West Coast Main Line Modernisation

Feasibility Study

Final Report

NOT HMRC
PRIVATE & CONFIDENTIAL

WCML Development Company Limited

RAILTRACK
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>5</td>
</tr>
<tr>
<td>GLOSSARY</td>
<td>6</td>
</tr>
<tr>
<td>1. BACKGROUND AND STRUCTURE OF THE REPORT</td>
<td></td>
</tr>
<tr>
<td>1.1 West Coast Main Line</td>
<td>8</td>
</tr>
<tr>
<td>1.2 The Need for Modernisation</td>
<td>8</td>
</tr>
<tr>
<td>1.3 Previous Studies</td>
<td>9</td>
</tr>
<tr>
<td>1.4 What has Changed?</td>
<td>10</td>
</tr>
<tr>
<td>1.5 Appointment of the Feasibility Study Team</td>
<td>11</td>
</tr>
<tr>
<td>1.6 Terms of Reference</td>
<td>13</td>
</tr>
<tr>
<td>1.7 Report Structure</td>
<td>14</td>
</tr>
<tr>
<td>2. WCML - EVOLUTION AND CURRENT STATUS</td>
<td></td>
</tr>
<tr>
<td>2.1 Historical Perspective</td>
<td>16</td>
</tr>
<tr>
<td>2.2 The WCML Network Today</td>
<td>17</td>
</tr>
<tr>
<td>2.3 Existing Railtrack Customers</td>
<td>23</td>
</tr>
<tr>
<td>3. BUSINESS OPPORTUNITIES AND FRAMEWORK FOR STRATEGY DEVELOPMENT</td>
<td></td>
</tr>
<tr>
<td>3.1 Opportunities</td>
<td>31</td>
</tr>
<tr>
<td>3.2 Framework for Strategy Development</td>
<td>35</td>
</tr>
<tr>
<td>3.3 Bedrock and Recovery Investment Approaches</td>
<td>36</td>
</tr>
<tr>
<td>3.4 Cost-Driven and Market-Driven Investment Approaches</td>
<td>38</td>
</tr>
<tr>
<td>3.5 Option Evaluation and Sifting Process</td>
<td>40</td>
</tr>
</tbody>
</table>
### 4. EVALUATION OF TECHNICAL OPTIONS AND DEVELOPMENT OF INVESTMENT STRATEGY

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-Driven Investments</td>
<td>41</td>
</tr>
<tr>
<td>Market-Driven Passenger Investments</td>
<td>49</td>
</tr>
<tr>
<td>Market-Driven Freight Investments</td>
<td>57</td>
</tr>
<tr>
<td>Conclusions</td>
<td>59</td>
</tr>
</tbody>
</table>

### 5. INVESTMENT APPRAISAL

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>61</td>
</tr>
<tr>
<td>Appraisal Methodology</td>
<td>62</td>
</tr>
<tr>
<td>Appraisal of Modernisation Options</td>
<td>65</td>
</tr>
<tr>
<td>Appraisal of Market-Driven Options</td>
<td>72</td>
</tr>
<tr>
<td>Overall Conclusions</td>
<td>81</td>
</tr>
</tbody>
</table>

### 6. THE RECOMMENDED STRATEGY

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>83</td>
</tr>
<tr>
<td>The Scheme</td>
<td>83</td>
</tr>
<tr>
<td>Engineering Components of Core Investment Programme</td>
<td>85</td>
</tr>
<tr>
<td>Additional Work for Market-Driven Investments</td>
<td>90</td>
</tr>
<tr>
<td>Contract Strategy</td>
<td>94</td>
</tr>
<tr>
<td>Implementation and Possession Strategy</td>
<td>96</td>
</tr>
<tr>
<td>Construction Programme</td>
<td>96</td>
</tr>
<tr>
<td>Safety</td>
<td>97</td>
</tr>
<tr>
<td>The Contribution of Other Railway Industry Stakeholders to the Strategy</td>
<td>98</td>
</tr>
<tr>
<td>Summary</td>
<td>100</td>
</tr>
</tbody>
</table>
7. SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT

7.1 Introduction ........................................................... 102
7.2 Local Authority Policies ............................................. 102
7.3 Impact on Regional Economic Development .................. 104
7.4 Employment Impact .................................................. 105
7.5 Project Overlap ...................................................... 105
7.6 Environmental Impact Assessment .............................. 106
7.7 Summary ................................................................. 111

8. FUNDING

8.1 Revenue and Cost Considerations ................................. 112
8.2 Proposed Funding Structure ....................................... 113
8.3 Funding Sources ..................................................... 117
8.4 Risk Considerations .................................................. 119

9. INVOLVEMENT OF OTHER RAILWAY STAKEHOLDERS

9.1 Train Operators and their Customers ............................ 121
9.2 OPRAF .................................................................. 122
9.3 