speeds will be examined as part of the development of these proposals.

16.2.2 As can be seen, a number of these projects are currently planned in the period following the implementation of this proposal. It is recommended that the opportunity to bring forward the planned renewal dates of these proposals to allow the potential synergies to be exploited will be addressed in more detail as part of the next stage of the development of the project.

16.3 Additional Disruptive Access Opportunities : Timetabled Weekend Blockades

16.3.1 Diversionary Routes 2 (Cowlairs to Greenhill Lower via Cumbernauld) and 3 (Greenhill Upper to Polmont via Falkirk Grahamston) provide regularly used alternatives to the sections of the Core Route between Cowlairs and Polmont, a distance of some 23 miles. This represents approximately two thirds of the total length of the Core Route assessed in this report.

It is therefore recommended that the optimum way of progressing the required works on this section are by negotiating a series of long weekend blockades over a full timetable year. A similar access strategy was successfully applied on sections of the West Coast Main Line Upgrade project.

16.3.2 A similar consideration also applies to the shorter section between Winchburgh and Newbridge, a distance of some 4 miles, where there is a regularly used alternative diversionary route via Dalmeny that could also be utilised at weekends.

16.3.3 There is, however, no suitable diversionary route for the section of the Core Route between Polmont and Winchburgh, a distance of some 10 miles. Currently when major works are undertaken on this section E&G services are diverted to Glasgow Central High Level station. While this remains an option, it may be that the use of the re-instated Airdrie to Bathgate route is a better option for diverted services during periods of weekend blockades as they would use the existing Glasgow terminus, thereby minimising any passenger confusion.

16.3.4 The completion of the Stirling / Alloa / Kincardine project will also significantly ease the implementation of these works. From late 2007 the existing heavy flows of Hunterston to Longannet coal traffic which traverses the section of the Core Route between Polmont and Winchburgh will in future travel via Stirling. Currently this traffic significantly restricts the available Rules of the Route access opportunities on the Core Route.

16.4 Additional Disruptive Access Opportunities : Longer Blockades

16.4.1 A number of the works identified in this report can, by their nature, only be implemented during an extended blockade. These are summarised below.

16.4.2 Haymarket North Tunnel (Diversionary Route 1)

Further investigative works are needed before it can be determined whether full slab tracking of the Tunnel is required or whether a form of ballast treatment can be deployed to achieve the track lowerings required to provide the necessary clearances for OHLE installation. Both options would have to be undertaken during blockades, but the duration of these is significantly different. This is currently assessed as approximately four months for the former and two weeks for the latter technical solutions.

The track and signalling works currently being undertaken at Haymarket Station as part of the Edinburgh Waverley Infrastructure Works project allow the Station to function effectively as a terminal station when the line between Haymarket and Waverley is closed and will facilitate the progression of these works. A new bay platform (Platform 0) is being provided at the north side of the Station and signalled turnback moves from the west are being provided in all 4 of the existing through platforms.

As identified above, the optimum way to undertake this work in order to minimise overall disruption may be to carry it out during the same possession as the Princes Street Gardens S&C renewals.

16.4.3 Carmuirs Tunnel

As with Haymarket North Tunnel, further investigative work is required to determine the optimum technical solution to achieve the necessary clearances. Both potential solutions require blockades, which again will be of differing durations.

The optimum time to undertake these works would be during the two week summer shutdown of Longannet power station when coal traffic is suspended. It is currently planned to cut over the wagon fleet on the Hunterston to Longannet traffic to 100 ton HTA hoppers on completion of the Stirling / Alloa / Kincardine project to increase the loadings on each service. These wagons are not cleared to operate over the Forth Bridge which will restrict the future availability to divert these services during blockades.

16.5 Conclusion

An initial implementation strategy has been prepared for the required physical works based on the considerations outlined above. This is based on a concept of rolling weekend blockades supplemented by extended blockades where necessary for the major tunnel works required. A similar strategy was adopted by Network Rail in consultation with affected train operators for the implementation of the majority of the West Coast Route Modernisation project works.

The proposed strategy is summarised in the tables overleaf.

These tables also include details of the likely level of TOC compensation associated with the blockades proposed in this strategy. The total associated estimated compensation payable to affected train operators is £34.3m. This comprises £9.1m for the Core Route and £22.0m, £2.2m and £1.0m respectively for the three Diversionary Routes.

Recommended Implementation Strategy : Core Routes

Route Section	Works Required	Recommended Implementation Strategy	Associated Exceptional Access Requirements
Core Route : Queen St High Level to Cowlairs	Queen St HL Tunnel Structures Works OHLE Installation Track Circuit Conversions	No significant works required in Queen St Tunnel. 52hr weekend blockades of pairs of platforms over a timetabled period. (assumes no service alterations required). Use existing RoR access and piggyback opportunities for all other works.	None at this stage.
Core Route : Cowlairs to Greenhill Upper via Croy	Structures Works OHLE Installation Track Circuit Conversions	Greenhill Upper Jcn advance works as part of S&C renewal. 52hr weekend blockades over a full timetable period. (traffic diverted via Cumbernauld). Additional use of existing RoR access and piggyback opportunities.	50 no 52hr blockades
Core Route : Greenhill Upper to Polmont via Falkirk H	Falkirk High Tunnel Structures Works OHLE Installation Track Circuit Conversions	No significant works required in Falkirk HighTunnel. 52hr weekend blockades over a full timetabled period. (traffic diverted via Falkirk Grahamston). Additional use of existing RoR access and piggyback opportunities.	20 no 52hr blockades
Core Route : Polmont to Winchburgh	Structures Works OHLE Installation Track Circuit Conversions	Await completion of Airdrie to Bathgate project which will provide an alternative service from Glasgow QS to Edinburgh. 52hr weekend blockades over full timetable period. (services terminated short – alternative bussing arrangements) Additional use of existing RoR access and piggyback opportunities.	20 no 52hr blockades
Core Route : Winchburgh to Newbridge	Winchburgh Tunnel Structures Works OHLE Installation Track Circuit Conversions	Two week blockade required for Tunnel works. Newbridge Jcn advance works as part of A2B project. Additional use of existing RoR access and piggyback opportunities.	Two week blockade.

Recommended Implementation Strategy : Diversionary Routes

Route Section	Works Required	Recommended Implementation Strategy	Associated Exceptional Access Requirements
Diversionary Route 1 : New Gogar Jcn / North Lines	Haymarket North Tunnel Structures Works OHLE Installation Track Circuit Conversions	Prince St Gardens advance works as part of planned S&C renewal. Four month blockade required for Tunnel works. (majority of North Line services terminate at Haymarket). 52hr weekend blockades over a full timetabled period. (traffic diverted via Winchburgh / Dalmeny). Synergy with EARL Gogar Jcn installation to be explored. Use existing RoR access and piggyback opportunities.	Four month blockade. 15 no 52hr blockades
Diversionary Route 2 : Greenhill Upper to Polmont via Falkirk Grahamston	Carmuirs Tunnels Structures Works OHLE Installation Track Circuit Conversions	Carmuirs East Jcn advance works as part of planned S&C renewal. Two week blockade required for Tunnel works. (to co-incide with two week Longannet shut down). 52hr weekend blockades over a full timetabled period. (traffic diverted via Winchburgh / Dalmeny). Additional use of existing RoR access and piggyback opportunities.	Two week blockade. 20 no 52hr blockades
Diversionary Route 3 : Cowlairs South Jcn to Greenhill Lower Jcn via Cumbernauld	Structures Works OHLE Installation Track Circuit Conversions	52hr weekend blockades over a full timetable period. (traffic diverted via Croy). Additional use of existing RoR access and piggyback opportunities.	50 no 52hr blockades

17) RESOURCE CONSIDERATIONS

17.1 Synergies with Other Planned Enhancement Projects

17.1.1 The electrification projects itemised in the table below are likely to be progressing to a similar timescale, based on current working assumptions.

Project	**Design Work**	**Planned Start Date**	**Planned Commissioning**
Airdrie to Bathgate (A2B)	In Hand	2007 Early Works at Mound Tunnel	2010
Glasgow Airport Rail Link (GARL)	2007	2007 Early Works on Paisley Corridor	2010
Edinburgh Airport Rail Link (EARL)	2007/08	2009	2011
Edinburgh to Glasgow Electrification	2008/09	2010	2013

17.1.2 If the implementation of all of these projects is authorised, construction manpower, plant and materials will all be in high demand during the immediate period to 2012. The other critical resource during this period will be workshop and depot construction facilities required to support these projects. It is therefore recommended that a fully integrated approach is adopted towards their delivery to smooth out resource peaks and ensure that they are collectively delivered at the lowest possible cost.

17.1.3 The benefits of an integrated approach are that specialist resources can be allocated efficiently and works can be delivered without costly and time consuming mobilisation and demobilisation periods. A number of potential opportunities to integrate works with the Airdrie to Bathgate (A2B) project have already been identified as described in Section 3 of this report.

17.1.4 Several integrated approaches for project implementation could be considered. The options considered most worthy of further evaluation are :

- a dedicated electrification construction group based in Scotland, supported by local maintenance teams as appropriate
- the use of the resources from an enhanced maintenance construction group that is based in LNW Route
- the use of a dedicated contractor similar to the WCML Upgrade GTBB Joint Venture organisation.

17.2 Construction Logistics

17.2.1 The GTBB Joint Venture that was created to deliver various electrification works on the WCML is currently being disbanded. The associated Network Rail owned plant will either be re-allocated for maintenance use, sold or scrapped. The main plant of interest for future electrification projects are the wiring and piling trains, SRS road rail vehicles and other specialist OLE construction equipment.

One wiring train and a number of SRS vehicles from the Joint Venture are being retained for operation by the LNW OLE renewals team. It is essential that any expressions of interest regarding the remaining plant are lodged quickly because the WCRM project have a clear remit to dispose of any surplus plant that is not re-allocated.

17.2.2 To deliver the proposed volume of OHLE work within the limited access opportunities will require a dedicated construction depot. A depot at Millerhill was previously used for the East Coast Main Line (ECML) and Edinburgh to Carstairs projects and appears to be ideally located to service A2B and this project. Fabrication facilities could be redeveloped and space for field engineers, technical and other staff is available. The site could be re-activated comparatively easily for storage of rail based plant that would work across the various projects.

17.2.3 In addition to the specialist plant described above, specialist resources from senior management, engineering and construction specialists, machine operators and installation staff will also be required. The cost of employing contractors to fulfil all of these functions has proven to be expensive and problematic during the early stages of the WCML Upgrade project, and Network Rail took on more responsibility for direct delivery of these during the latter stages of the project.

17.2.4 With a guaranteed continuity of work a specialist electrification construction organisation could be created. This would typically comprise 40 to 50 linesmen, 12 supervisors, 6 to 10 field engineers and a suitable management team. It is proposed that design activities, except for site changes, would be contracted in along with all associated civil engineering works.

Clearly the necessary recruitment and establishment of this organisation would need to start under the A2B project to support the other projects.

17.2.5 A significant challenge associated with integrating works is the need to align project timescales to make efficient use of resources. To achieve shortening of timescales some works could be progressed in advance of the majority of the project and design could be progressed to detail for specific areas that are time critical.

A simplification of the allocation design process could be also achieved with a reduction in the overall design to construction time through the use of competent field engineering resources.

17.3 Programming Opportunities

There are several immediately evident opportunities that could arise from an integrated programme approach. The most significant of these are summarised below.

Diversionary Route 1 : Haymarket to Gogar

The Airdrie to Bathgate (A2B) project is wiring the southernmost pair of lines over the four track North and South Lines section between Haymarket and Gogar, the point at which the North and South Lines diverge.

As the clearances between the tracks is insufficient to allow the installation of masts for the South Lines only, the A2B project is proposing to install headspans over this section with the supporting masts installed adjacent to the outermost tracks. It is therefore a reasonably minor extension to the A2B works to also include the installation of catenary over the North Lines. It is therefore recommended that this should be varied into the A2B project scope if it is decided that electrification of Diversionary Route 1 is also to proceed.

Associated EARL Infrastructure : Winchburgh Junction to Kirkliston Junction

It is recommended that this section of the existing network on the Dalmeny Chord line, of some two and a half miles in length, should be incorporated as part of the electrification works under this project rather than under the EARL project. There will be a requirement for the EARL project to electrify the new infrastructure that they are providing, but it would be best to restrict this to the green field site sections of the project. A similar principle applies at the east end of EARL where the Diversionary Route 1 works would extend as far as the location of the new Gogar Junction.

Given that the EARL project includes a major re-alignment of Winchburgh Junction to permit 100mph running on what is currently the diverging route, electrification works in the area of the Junction would have to await the completion of the sluing of the tracks approximately 30 metres to the north to their new permanent alignment.

17.4 Recommended Next Steps

- Define the extent of this project (Core Route plus Diversionary Routes).
- Optimise the scope of works for this project that are linked to the A2B project.
- Vary these works into the A2B project where practically possible.
- Develop numbers of disruptive possessions required and optimise piggyback possession opportunities.
- Finalise resource strategy for recommended integrated programme approach.
- Finalise depot strategy and associated mobilisation issues.
- Identify and secure plant requirements from current WCML Upgrade pool (wiring train, piling train, access platforms, small plant etc).

Appendix 1

SUMMARY OF ISSUES TO BE ADDRESSED IN TRANSPORT SCOTLAND'S REMIT

OHLE	• OHLE issues and constraints. • Proposals for innovative solutions, including the use of solid conductors where applicable into bay platforms and through tunnels. • Likely locations for feeder stations based on appropriate calculations and simulations. The geographic extent of these simulations, the rolling stock characteristics and the number of sensitivity tests to be applied are to be agreed in a separate discussion. • Proposals for supplying power to both terminal stations.
Structures	• Summary of works required to bridges, tunnels, viaducts, cuttings etc. to provide the required OHLE clearances and accommodate the associated masts, fixtures etc. • Identification of where opportunities to reduce the extent of the works exist through the application of derogations to the normally applied standards.
Signalling & Telecommunications	• Requirement for the immunisation of critical equipment. • Requirement for modification of track circuits.
Operations	• Interface with any longer term proposals for Cathcart ECR.
General	• Identification of any critical equipment with long lead times. • Interface / synergies with any planned NR renewals. • Ongoing maintenance impact.

Appendix 2

FINAL ASSUMPTIONS LOG

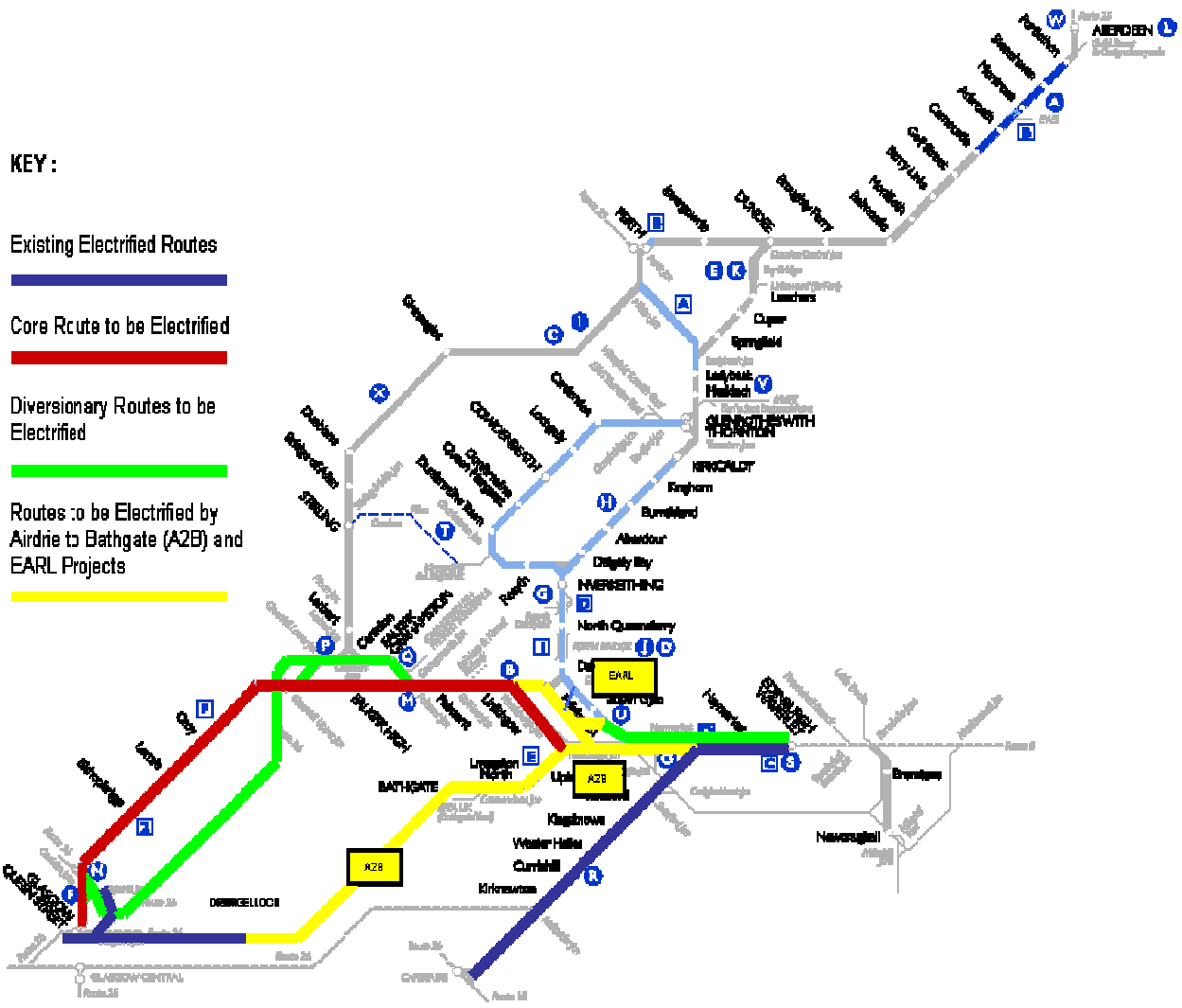
Item	Date Raised	Issue	Close Out / Decision
EGE 001	09/06/06	Airdrie to Bathgate Project : Extent of Wiring	Drumgelloch / Bathgate / Newbridge Jcn / Haymarket East Jcn (via South Lines) only being wired by Airdrie to Bathgate Project.
EGE 002	09/06/06	Airdrie to Bathgate (A2B) Project : Feeding Strategy	Current project assumption is a new feeder station at Bathgate. NR is developing an alternative proposal to upgrade the existing distribution site at Currie which is considered to be a cheaper option as it can be progressed on the back of a planned renewal and it provides a better strategic fit with known planned enhancements. Assume this proposal will be adopted for the purpose of this commission. Assume that TSC to be provided at Newbridge Jcn under A2B project will make space provision for future E&G connection.
EGE 003	09/06/06	Edinburgh Waverley Bay Platforms	Platforms 12 to 15 to be wired as part of Edinburgh Waverley Phase 1 project. Platforms 16 to 18 need to be wired as part of the EGE project.
EGE 004	09/06/06	Mound Tunnel : Lines X & Y	Lines X & Y to be wired as part of Edinburgh Waverley Phase 1 project.
EGE 005	09/06/06	Princes St Gardens to Haymarket Central Jcn via North Lines	To be wired as part of the EGE project. (covered by specified Diversionary Routes 1)
EGE 006	09/06/06	Edinburgh Airport Rail Link (EARL) : Wiring of new infrastructure	Any requirement to electrify the new EARL infrastructure will be dealt with by the EARL project. Feeding assessments to assume that the new EARL infrastructure will be wired.
EGE 007	09/06/06	E&G Services : 2011 Service Specification	No change to current service levels. All peak hour services to be formed by 6 car formations.
EGE 008	09/06/06	E&G Services : New rolling stock specification	Assume new E&G EMU stock will be based on 3 x 23metre vehicle formations. Assume similar power characteristics to worst case of new Desiro and Electrostar builds. Detailed traction curves not required for this GRIP Stage 1 assessment.
EGE 009	09/06/06	Other EMU Services : Glasgow to Cumbernauld / Falkirk Grahamston and Motherwell to Cumbernauld	Not to be considered at this stage. To be identified as potential synergy opportunities in final report.
EGE 010	09/06/06	Possible electrified freight services from Grangemouth	Not to be considered at this stage.
EGE 011	09/06/06	Extent of wiring in existing depots	Current TS assumption is that a fleet of @20 EMU's will be required. These will be maintained at Shields Depot. Limited stabling available in Edinburgh area, therefore assume use of Eastfield site for stabling purposes. Assume all sidings in existing Eastfield Depot layout wired.

Item	Date Raised	Issue	Close Out / Decision
EGE 012	23/06/06	Eastfied Depot Power Supply	Assume a dedicated breaker will be provided in the new TSC proposed for the Cowlairs area to give a single feeder to the depot. Note that this will not guarantee a 24/7 supply and the access regime will need to allow for Rules of the Route maintenance access opportunities.
EGE 013	09/06/06	Extent of wiring in loops and sidings	Assume all crossovers and passenger loops are to be wired. Minimum overruns to be provided into other loops and sidings. Detailed track plans showing extent of wiring to be produced.
EGE 014	09/06/06	OHLE Power Supply Modelling	Use of OSLO not appropriate for a GRIP Stage 1 study. OSLO requires a VISION model to be created of the area which will not be possible within the study time and cost constraints. Assessments to be made of type of feeding and likely loads based on extrapolating from recent A2B work, other historic studies and existing records.
EGE 015	09/06/06	Interface with Edinburgh Tram proposals : and any required immunisation works	Tram Line 2 DC OHLE system planned for energisation in late 2009. Tram alignment runs parallel to existing rail network for @ 3 miles. Tram project currently only planning to demonstrate compatability with existing network with no passive provision for future electrification. Clearances extremely tight at Baird Drive corridor for positioning of signals and masts. TS to raise with tie appropriate requirements to avoid potential future abortive work. Issue will have to be addressed in first instance by Airdrie to Bathgate project. Interface issues to be discounted meantime for the purpose of this commission.
EGE 016	09/06/06	Timeline for E&G electrification project.	E&G works have to be completed by planned EARL completion date to align with delivery dates for new rolling stock. Planned energisation date is therefore August 2011.
EGE 017	09/06/06	Airdrie to Bathgate synergies	Economies of scale will be realised if the E&G works are progressed in tandem with the Airdrie to Bathgate works via an integrated rather than a sequential programme. Consider how costs can be presented to highlight this opportunity.
EGE 018	09/06/06	Use of NR's high output piling & wiring train used on the WCRM project.	As Item 16) above.
EGE 019	09/06/06	Signal sighting	Assume that existing signals represent immovable objects. Project estimates to include an allowance for additional OHLE costs for provision of cantilevers in areas of potential poor signal sighting.
EGE 020	09/06/06	Track drainage	Project estimates to include an allowance for re-routing existing track drainage in areas where it is currently foul of OHLE mast locations.
EGE 021	23/06/06	Cowlairs East Triangle	Feeding of west end of the E&G is proposed to be from the existing Parkhead feeder station installation. The EGE project should therefore also address wiring of the route from Springburn station to Cowlairs for feeding purposes. If the cost of providing OHLE clearance to the bridge at Springburn station is found to be excessive, the cost of a buried feeder over this section should be assumed.

Item	Date Raised	Issue	Close Out / Decision
EGE 022	23/06/06	Platform extensions	Work by NR on the Scotland RUS and the EARL rapid review has highlighted a requirement to lengthen E&G train formations to accommodate projected future demand in the next 10 to 15 years. Assume this will be progressed as a separate project, therefore EGE should make passive provision for future extension of all platforms to 9 car length where practically possible.
EGE 023	23/06/06	Winchburgh Junction	Assume renewed as a double junction with 100mph running towards Dalmeny as per the current EARL proposals.
EGE 024	23/06/06	Newbridge Junction	Assume renewed as a double junction as part of the current Airdrie to Bathgate advance works proposals.
EGE 025	23/06/06	Grangemouth Junction	Assume renewed as a single lead junction as per the current 2006/07 Scotland Territory track renewals programme.
EGE 026	23/06/06	Gartcosh / Garnqueen Junctions to Gartsherrie Junctions	Wiring of these short lengths of track would create additional electricified working opportunities (in particular ECS routes to Shield Depot) and provide security of feeding. To be highlighted as opportunities in the NR report but not to be included in the EGE costings.
EGE 027	23/06/06	Waverley Railway	No current interfaces envisaged, therefore discount this project.
EGE 028	23/06/06	Rolling Stock Acceptance Board Issues	Not to be assessed at this stage. These can only be quantified once the characteristics of the proposed new rolling stock are understood.
EGE 029	23/06/06	Regenerative Braking	All of the existing electrified network in Scotland is cleared for regenerative braking. Assume that the routes being considered by this study will be similarly cleared. NR report to list associated issues that will need to be considered further. All loading assessments will be based on worst case (no regenerative braking) assumption.

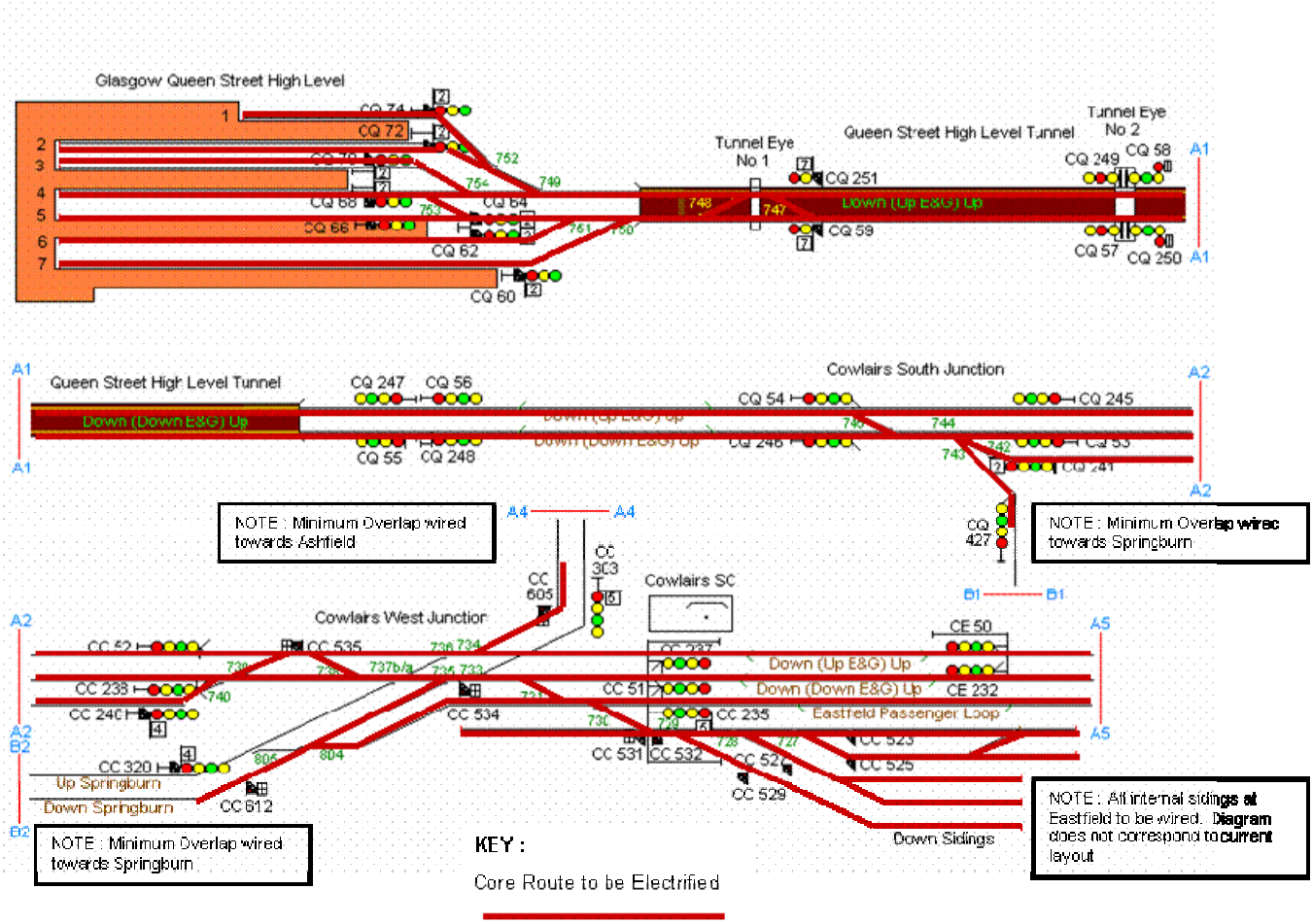
Appendix 3

MAP OF GEOGRAPHIC SCOPE OF STUDY



INDIVIDUAL TRACK DIAGRAMS :

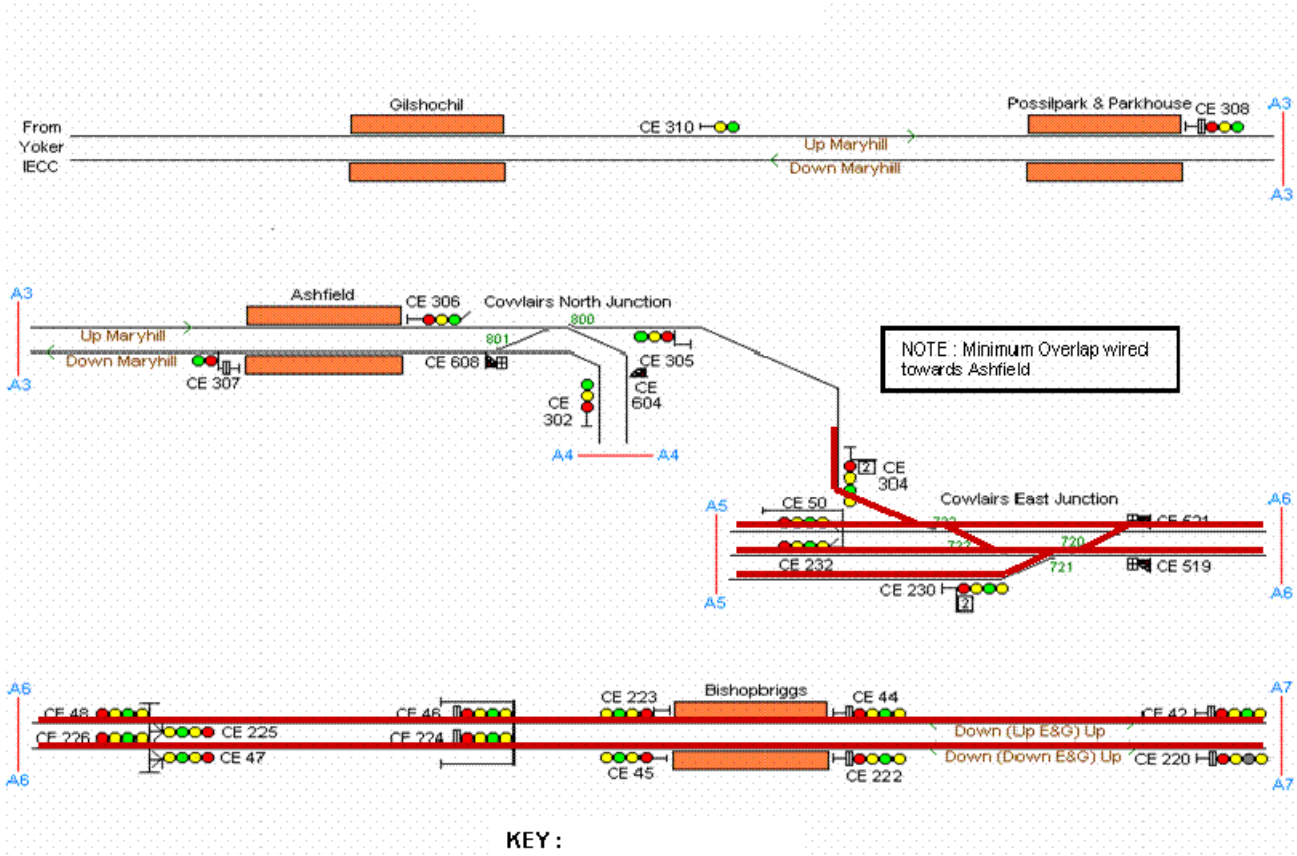
Page 1 of 18 : Core Route – Queen Street High Level to Cowlairs



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 2 of 18 : Core Route – Cowlairs to Bishopbriggs



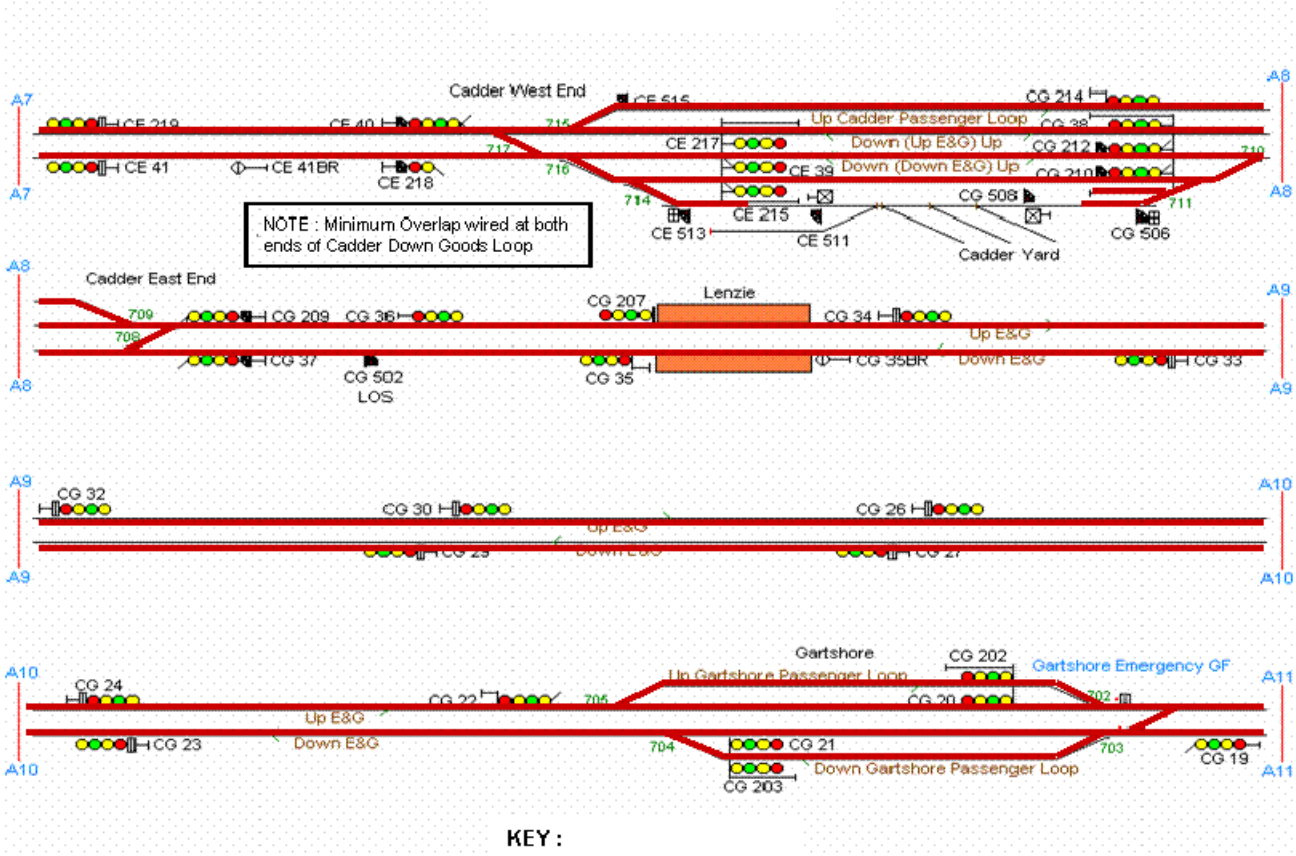
KEY :

Core Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 3 of 18 : Core Route – Bishopbriggs to Gartshore



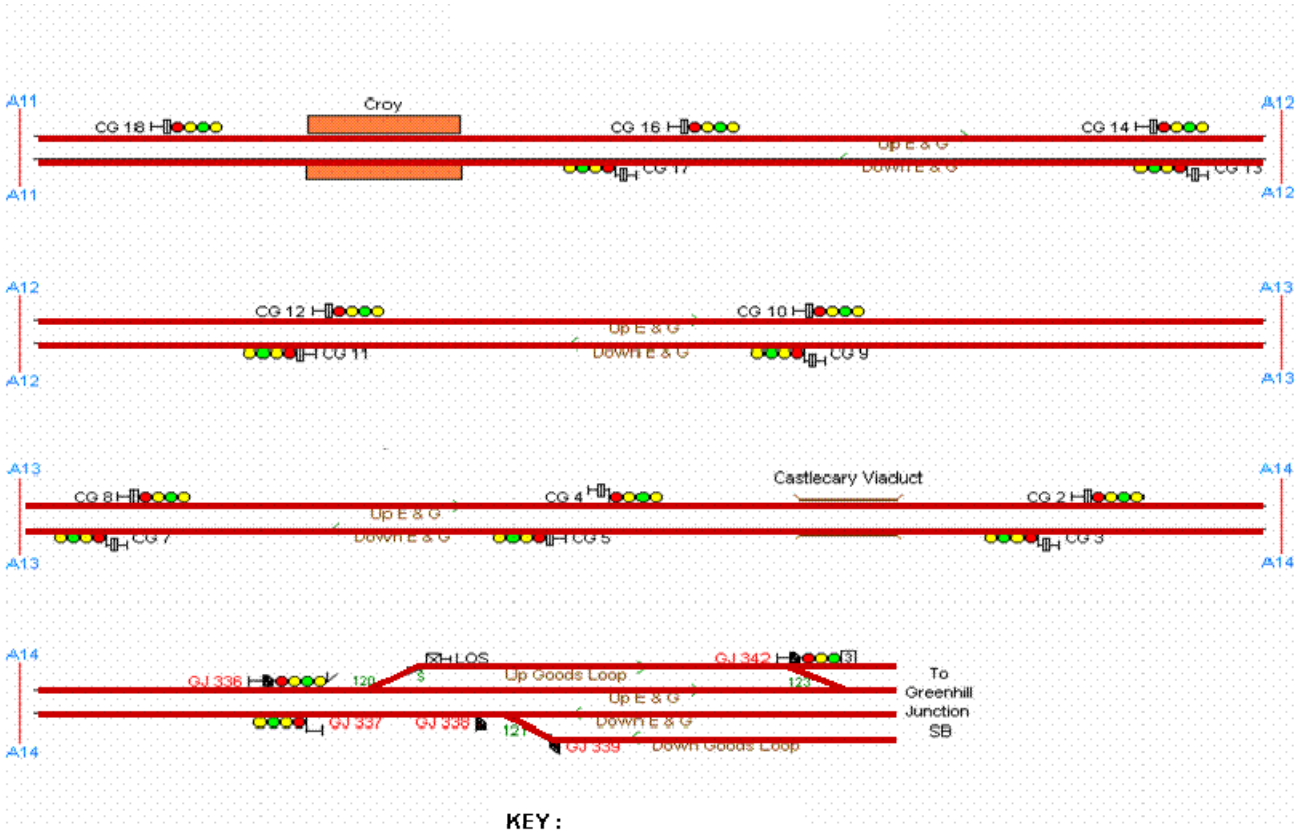
KEY :

Core Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 4 of 18 : Core Route – Gartshore to Castlecary



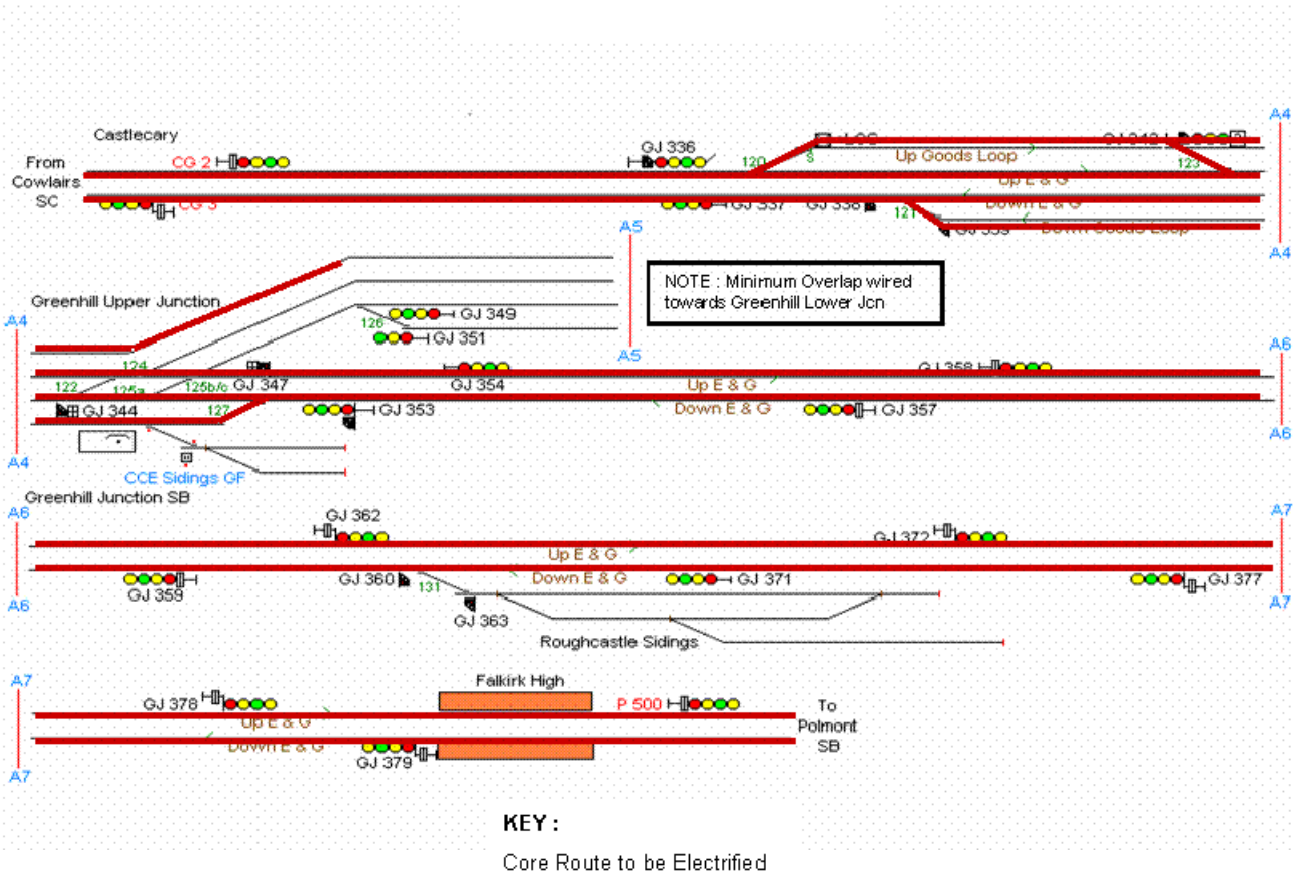
KEY :

Core Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

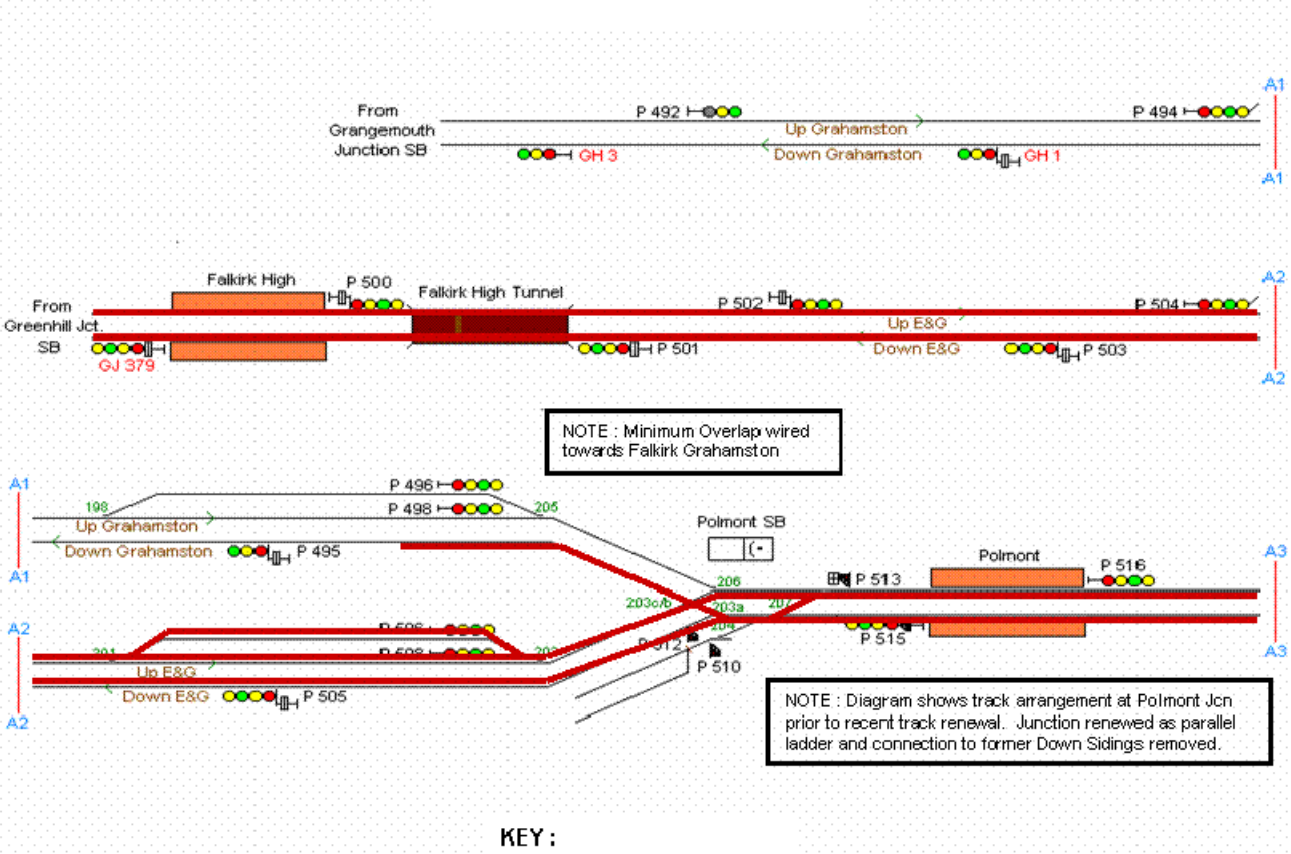
Page 5 of 18 : Core Route – Castlecary to Falkirk High



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 6 of 18 : Core Route – Falkirk High to Polmont



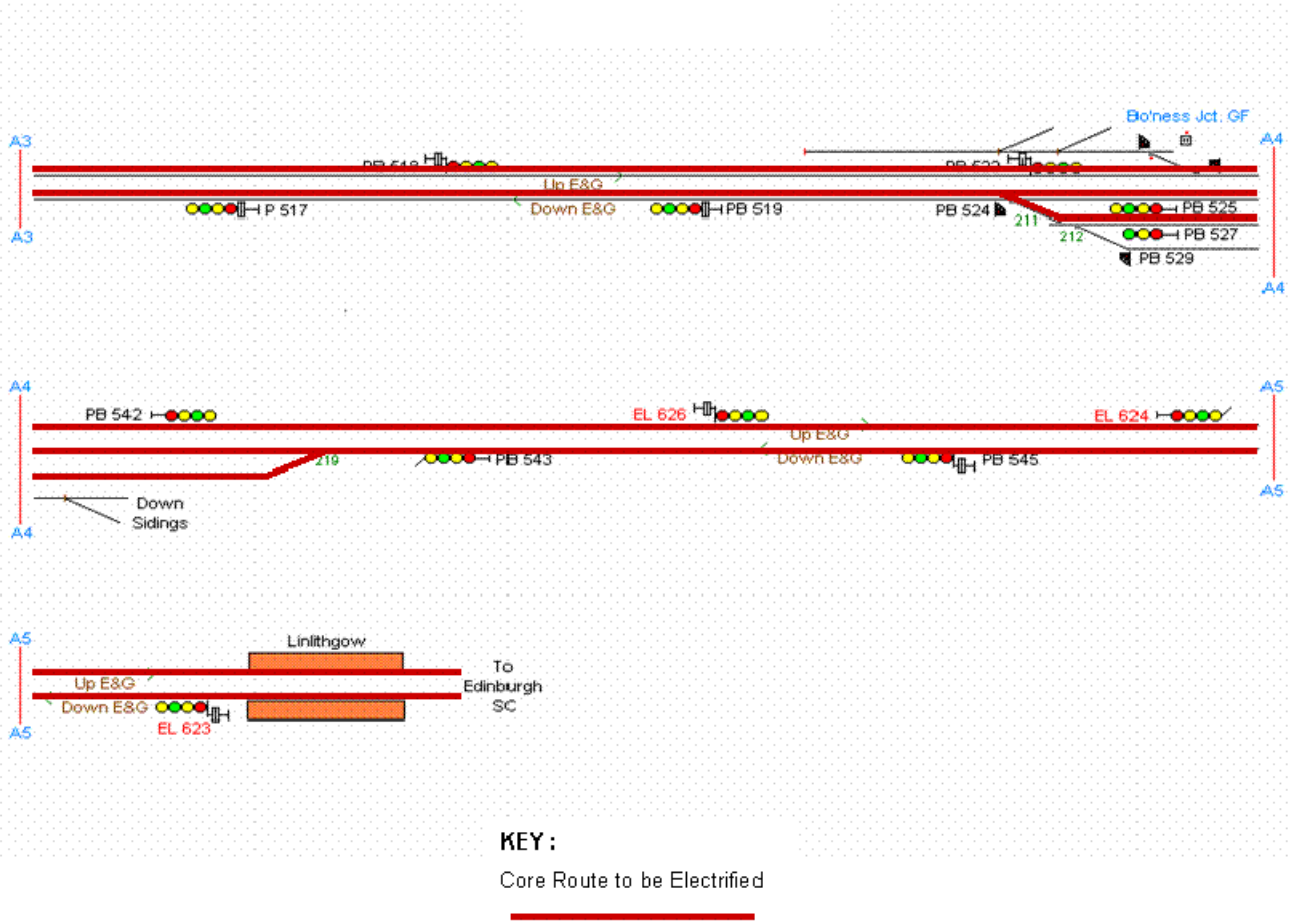
KEY :

Core Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

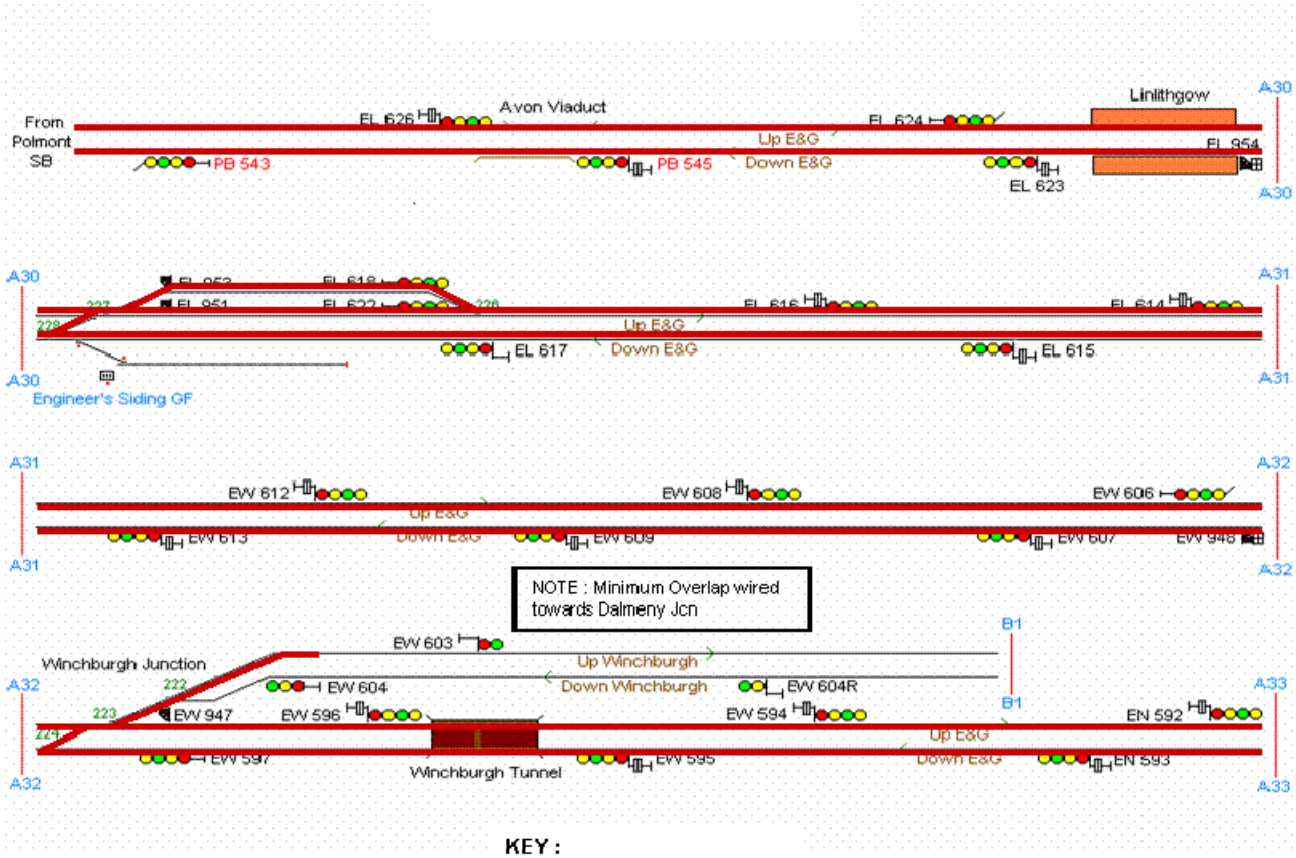
Page 7 of 18 : Core Route – Polmont to Linlithgow



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 8 of 18 : Core Route – Linlithgow`to Winchburgh



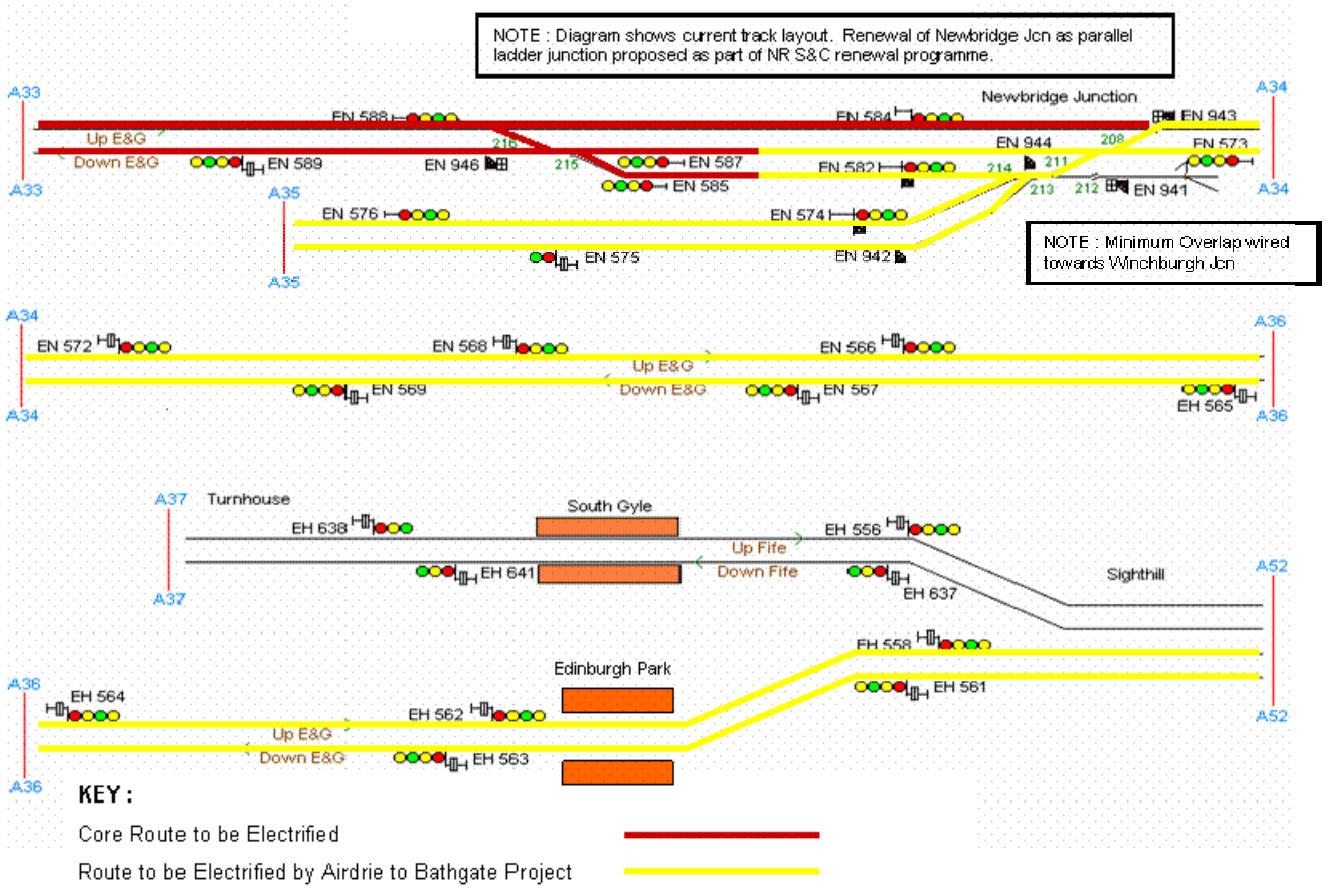
KEY :

Core Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

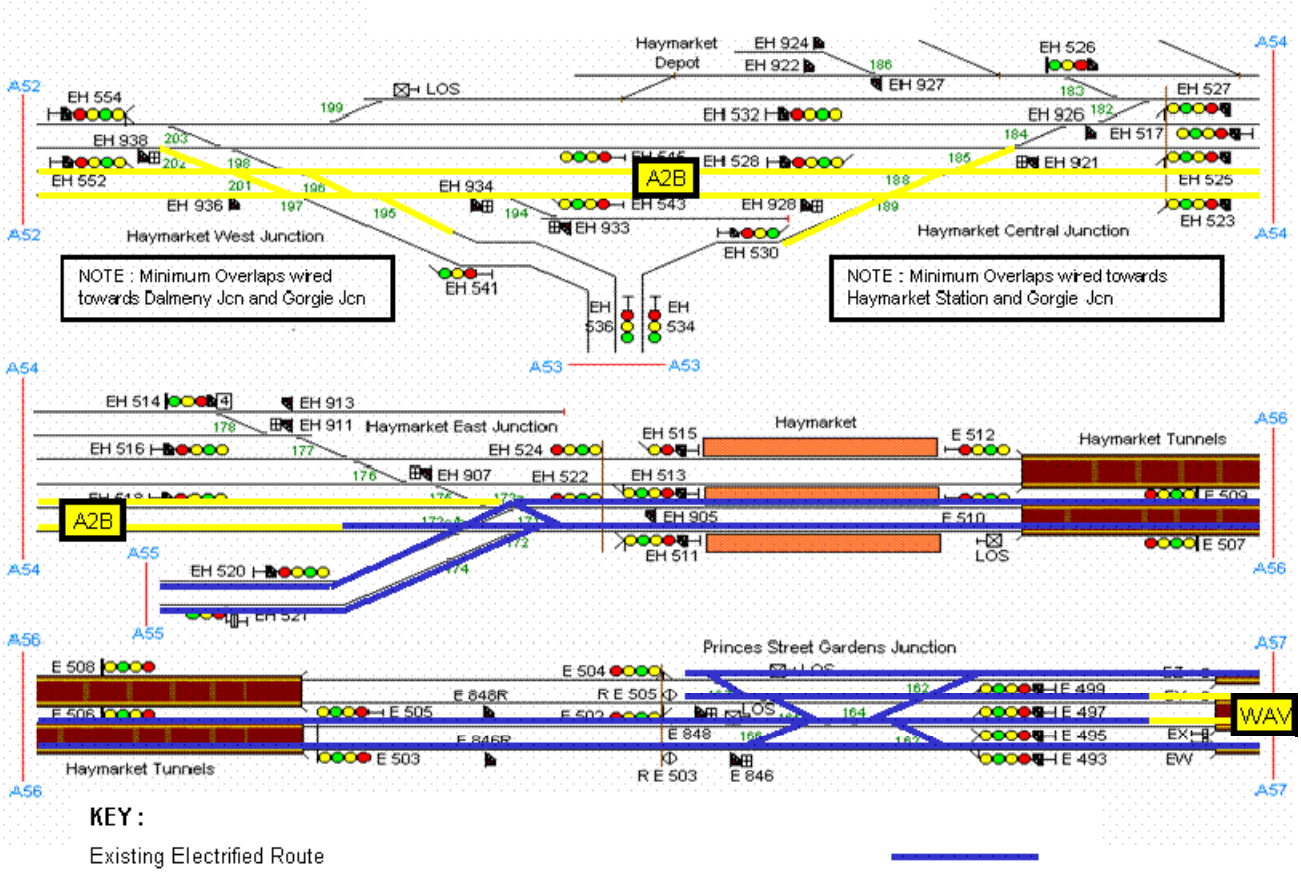
Page 9 of 18 : Core Route – Winchburgh to Haymarket West



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

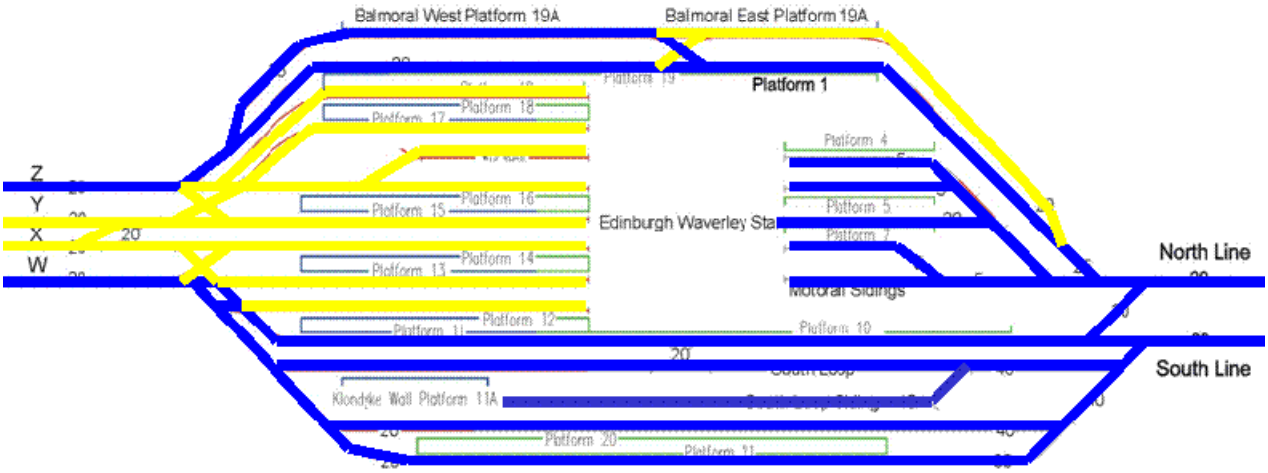
Page 10 of 18 : Core Route – Haymarket West to Haymarket East



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 11 of 18 : Core Route – Waverley Station



KEY :

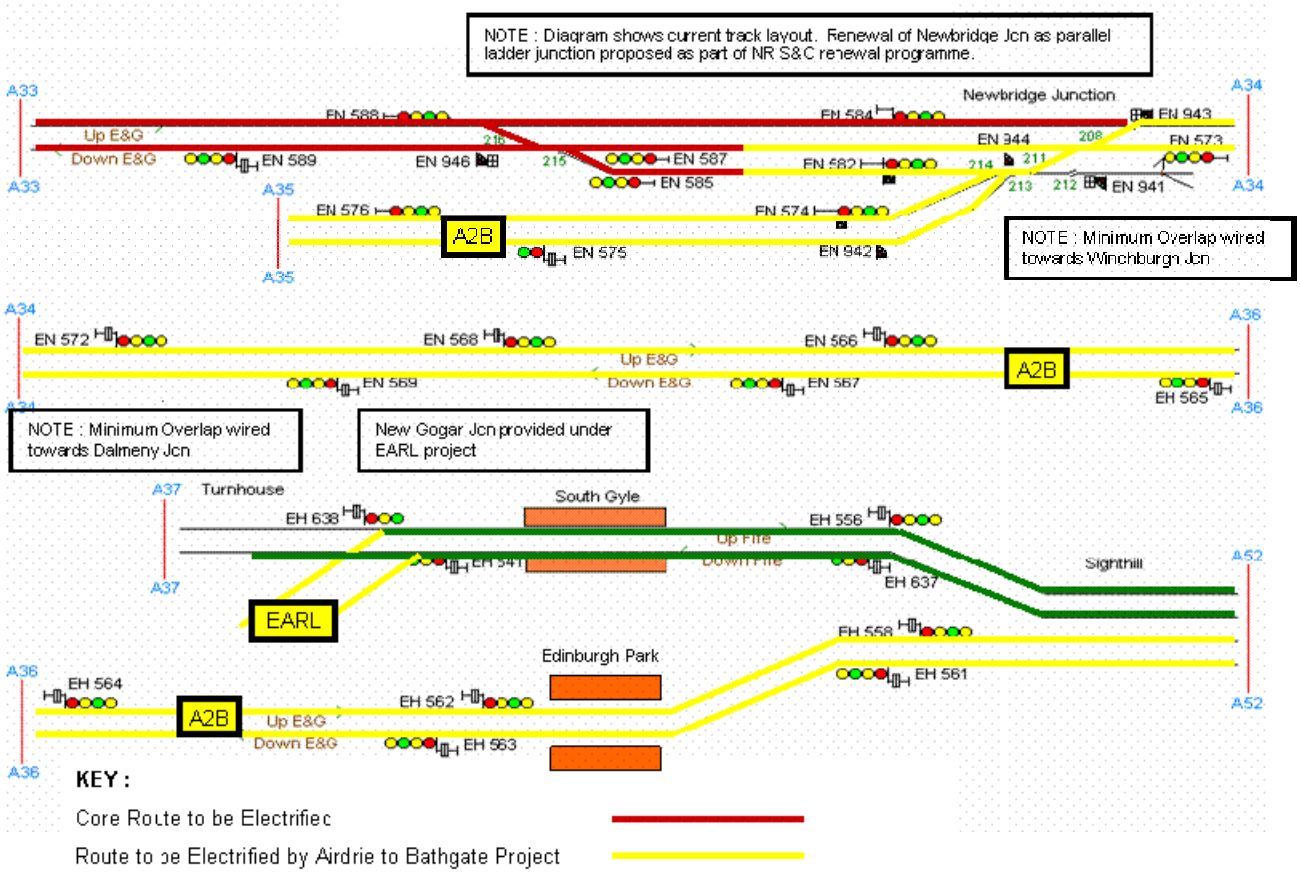
Existing Electrified Route

Route tc be Electrified by Airdrie to Bathgate (A2B) or Waverley (WAV) Project

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

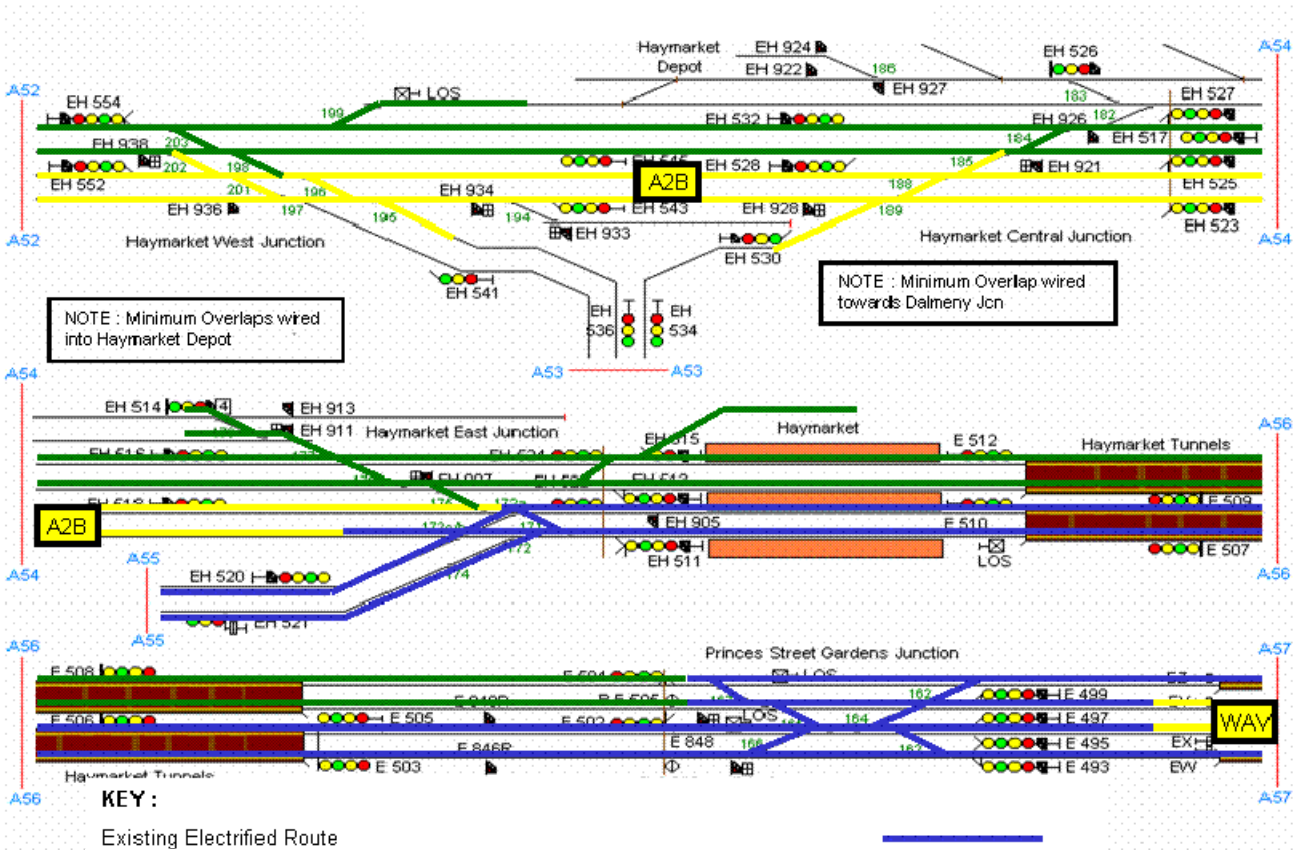
Page 12 of 18 : Diversionary Route 1 – Gogar to Haymarket West



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

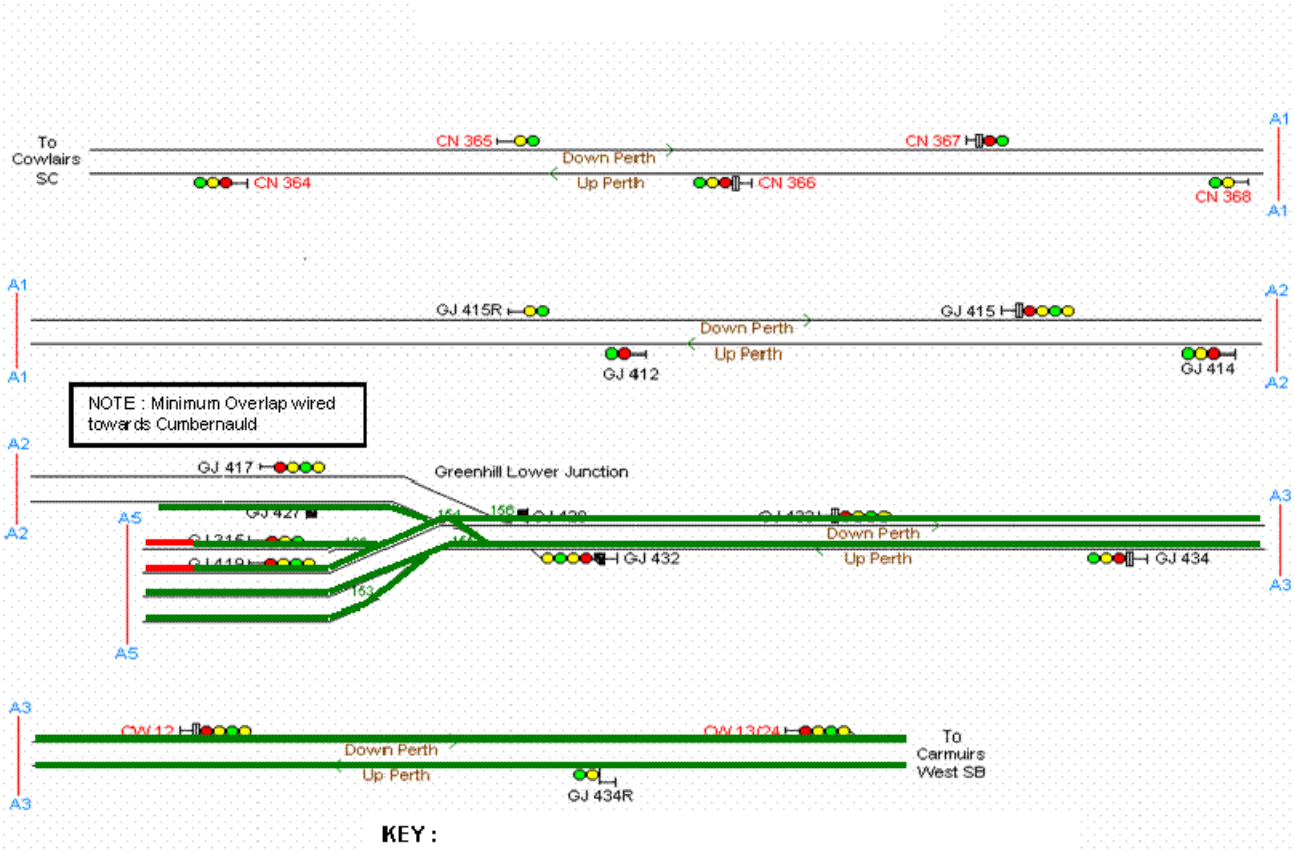
Page 13 of 18 : Diversionary Route 1 – Haymarket West to Princes St Gardens



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

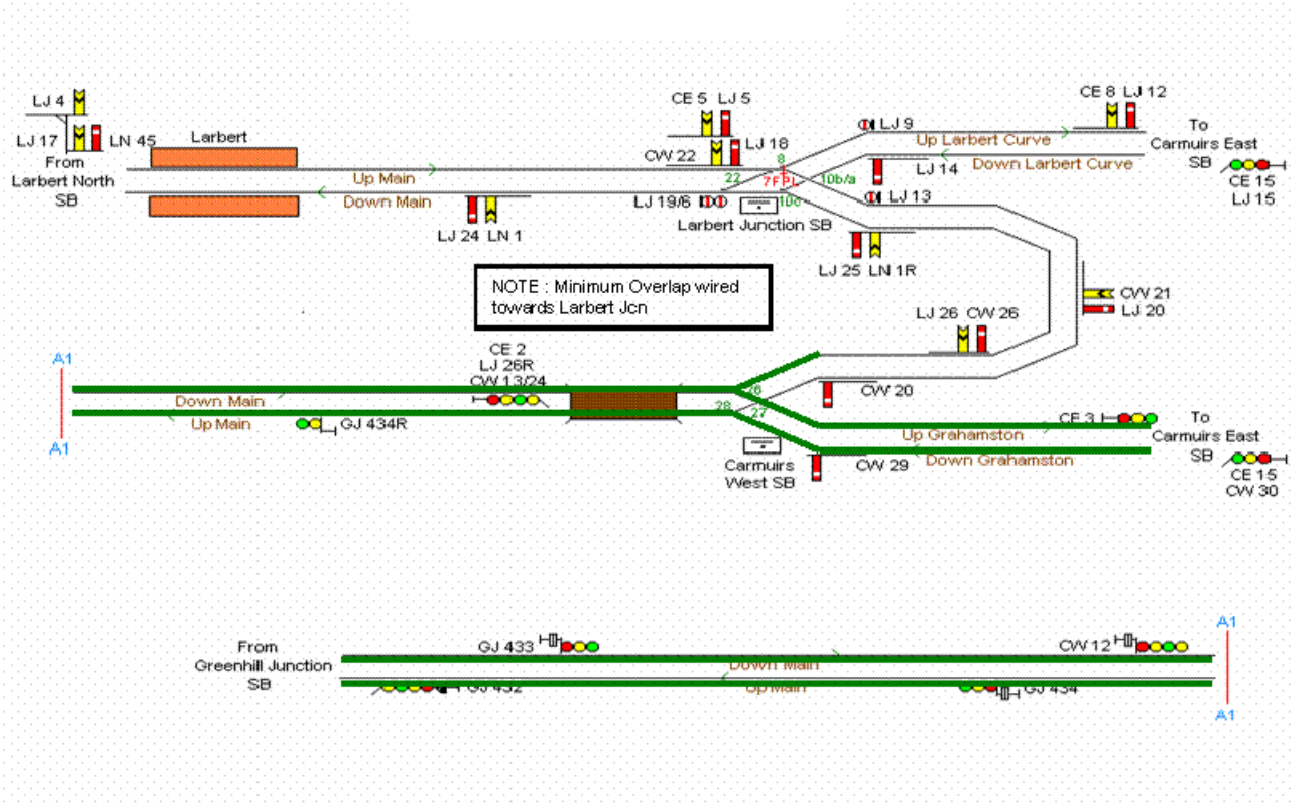
Page 14 of 18 : Diversionary Route 2 – Greenhill Upper to Greenhill Lower



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 15 of 18 : Diversionary Route 2 – Greenhill Lower to Carmuirs West



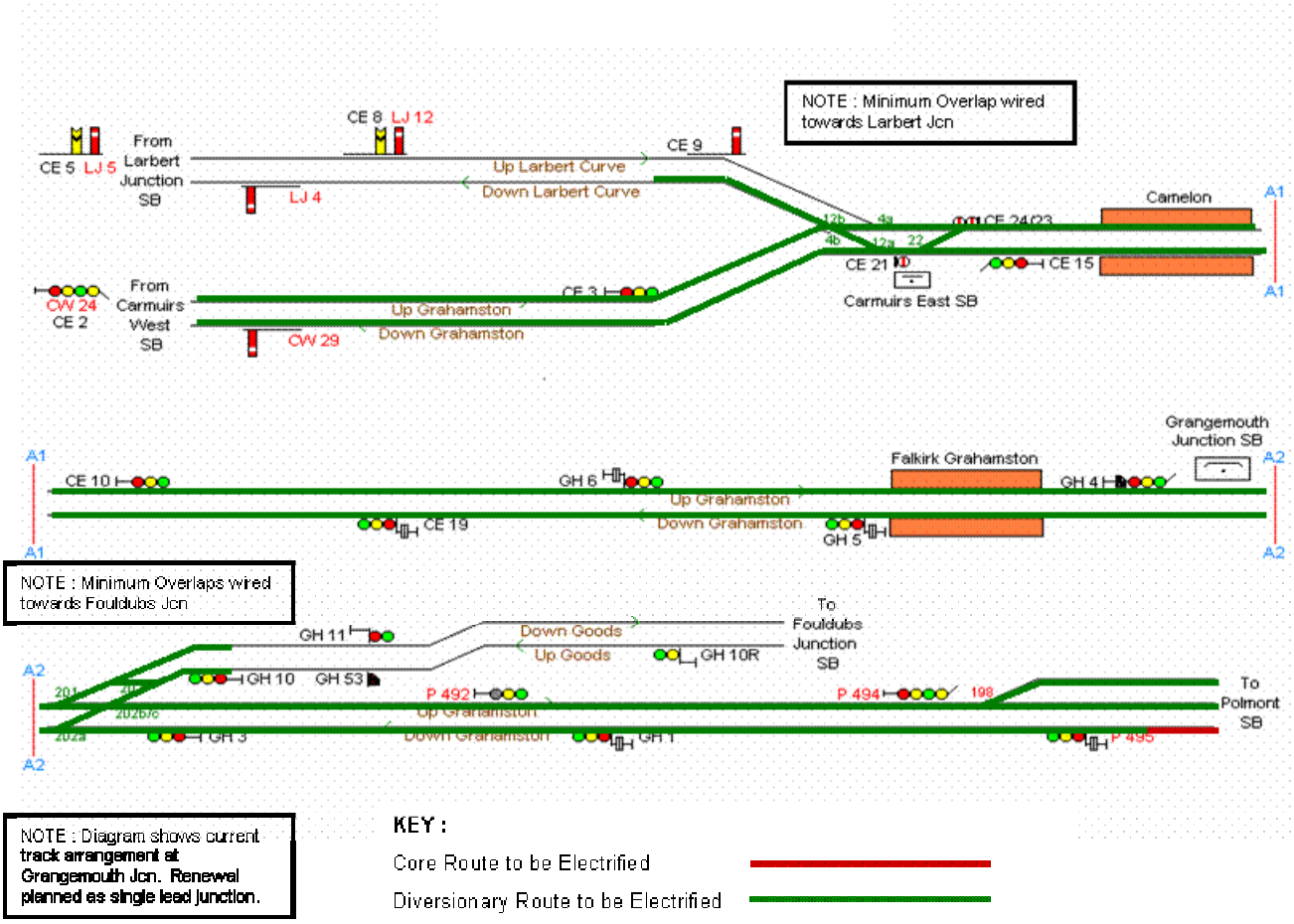
KEY :

Diversionary Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 16 of 18 : Diversionary Route 2 – Carmuirs West to Polmont



NOTE : Diagram shows current track arrangement at Grangemouth Jcn. Renewal planned as single lead junction.

KEY :

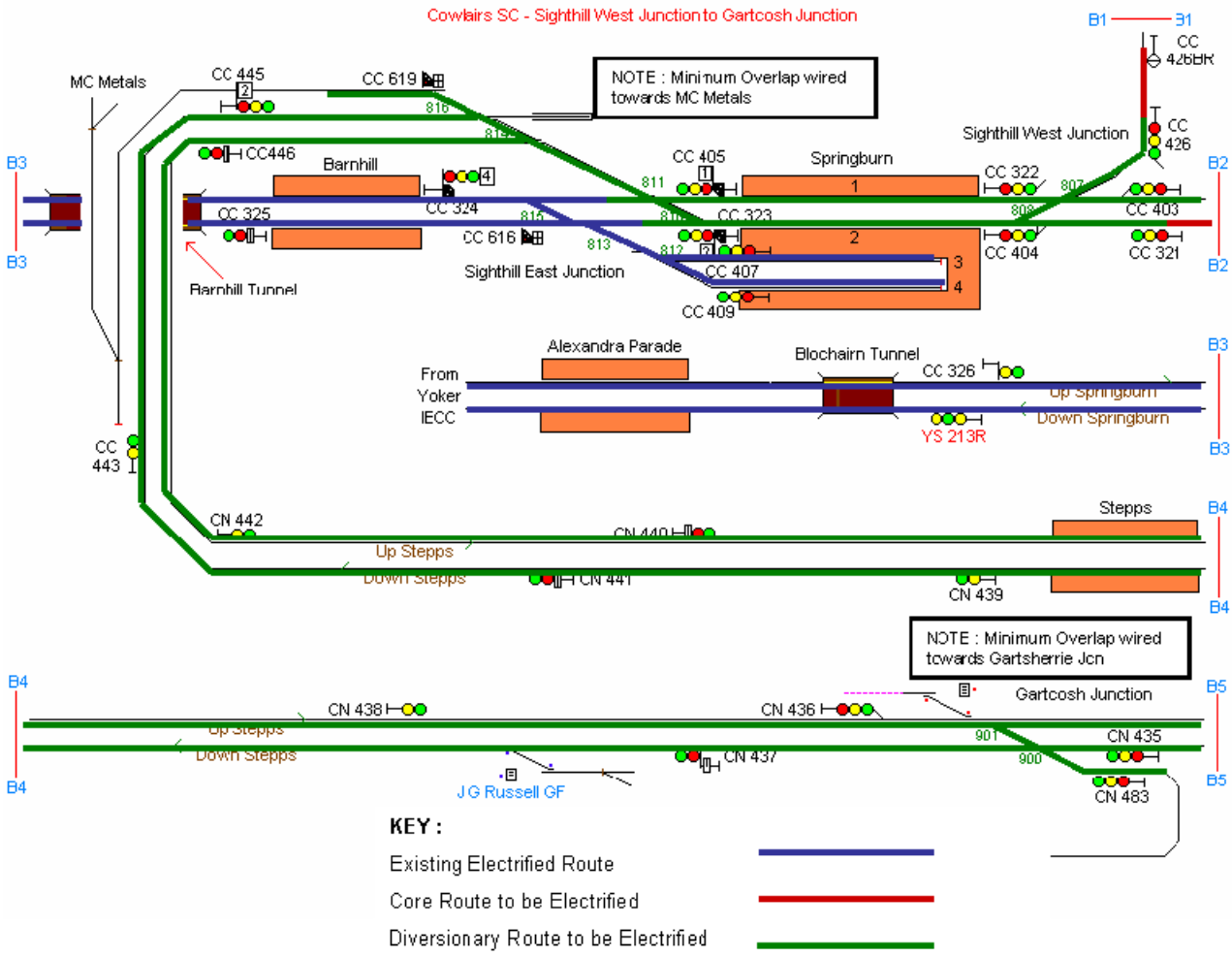
Core Route to be Electrified

Diversionary Route to be Electrified

Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

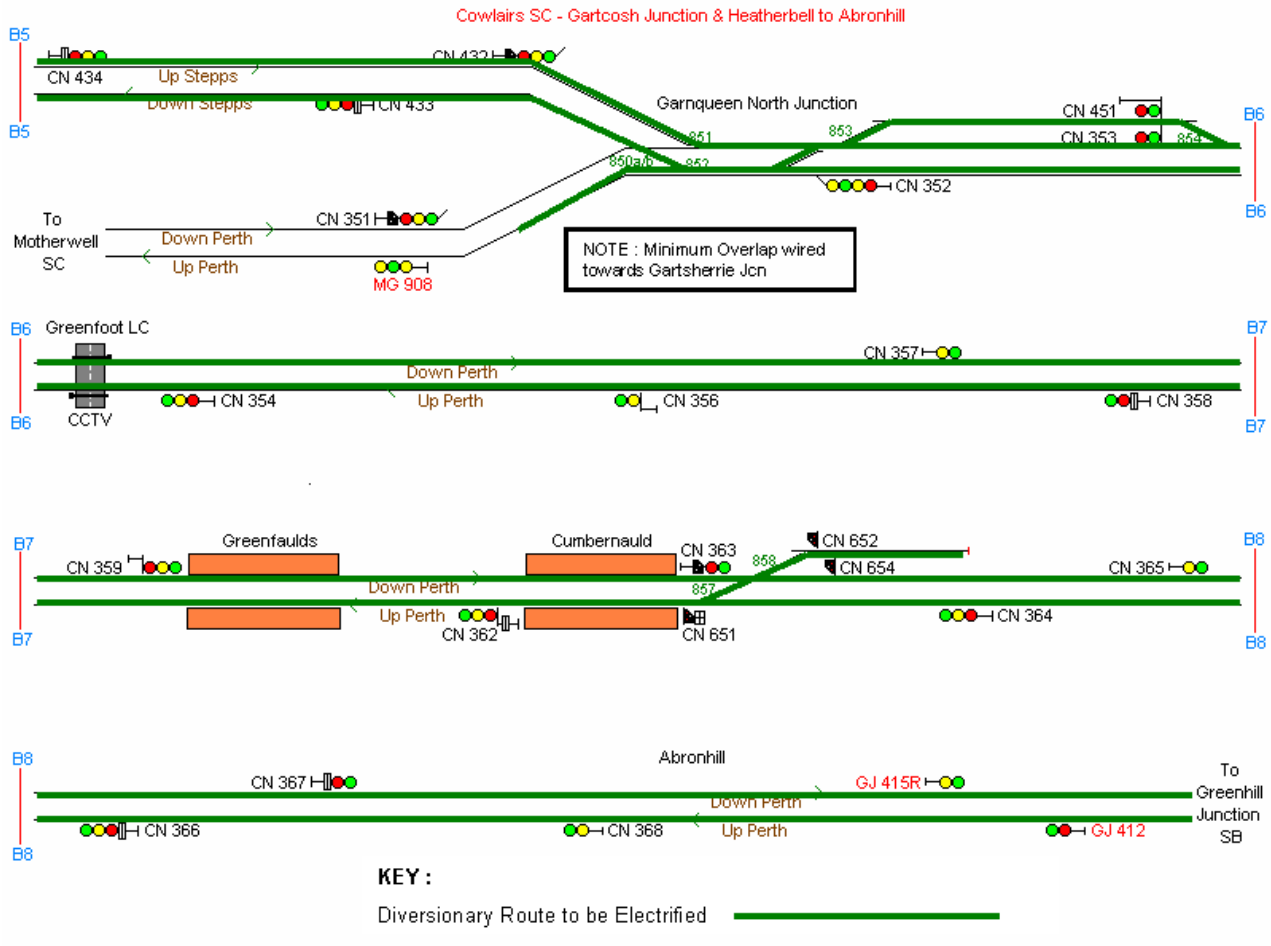
Page 17 of 18 : Diversionary Route 3 – Springburn to Gartcosh



Appendix 4

INDIVIDUAL TRACK DIAGRAMS :

Page 18 of 18 : Diversionary Route 3 – Gartcosh to Greenhill Lower



Appendix 5

BREAKDOWN OF ADDITIONAL ELECTRIFIED TRACK (Page 1 of 5)

	Plain Line (m)	Junctions	Cross Overs	Run Offs	Notes
Core Route					
Main Tracks 14ch to 38m 53 ch	124000				
Glasgow Queen Street Station					
Platform 1	141	1			Platform 0m7ch to 0m14ch
Platform 2	221	1			Platform 0m3ch to 0m14ch
Platform 3	221	1			Platform 0m3ch to 0m14ch
Platform 4	221		1		Platform 0m3ch to 0m14ch
Platform 5	221				Platform 0m3ch to 0m14ch
Platform 6	221	1			Platform 0m3ch to 0m14ch
Platform 7	221	1			Platform 0m3ch to 0m14ch
Queen Street Tunnel			2		
Cowlairs South Junction		1	1		
Cowlairs Passing Loop	538	1		1	Loop 1m25ch to 1m49ch + Run off to chord
Cowlairs West Junction	201	2	5	3	Springburn Line -0.01 to 0.04 + 2 run offs. Crossovers in Main and Springburn Lines. Run off to Ashfield
Eastfield Loop	804	4		2	Loop 1.68 to 2.18 + conn to Springburn Lines 1.71 E&G to 0.04 Springburn. Run offs to Depot
Cowlairs East Junction			2	1	
Cadder Yard			2		
UPL	1348	2			4.53 to 5.40
DPL	1368	2			4.46 to 5.34
D Arrival				1	Run Off E end only

Appendix 5

BREAKDOWN OF ADDITIONAL ELECTRIFIED TRACK (Page 2 of 5)

	Plain Line (m)	Junctions	Cross Overs	Run Offs	Notes
Core Route					
Gartshore			1		
UPL	865	2			10.03 to 10.46
DPL	865	2			10.14 to 10.47
Greenhill Upper			2	1	
UGL	645	2		1	16.77 to 17.29
DGL	640	2			UGL length from SA + 200m
Polmont			2	1	
UPL	905	2			24.01 to 24.46
Bo'Ness					
DPL	503	2			27.05 to 27.30
Linlithgow			1		
UPL	624	2			29.67 to 30.18
Winchburgh Jn			2	1	
Newbridge Jn		1	1		Jn on up Line
DPL	704	1			38.20 to 38.55
Minus EARL Winchburgh remodelling	3200		1	1	Assumed 1 tension length each line plus crossover and run off
Total For Core Route	**133277**	**33**	**21**	**11**	

Appendix 5

BREAKDOWN OF ADDITIONAL ELECTRIFIED TRACK (Page 3 of 5)

	Plain Line (m)	Junctions	Cross Overs	Run Offs	Notes
Diversionary Route 1					
Main Tracks	4023				0.40 to 1.60
Haymarket Central			3	3	Run offs to Depot and Fife
Haymarket Station	300	1			New Bay Platform
Waverley Station	0		0		No Waverley electrification in this study
Plus Haymarket to Gogar Jn (EARL)	11708	2	4	1	1.60 to 5.31 (South Gyle Stn)
Total For Div 1	**16031**	**3**	**7**	**4**	
Diversionary Route 2					
Main Tracks					
Greenhill U to L	2334				0.00 to 0.58
Greenhill L to Carmuirs W	7081				106.60 to 108.76
Carmuirs W to E	1610				0.00 to 0.40
Carmuirs E to Polmont	15289				21.20 to 25.80
Greenhill Upper					
UGL	483	1			0.00 to 0.24
DBGL	543	2			0.11 to 0.38
Greenhill Lower			1	1	
Carmuirs West				1	
Carmuirs East			1	1	
Grangemouth Jn				1	
Polmont		1			
UNPL	745	2			21.59 to 21.22
Total For Div 2	**28085**	**6**	**2**	**4**	

Appendix 5

BREAKDOWN OF ADDITIONAL ELECTRIFIED TRACK (Page 4 of 5)

	Plain Line (m)	Junctions	Cross Overs	Run Offs	Notes
Diversionary Route 3					
Main Tracks					
Springburn to Gartcosh	20801				97.06 to 103.43
Gartcosh to Garnqueen	4546				0.00 to 1.33
Garnqueen to Greenhill L	31181				97.05 to 106.60
Cowlairs Chord	1771	3	2	2	Chord 0.00 to 0.30. Springburn Station 0.30 to 0.59. Run offs to works and Up Springburn
Sighthill		1			
Gartcosh			1		
Garnqueen		2	1		
DGL	885	2			97.16 to 97.60
Cumbernauld	300	1	1		DRS and Crossover
Greenhill Lower		1			
Total For Div 3	**59484**	**10**	**5**	**2**	
Eastfield Depot					
CET/Fuel 1	320				
CET/Fuel 2	260	2			
Headshunt	95				
No1 Down Siding	450	2			
No2 Down Siding	390	2			
No3 Down Siding	360	2			
No4 Down Siding	300	2			
No5 Down Siding	240	2			
No6 Down Siding	190	2			
No7 Down Siding	190	2			
No 1 Carriage	280	1			
No 2 Carriage	220	1			
No 3 Carriage	190	1			
Total For Depot	**3485**	**19**	**0**	**0**	

Appendix 5

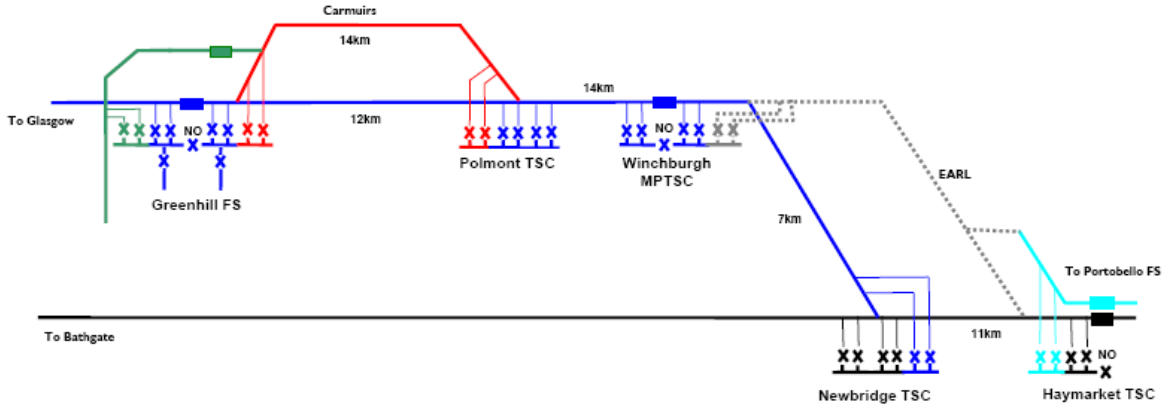
BREAKDOWN OF ADDITIONAL ELECTRIFIED TRACK (Page 5 of 5)

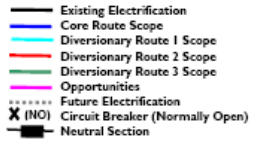
	Plain Line (m)	Junctions	Cross Overs	Run Offs	Notes
Opportunity 1 - Cowlairs W Jn to Springburn					
Springburn Lines	1046	1	0	0	Lines 0.04 to 0.30
Total For Opportunity 1	**1046**	**1**	**0**	**0**	
Opportunity 2 - Tie into existing electrification at Gartsherrie					
GHE connection	1610	1			96.06 to 97.06
Garnqueen to Gartsherrie	4707				95.68 to 97.05
Total For Opportunity 2	**6317**	**1**	**0**	**0**	

Appendix 6

PROPOSED FEEDING ARRANGEMENTS : EAST END

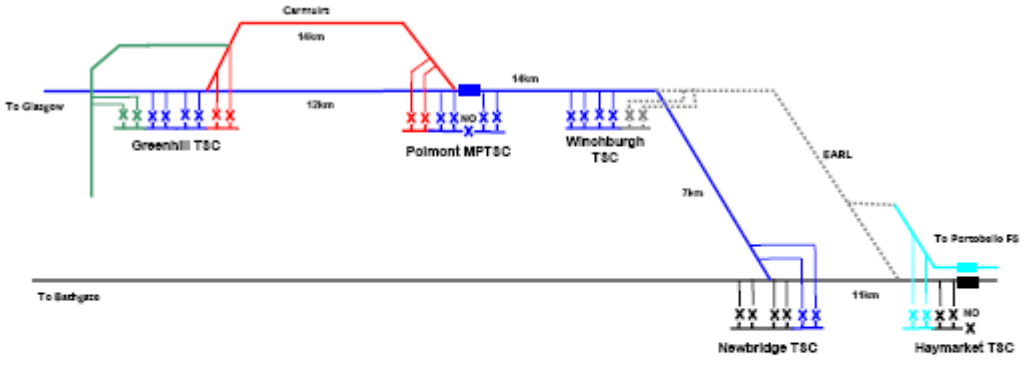
Option 1 : Feeder Station at Greenhill

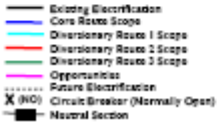




E&G Electrification Study
Major Feeding Diagram
Edinburgh

Option 2 : Feeder Station at Cowlairs



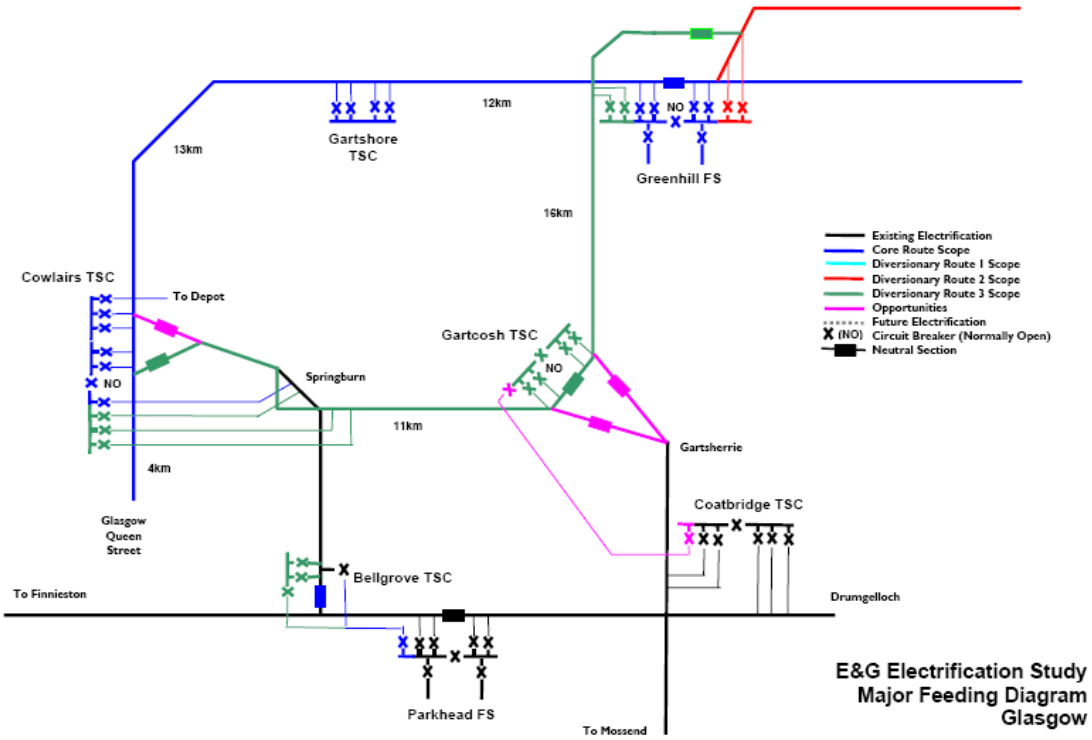


E&G Electrification Study
Major Feeding Diagram
Edinburgh (Option 2)

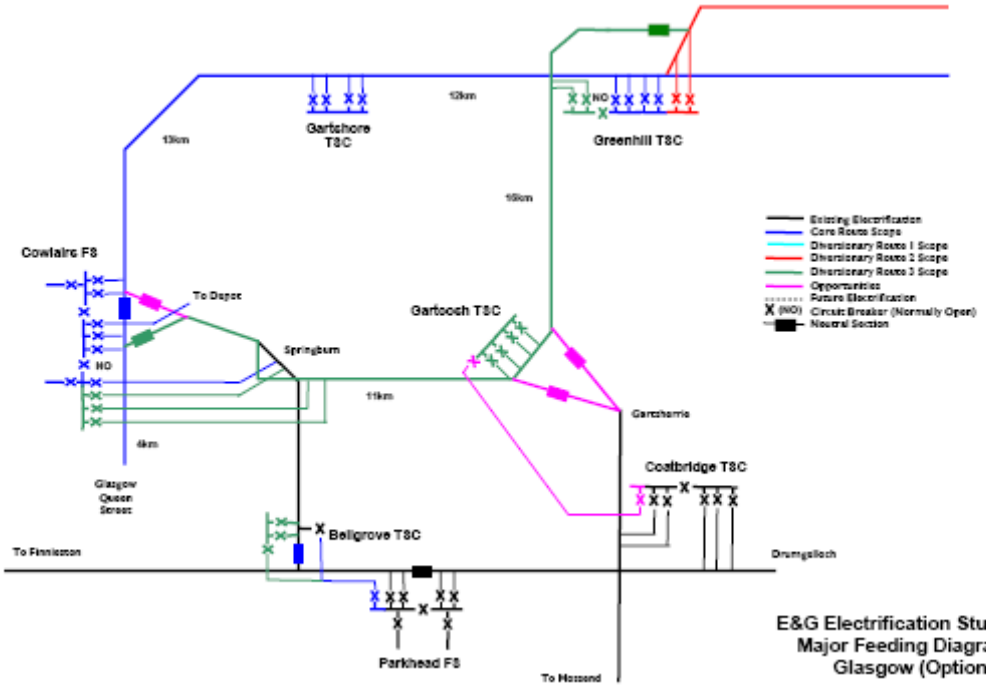
Appendix 7

PROPOSED FEEDING ARRANGEMENTS : WEST END

Option 1 : Feeder Station at Greenhill



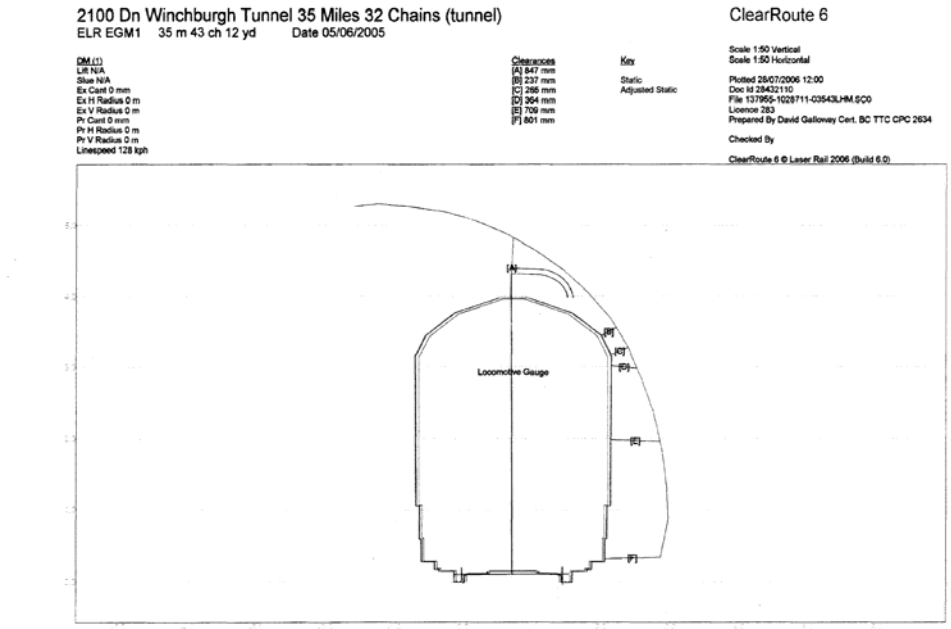
Option 2 : Feeder Station at Cowlairs



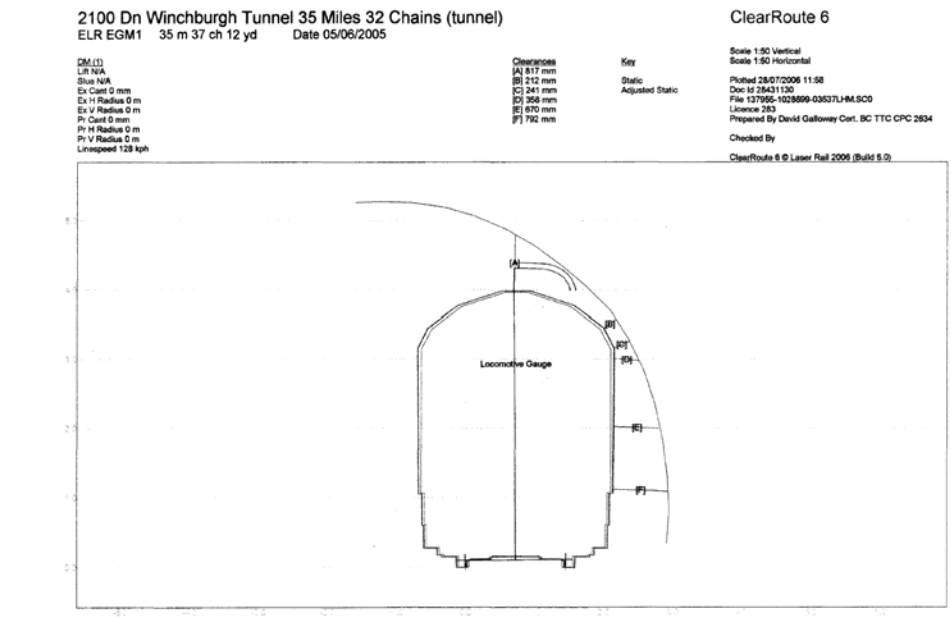
Appendix 8

KEY TUNNEL PROFILES

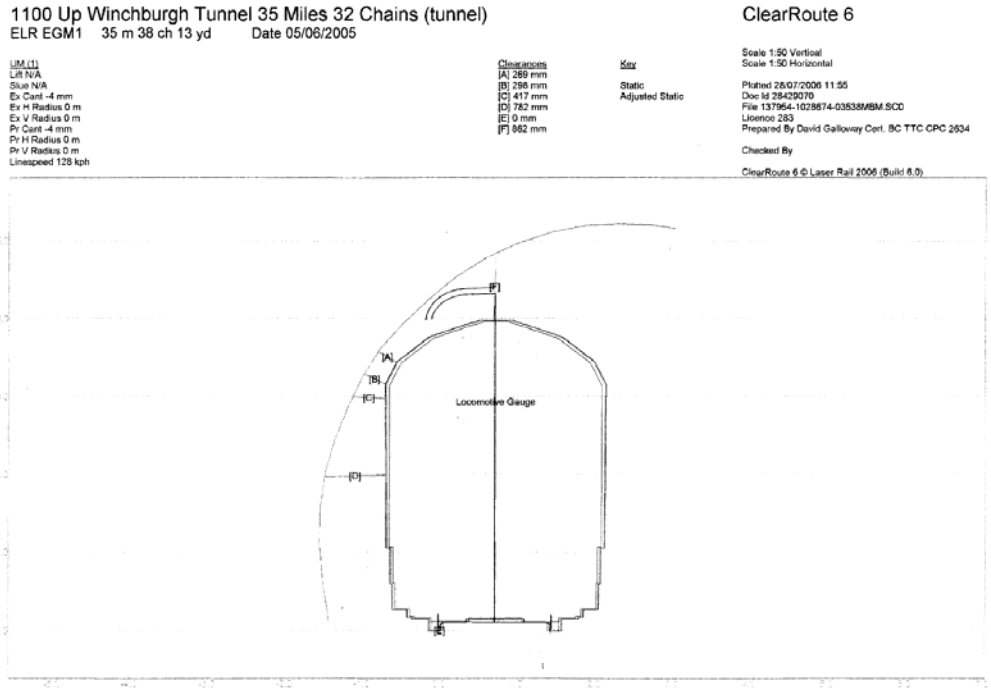
1) Winchburgh Tunnel Down Line : 200mm pan clearance : OK



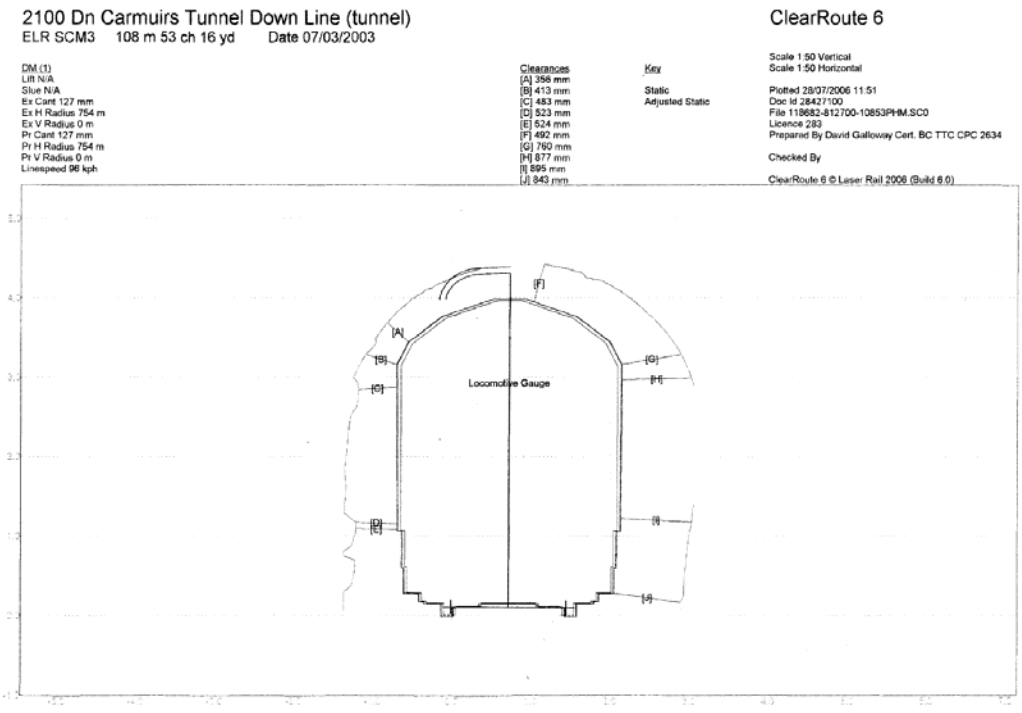
2) Winchburgh Tunnel Down Line : 150mm pan clearance : FOUL



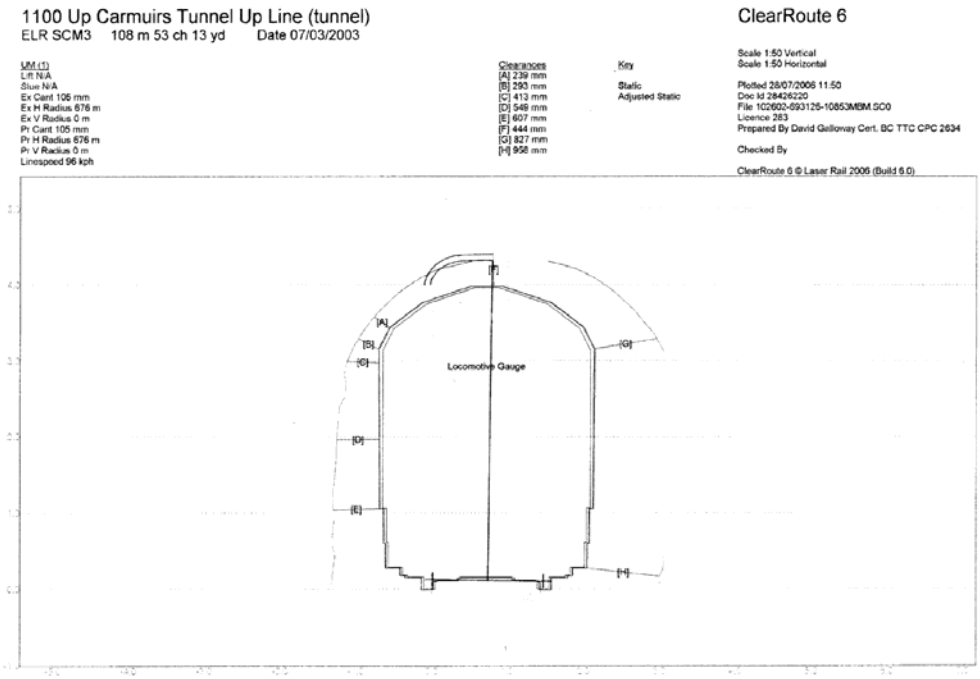
3) Winchburgh Tunnel Up Line : 250mm pan clearance : OK



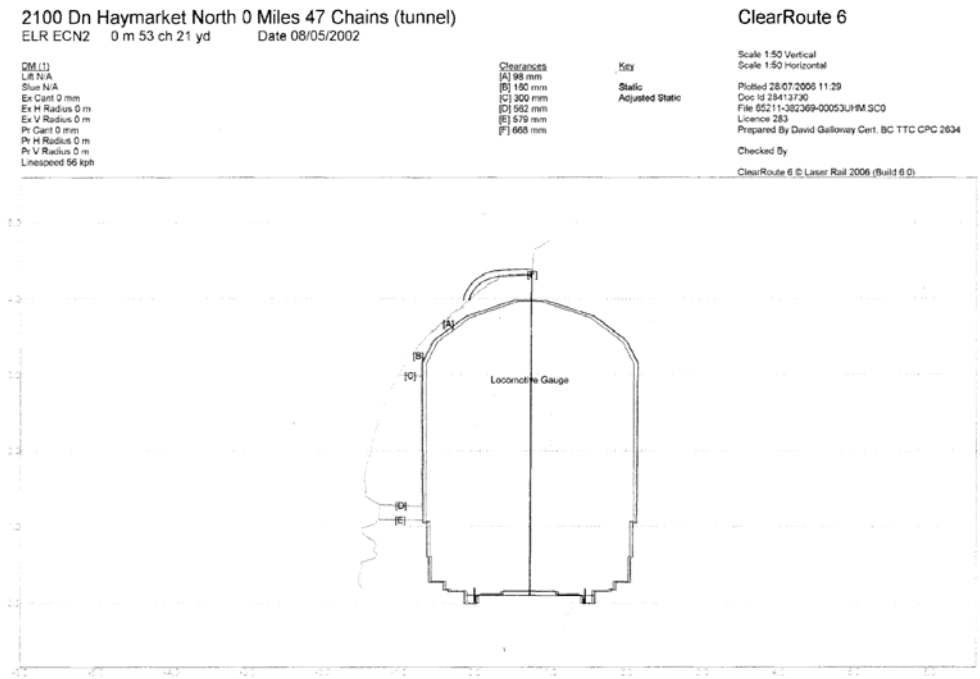
4) Carmuirs Tunnel Down Line : 50mm pan clearance : FOUL



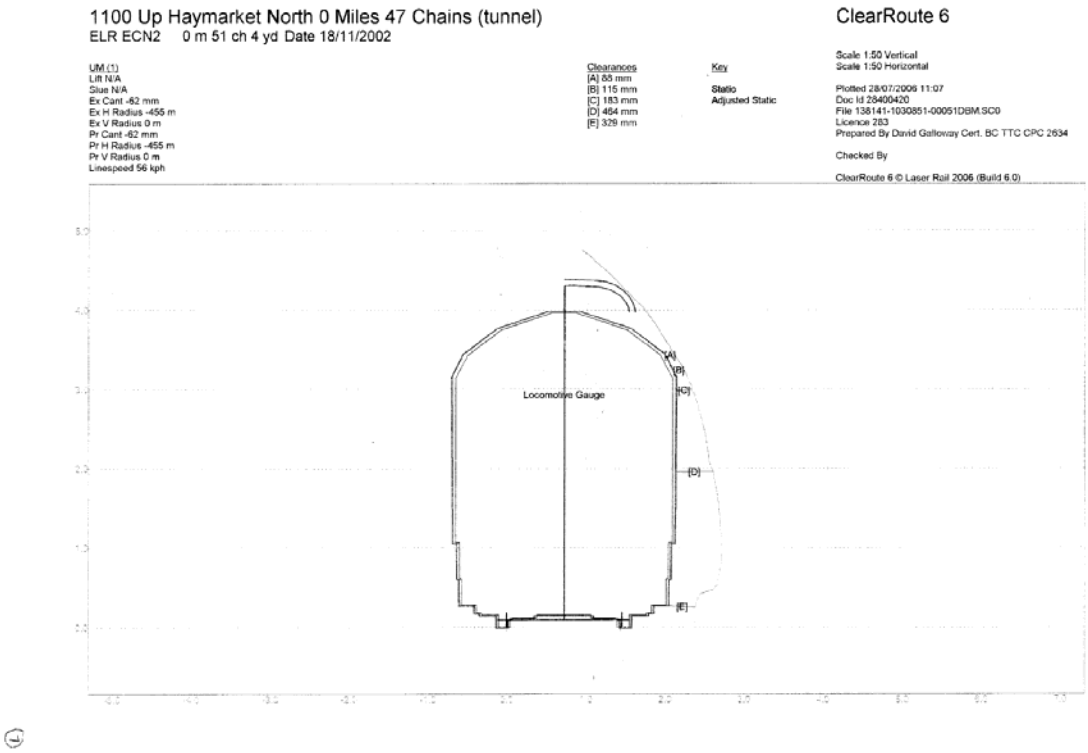
5) Carmuirs Tunnel Up Line : - 50mm pan clearance : FOUL



6) Haymarket North Tunnel Down Line : - 100mm pan clearance : FOUL



7) Haymarket North Tunnel Up Line : 20mm pan clearance : FOUL



Appendix 9

SUMMARY OF STRUCTURES WORKS : CORE ROUTE

Edinburgh Waverley / Haymarket South Tunnel / Haymarket Station Platforms 3 & 4 / Newbridge Jcn
Newbridge Jcn / Linlithgow / Polmont Jcn / Falkirk High / Greenhill Upper Jcn / Croy / Cowlairs South Jcn / Glasgow Queen St High Level

Location	Clear / Foul	Assessed Works Required
Edinburgh Waverley Stn : West End Bays (EGM 4)	*Foul*	*GRIP 4 complete July 06. Delivery in Q2 2007. Assumed to be undertaken as advance works for the A2B project.*
Mound Tunnel : Mid Bore (EGM 3 : 0/330 to 0/446)	*Foul*	*GRIP 4 complete July 06. Delivery in Q2 2007. Assumed to be undertaken as advance works for the A2B project.*
O/B 9 Carricknowe F/B (EGM1 : 44m 52y)	*Clear*	*None.*
O/B xx Ed Park Stn F/B (EGM1 : xxxx)	*Clear*	*None.*
O/B 4 Gogar (EGM1 : 42m 77y)	*Foul*	*Re-decking required. Included in scope of A2B project.*
O/B 6 Gogar (EGM1 : 41m 1362y)	*Foul*	*Re-decking required. Included in scope of A2B project.*
O/B 7 Roddinglaw (EGM1 : 40m 1693y)	*Foul*	*Re-decking required. Included in scope of A2B project.*
O/B 10 Norton Drive (EGM1 : 39m 1125y)	*Foul*	*Re-decking required. Included in scope of A2B project.*
O/B 12 Ratho (EGM1 : 39m 38y)	*Foul*	*Re-decking required. Included in scope of A2B project.*
O/B 19 Broomhouse (EGM1 : 36m 358y)	Clear	Parapet Protection works required.
O/B 20 Niddry Castle (EGM1 : 36m 32y)	Clear	Parapet Protection works required.
Winchburgh Tunnel (EGM1 : 35/701 to 35/1089)	Foul in localised areas	Allow 3 x 10m sections to be rock bolted and relined. 60m sprayed concrete.
O/B 22 Aqueduct & F/B (EGM1 : 35m 439y)	Foul	Re-decking required.
O/B 23 Myre Bridge (EGM1 : 35m 86y)	Clear	Parapet Protection works required.
O/B 23a Gas Pipe (EGM1 : 35m 83ch)	Foul	Re-construction at higher level required.
O/B 24 Priestinch (EGM1 : 34m 901y)	Clear	Parapet Protection works required.

Location	Clear / Foul	Assessed Works Required
O/B 25 Aqueduct (EGM1 : 34m 573y)	Foul	Re-decking required.
O/B 26 Craigton (EGM1 : 33m 1504y)	Clear	Parapet Protection works required.
O/B 27 Stone Couple (EGM1 : 33m 1154y)	Clear	Parapet Protection works required.
O/B 28 Cockmuir (EGM1 : 33m 589y)	Clear	Parapet Protection works required.
O/B 29 B8046 Road (EGM1 : 33m 357y)	Foul	Re-decking required.
O/B 30 Philipstoun Stn (EGM1 : 32m 1399y)	Foul	Re-decking required.
O/B 34 Park Farm (EGM1 : 31m 335y)	Clear	Parapet Protection works required.
O/B 40 Lion Well F/B (EGM1 : 29m 603y)	Foul	Re-decking required.
O/B 50 Boness High Jcn (EGM1 : 27m 209y)	Foul	Re-decking required.
O/B 51 Haining Wood (EGM1 : 26m 643y)	Clear	Parapet Protection works required.
O/B 51a A801 Road (EGM1 : 26m xxxxy)	Clear	Parapet Protection works required.
O/B 52 Nicolton Road (EGM1 : 26m 114y)	Clear	Parapet Protection works required.
O/B 54 Battock (EGM1 : 25m 1101y)	Clear	Parapet Protection works required.
O/B 56 Polmont Stn Rd (EGM1 : 24m xxxxy)	Clear	Parapet Protection works required.
O/B 56a Polmont Stn F/B (EGM1 : 24m xxxxy)	Clear	None.
O/B 57 Polmont Jcn (EGM1 : 24m 1410y)	Foul	Re-decking required.
O/B 58 Redding Road (EGM1 : 24m 350y)	Foul	Parapet Protection and Track Lowering works required. 1,000m single track lowering. 1,030m drainage.
O/B 62 Hallglen (EGM1 : 22m 1008y)	Clear	Parapet Protection works required.
Falkirk High Tunnell (EGM1 : 21/1648 to 22/788)	Clear	Installation of Drip Trays over 860m length.
O/B 64 Slammanan Road (EGM1 : 21m xxxxy)	Clear	Parapet Protection works required.
O/B 64a Falkirk High Stn F/B (EGM1 : 21m 1364y)	Clear	None.

Location	Clear / Foul	Assessed Works Required
O/B 69 Barnes Bridge (EGM1 : 20m 696y)	Foul	Proposed removal.
O/B 70 Lime Road (EGM1 : 20m 343y)	Foul	Re-decking required.
O/B 71 Bonnyhill Road (EGM1 : 19m 1431y)	Foul	Re-decking required.
O/B 76 Dykehead (EGM1 : 18m 125y)	Foul	Re-decking required.
O/B 81 Muirside Road (EGM1 : 16m 998y)	Clear	Parapet Protection works required.
O/B 85 Wyndford Road (EGM1 : 15m 168y)	Clear	Parapet Protection works required.
O/B 95 West Dullatur (EGM1 : 12m 1045y)	Foul	Re-decking required.
O/B 95a Constarry Road (EGM1 : 11m 937y)	Clear	Parapet Protection works required.
O/B 96 Croy Stn F/B (EGM1 : 11m 884y)	Clear	Parapet Protection works required.
O/B 99 Drumgrew Road (EGM1 : 09m 1531y)	Foul	Re-decking required.
O/B 99a Sewer Pipe (EGM1 : 9m 1520y)	Clear	None.
O/B 104 Woodilee (EGM1 : 07m 675y)	Clear	Parapet Protection works required.
O/B 107 Lenzie Stn F/B (EGM1 : 6m 428y)	Clear	None.
O/B 108 Cadder East (EGM1 : 05m 885y)	Clear	Parapet Protection works required.
O/B 109 Littlehill (EGM1 : 04m 1019y)	Clear	Parapet Protection works required. Possible re-construction under Bridgeguard Programme.
O/B 110 W Cleddens Rd (EGM1 : 3m xxxxy)	Clear	Parapet Protection works required.
O/B 111 Bishopbriggs Stn F/B (EGM1 : 3m 438y)	Clear	None.
O/B 114 Kirkintilloch Rd (EGM1 : 02m 1572y)	Clear	Parapet Protection works required.
O/B 115 Coltpark Ave (EGM1 : 02m 1232y)	Clear	Parapet Protection works required.
O/B 116 Colston Rd (EGM1 : 2m 985y)	Clear	Parapet Protection works required.
O/B 117 Everard Drive (EGM1 : 02m 69y)	Clear	Parapet Protection works required.

Location	Clear / Foul	Assessed Works Required
O/B 121 Gourley St (EGM1 : 01m 557y)	Foul	Parapet Protection and Track Lowering works required. 1,000m single track lowering. Drainage 1,022m
O/B 122 Keppochill Rd (EGM1 : 01m 443y)	Clear	Parapet Protection works required.
O/B 123 Fountainwell Rd (EGM1 : 01m 298y)	Clear	Parapet Protection works required.
O/B 126 Pinkston Rd (EGM1 : 0m 1507y)	Clear	Parapet Protection works required.
Queen St HL Tunnel (EGM1 : 0/330 to 0/1340)	Clear	Installation of Drip Trays over 1080m length.
O/B 130 Cathedral St (EGM1 : 0m xxxxy)	Clear	Parapet Protection works required. Possible re-construction under Bridgeguard Programme.

Appendix 10

SUMMARY OF STRUCTURES WORKS : DIVERSIONARY ROUTE 1

Haymarket North Tunnel / Haymarket Station Platforms 1 &2 / Haymarket Central Jcn / North Lines / New Gogar Jcn

Location	Clear / Foul	Assessed Works Required
Haymarket North Tunnel (ECN2 : 0/1018 to 1/259)	Foul	Slab tracking and tunnel wall underpinning works required. 2,040m slab track. Lower track 800m. 850m drainage. Rock anchors 3,132m.
O/B 090 / 011 (ECN2 : 4m 0058y)	Foul	Re-decking required.
O/B 090 / 012 (ECN2 : 4m 0213y)	Clear	Parapet Protection works required.
O/B 090 / 013 (ECN2 : 4m 0893y)	Foul	Re-decking required.
O/B 090 / 016 (ECN2 : 5m 0576y)	Foul	Parapet Protection and Track Lowering works required. 4 lane skewed highway bridge. 1000m track lowering. Drainage 1,032m.
O/B 090 / 018 (ECN2 : 5m 1430y)	Foul	Re-decking required.

Appendix 11

SUMMARY OF STRUCTURES WORKS : DIVERSIONARY ROUTE 2

Greenhill Upper Jcn / Greenhill Lower Jcn / Carmuirs West Jcn / Carmuirs East Jcn / Falkirk Grahamston / Polmont Jcn

Location	Clear / Foul	Assessed Works Required
O/B 51 Bonnyside Farm (SCM3 : 107m 721y)	Foul	Re-decking required.
O/B 49 Carmuirs Loan (SCM3 : 108m 718y)	Clear	Parapet Protection works required.
Carmuirs Tunnels : (SCM3 : 108/1179 - 108/1225)	Track Lowering. Slabtrack. Drainage	80m slabtrack. Lower track 1,000m. Drainage 1,080m
O/B 47 Bonnyside Rd (SCM3 : 108m 1320y)	Clear	Parapet Protection works required.
O/B 2 Carmuirs W - E (CMS : 0m 642y)	Foul	Re-decking required.
O/B 19 Carmuirs Fm Rd (PMT : 25m 1408y)	Foul	Re-decking required.
O/B 17a Camelon Stn F/B (PMT : 25m 1100y)	Clear	None.
O/B 14aa Mungalhead (PMT : 24m 1530y)	Clear	None.
O/B 11 Hope St Falkirk (PMT : 24m 660y)	Foul	Re-decking required.
Structure ?? 24m 0715yds	Clear	None.
O/B 10a Grahamston F/B (PMT : 24m 418y)	Clear	None.
O/B 10 Grahams Rd (PMT : 24m 315y)	Clear	Parapet Protection works required.
O/B 5a New Hallglen Rd (PMT : 22m 1100y)	Clear	None.
O/B 5 Callander Glen Rd (PMT : 22m 924y)	Foul	Re-decking required.
O/B 3 Knowehead Farm (PMT : 22m 682y)	Foul	Re-decking required.
O/B 2a Water Trough (PMT : 21m 1738y)	Clear	Parapet Protection works required.
O/B 2aa Pipe Bridge (PMT : 21m 1733y)	Clear	Parapet Protection works required.

Location	Clear / Foul	Assessed Works Required
O/B 2 Burrells Road (PMT : 21m 1694y)	Clear	Parapet Protection works required.
O/B 1c Footbridge (PMT : 21m 1672y)	Clear	Parapet Protection works required.
O/B 1b Pipe Bridge (PMT : 21m 1584y)	Clear	Parapet Protection works required.
O/B 1a Footbridge (PMT : 21m 1530y)	Clear	Parapet Protection works required.
O/B 1 Main St Redding (PMT : 21m 1496y)	Foul	Re-decking required.
O/B 081 / 001 GHL 1000	Foul	Re-decking required.

Appendix 12

SUMMARY OF STRUCTURES WORKS : DIVERSIONARY ROUTE 3

Cowlairs South Jcn / Springburn / Gartcosh / Cumbernauld / Greenhill Lower Jcn

Location	Clear / Foul	Assessed Works Required
O/B 2a A803 Road (SGN : 0m 520y)	Clear	None.
O/B 3 Springburn Rd (SGN : 0m 750y)	Clear	Parapet Protection works required.
O/B 3a S'burn Stn F/B (SGN : 0m 760y)	Clear	None.
O/B 68a Broomfield Rd (CBD2 : 102m 910y)	Clear	Parapet Protection works required.
O/B 68 Broomfield Rd (CBD2 : 102m 880y)	Foul	Re-decking required.
O/B 70b F/B (CBD2 : 101m 1672y)	Clear	None.
O/B 71a Robroyston Dr (CBD2 : 101m 1410y)	Clear	None.
O/B 72 Hospital F/B (CBD2 : 101m 462y)	Foul	Footbridge replacement
O/B 73 Station Rd (CBD2 : 100m 1694y)	Foul	Re-decking required.
O/B 74 Cumbernauld Rd (CBD2 : 100m 198y)	Foul	Re-decking required.
O/B 75 Cardowan Rd (CBD2 : 99m 1320y)	Clear	None.
O/B 76 High C'dowan Rd (CBD2 : 99m 770y)	Foul	Re-decking required.
O/B 77 Distillery Rd (CBD2 : 98m 1600y)	Foul	Re-decking required.
O/B 80a Gartcosh Rd (CBD2 : 97m 1030y)	Clear	None.
O/B 80 Hallbrae (SCM3 : 99m 44y)	Foul	Re-decking required.
O/B 79 Mudycroft Rd	Clear	None.
O/B 76	Clear	None.
O/B 75b Cumbernauld (SCM3 : 100m 1514y)	Clear	None.
O/B 75a Cumbernauld (SCM3 : 100m 1561y)	Clear	None.

Location	Clear / Foul	Assessed Works Required
O/B 75 Cumbernauld (SCM3 : 100m 1601y)	Clear	Parapet Protection works required.
O/B 74a Footbridge (SCM3 : 100m 1655y)	Clear	Parapet Protection works required.
O/B 74 Cumbernauld (SCM3 : 101m 330y)	Foul	Re-decking required.
O/B 73 C'nld Stn F/B (SCM3 : 101m 440y)	Clear	None.
O/B 71a Footbridge (SCM3 : 101m 1232y)	Clear	None.
O/B 69a Footbridge (SCM3 : 101m 1716y)	Clear	Parapet Protection works required.
O/B 68a Footbridge (SCM3 : 102m 726y)	Clear	Parapet Protection works required.
O/B 66 Arns Road (SCM3 : 103m 176y)	Foul	Re-decking required.
O/B 65ab xxxx (SCM3 : 103m 924y)	Clear	None.
O/B 63 Walton Road (SCM3 : 104m 110y)	Foul	Re-decking required.
O/B 62 Rail over Rail (SCM3 : 104m 1100y)	Clear	None.
O/B 59 Skipton Farm (SCM3 : 105m 1276y)	Foul	Re-decking required.
O/B 58 Dalnair Farm (SCM3 : 105m 1540y)	Clear	None.
O/B 55 Greenhill Rd (SCM3 : 106m 924y)	Clear	None.

Appendix 13

LISTS OF PLANNED NETWORK RAIL RENEWALS

A13.1 Structures

A13.1.1 Core Route

Year	Location	Mileage	Workscope	Interface
2006/07	OB130 Cathedral St	0.0200	Strengthening and Painting	Scope to include parapet protection
2006/07	Qn St HL Station	0.0200 to 0.0300	Drainage	None
2006/07	Qn St HL Tunnel	0.0330 to 0.1320	Brickwork Repairs	None
2006/07	UB105 Garngaber	6.1486 to 6.1585	Masonry Repairs and Waterproofing	None
2006/07	Falkirk High Tunnel	21.0770 to 22.0770	Brickwork Repairs	None
2006/07	Falkirk High Tunnel	22.1184	Earthwork Repairs and Drainage at East Portal	None
2006/07	Winchburgh Cutting	33.0341 to 33.1152	Retaining Wall Repairs	Scope to accommodate masts
2006/07	UB15 Almond Valley Viaduct	37.1143 to 38.0010	Masonry Repairs and Ballast Retention Wall	None
2006/07	UB11 Norton Drive	39.1137 to 39.1151	Masonry Repairs	None
2007/08	UB97 Croy Viaduct	10.1654 to 10.1700	Masonry Repairs and Waterproofing	None
2007/08	Boness Junction	26.1473 to 27.0103	Earthwork Repairs	None
2007/08	Craigton	33.0341 to 33.1152	Rockfall Protection Works	Scope to accommodate masts
2007/08	Winchburgh Tunnel	35.0700 to 35.1060	Tunnel Repairs	Linkage with proposed clearance works
2008/09	Dullatur	13.1004	Culvert Replacement	None
2008/09	Craigton	33.0341 to 33.1152	Rockfall Protection Works	Scope to accommodate masts
2009/10	UB8 Ballgreen Road	2.0764 to 2.0778	Bridge Stregthening	None

A13.1.2 Diversionary Route 1

Year	Location	Mileage	Workscope	Interface
2007/08	Haymarket North Tunnel	0.0997 to 1.0209	Brickwork Repairs	Linkage with proposed clearance works

A13.1.3 Diversionary Route 2

Year	Location	Mileage	Workscope	Interface
2006/07	Carmuirs Tunnel	108.0200 to 109.0100	Drainage	Linkage with proposed clearance works

A13.1.4 Diversionary Route 3

Year	Location	Mileage	Workscope	Interface
2006/07	Skipperton Farm	105.1120 to 105.1300	Drainage	None
2006/07	OB 55 Greenhill Road	106.0912 to 106.0925	Reconstruction	Provision of electrification clearances

A13.2 Signalling

A13.2.1 Core Route

Year	Location	Mileage	Workscope	Interface
2008/09	Linlithgow	29.1100	Relay Room Re-Wiring	None
2008/09	Newbridge	38.1300	Relay Room Cable Renewals	None
2008/09	Qn St HL	0.0000	Axle Counter Renewals	None
2008/09	Qn St HL	0.0000	Point Machine Renewals	None

A13.3 Telecommunications

A13.3.1 Core Route

Year	Location	Mileage	Workscope	Interface
2008/09	Greenhill SB	17.640	SPT Concentrator Renewal	None
2009/10	Polmont SB	24.1320	SPT Concentrator Renewal	None
2008/09	Bishopbriggs / Lenzie / Croy	n/a	Station LLPA Renewal	None
2010/11	Falkirk High / Polmont / Linlithgow	n/a	Station LLPA Renewal	None

A13.3.2 Diversionary Route 2

Year	Location	Mileage	Workscope	Interface
2010/11	Camelon / Falkirk Grahamston	n/a	Station LLPA Renewal	None

A13.3.3 Diversionary Route 3

Year	Location	Mileage	Workscope	Interface
2008/09	Stepps	n/a	Station LLPA Renewal	None

A13.4 Track : Switches and Crossings

A13.4.1 Core Route

Year	Location	Mileage	Workscope	Interface
2006/07	Cowlairs West Junction	1.1370 to 1.1550	Entire Renewal	None : Like for Like Renewal Proposed
2008/09	Cadder East	5.750 to 5.880	Entire Renewal	None : Like for Like Renewal Proposed
2008/09	Newbridge Junction	38.1320 to 38.1450	Entire Renewal	Renewal as Double Junction Proposed as A2B Advance Works
2009/10	Cowlairs East Junction	1.1370 to 1.1550	Entire Renewal	None : Like for Like Renewal Proposed
2009/10	Eastfield	2.0300 to 2.0400	Entire Renewal	None : Like for Like Renewal Proposed
2009/10	Boness Junction	27.0380 to 27.0450	Entire Renewal	None : Like for Like Renewal Proposed
2010/11	Greenhill Upper Junction	17.0500 to 17.0700	Entire Renewal	Renewal in re-modelled form being considered to allow higher turnout speeds.
2010/11	Winchburgh Junction	34.0990 to 34.1190	Entire Renewal	Being renewed under EARL project further to the north.
2010/11	Princes Street Gardens	0.0500 to 0.0780	Entire Renewal	None : Like for Like Renewal Proposed

A13.4.2 Diversionary Route 2

Year	Location	Mileage	Workscope	Interface
2009/10	Carmuirs East Junction	25.1690 to 26.0060	Entire Renewal	None : Like for Like Renewal Proposed

A13.4.3 Diversionary Route 3

Year	Location	Mileage	Workscope	Interface
2007/08	Garnqueen North Junction	97.0100	Entire Renewal	Proposed Re-modelling to allow higher speeds in Glasgow to Cumbernauld direction.
2009/10	Greenfoot Loop Connections	97.0275 to 97.1300	Entire Renewal	None : Like for Like Renewal Proposed

A13.5 Track : Plain Line

A13.5.1 Core Route

Year	Location	Mileage	Workscope	Interface
2006/07	Haymarket West : Down Line	44.0900 to 44.1560	Re-Rail and Re-Sleeper	None
2006/07	Norton Bridge : Up Line	38.1440 to 39.1320	Re-Rail and Re-Sleeper and Drainage	None
2007/08	Cowlairs : Up Line	1.1530 to 2.280	Re-Rail and Re-Sleeper	None
2007/08	Haymarket : Down Line	1.0406 to 45.1600	Re-Rail and Re-Sleeper and Drainage	None
2007/08	Haymarket : Up Line	45.1120 to 45.1480	Re-Rail and Re-Sleeper and Drainage	None
2008/09	Castlecary : Up Line	16.0000 to 16.1670	Re- Ballast and Re-Sleeper	None
2008/09	Croy : Up Line	12.0380 to 13.0040	Re- Ballast and Re-Sleeper	None
2008/09	Dullatur : Down Line	13.1500 to 14.0210	Re- Ballast and Re-Sleeper	None
2008/09	Lime Road : Up Line	20.0200 to 20.0800	Re- Ballast and Re-Sleeper	None

A13.5.2 Diversionary Route 2

Year	Location	Mileage	Workscope	Interface
2008/09	Falkirk Grahamston : Down Line	24.0550 tp 24.1460	Re-Rail, Re-Sleeper and Re-Ballast	None
2008/09	Redding : Down Line	21.0820 to 22.0340	Re-Rail and Re-Sleeper	None

A13.5.3 Diversionary Route 3

Year	Location	Mileage	Workscope	Interface
2007/08	Cumbernauld : Up Line	101.0580 to 101.0880	Re-Rail, Re-Sleeper and Re-Ballast	None
2007/08	Cumbernauld : Up Line	101.0880 to 101.1330	Re-Sleeper and Re-Ballast	None
2008/09	Allandale : Up Line	104.1060 to 105.0100	Re-Rail, Re-Sleeper and Re-Ballast	None
2008/09	Allandale : Down Line	104.1060 to 105.0100	Re-Rail, Re-Sleeper and Re-Ballast	None
2008/09	Garnkirk : Up Line	98.0100 to 99.0000	Re-Rail, Re-Sleeper and Re-Ballast	None
2008/09	Garnkirk : Down Line	98.0100 to 99.0000	Re-Rail, Re-Sleeper and Re-Ballast	None

A13.6 Plant

No renewals planned.

RISK REGISTER

Risk	Risk Title	Risk Description	Risk Impact	Probability	Impact	Score
1	Insufficient gauging clearance in tunnels	Insufficient gauging clearence in tunnnes to allow for electrification.	Tunnel blockade will need to be extended at Haymarket and Winchburgh tunnels.	4	5	20
2	A-B doesn't deliver sufficient infrastructure	A2B / Waverly does not deliver (or is delayed in delivering) sufficient infrastructure to enable		3	5	15
3	Structural stability of tunnels and bridges	Newbridge 36 arch (listed) and Castlecary.Structural stability of tunnels and bridges may be variable -		3	2	6
4	Additional works	Additional works to current bridges to protect OHLE, e.g parapet raising, enhancements etc. May		3	2	6
5	De-stabalisation of slopes	Destabalisation of slopes as a result of de-vegetation		2	3	6
6	Uncertain ground conditions	Uncertain ground conditions, over and above what was agreed in contract, results in a change of method for slope stability, track support, foundations for signals, platforms and retaining		3	3	9
7	Waterproofing of bridges insufficient	After building railway it is discovered that waterproofing of bridges is insufficient to allow for electrification.	Train delays and additional costs to undertake waterproofing in wet tunnels	4	2	8
8	Discover unforseen mining	Discover unforseen mining voids/disused mineworkings when commencing construction works	Remedial works and project delay	3	2	6
9	Electrification for structures	Electrification for structures unable to fit to restricted retainer walls and cuttings due to poor conditions		2	2	4
10	Location of structures affected by cess condition	May not have sufficient space to place structures where we want due to condition of cess	May need more land for construction, maintenance etc	2	2	4
11	Track lowering/slue unnachievable	Track lowering/ slue unnachievable		2	5	10
12	Track drainage alterations not considered.	Track drainage alterations not considered.	May result in additional unprogrammed works and operational issues	2	3	6
13	Drainage positions unkown	Drainage positions unknown which may result in burst pipes.	Construction risk	2	2	4
14	Provider unable to me NR timescales	Provider (Scottish Power) unable to provide supply to meet NR timescales and in locations required	Power supply not provided on time delaying programme	2	5	10
15	Relocation of new OHLE kit	Failure to adequately assess position of new OLE kit in relation to the position of the signal, ie,		2	2	4
16	Telecomms infrastructure doesn't support SCADA	Telecomms infrastructure may not support SCADA resulting in capacity issues		1	5	5
17	Earthing/ Bonding impacts on infrastructure	Earthing and bonding may impact on railway infrastructure e.g. may impact on telecomms, signalling etc	May find a relay room to close to the railway. May be unable to conduct bonding. May require additional design etc	4	2	8
18	Interfaces with other people	Project may result in interface issues with other people e.g. utilities(gas pipe, power cable),	May require utility diversion and alterations. May impact on programme and operational railway.	4	3	12
19	HMRI Approval	Failure or delay to gain HMRI approval for electrification of line.		1	4	4
20	Interface with existing network	Interfacing with other schemes which do not have passive provision may result in all	Additional costs .	2	5	10
21	Signal structure may need to be moved	Signal structure may need to be moved due to signal sighting		4	2	8
22	Exisitng line side circuits may need immunised	Existing signalling from Winchburgh to Greenhill-Existing line side circuits may need		3	2	6
23	Availability of source records	Source records may not be available (EARL project may have possession of them)		4	2	8
24	Source records not accurate	Existing source records may not be accurate reflection of site.		2	2	4
25	Immunsiation of Track Circuits.	May need to immunise Track Circuits.		3	1	3
26	High induced volts on cables	High induced volts on cables due to electrification.	Impact on staff safety. May result in wrong side failures and delays.	5	2	10
27	Cable routes	May be required to move cable routes due to location of masts-dependant on slack.	May result in insufficient capacity	5	2	10
28	Signal screening	May need to find alternative solution to signal screening due to inability to screen		3	2	6
29	May need to move FTN/GSMR equipment	May need to move exisitng FTN/GSMR (telecomms) equipment		2	2	4
30	May be required to obtain product approvals	May be required to obtain product approvals for telecomms equipment		2	1	2
31	May need to change FTN design	May be required to change FTN design to meet electrification.	If not completed may result in failure to run the railway.	0	0	0
32	Queen Street St NRN system unsuitable	Queen Street Station telecomms (NRN) system may need to be moved due to unsuitability.		0	0	0
33	May not obtain 4 Ohms required	May not obtain four ohms required for earthing and screening	Requirement for additional earthworks	4	2	8
34	OHLE compensation sysetm not optimised	Overhead line equipment compensation system not optimised resulting in failure of	Failure of signalling and telecomms systems	1	5	5
35	Land compensation costs	Land compensation costs greater than allowed for in estimate.	Additional costs and pssible delays	2	2	4
36	Access issues	May not get required access points to work sites.		0	0	0
37	Failure to complete electrification on time	Failure to complete electrification by end of 2011 resulting in failure to complete EARL.	May result in additional costs for acceleration.	2	5	10
38	Listed Building Consent	Failure or delay in obtaining listed building consent for Queen Street Station and Viaducts.		2	2	4
39	Position of signals in relation to rolling stock	Position of signals in relation to rolling stock may need to be altered.		0	0	0
40	Station alteration	May be required to make alterations to a number of stations to accommodate equipment, e.g.		2	1	2
41	Environmental contraints	Environmental constraints e.g tree vegetation, noise, pollutions and adverse weather. May be identified		3	1	3
42	Interoperability issues need to be examined	Interoperability issues need to be examined		0	0	0
43	Failure to obtain Scotish Power buy in	Failure to obtain Scottish Power buy in		0	0	0
44	Resource availability	Lack of Network Rail and contractor resources.		3	4	12
45	Price volatilty	Price volatility, e.g. copper		0	0	0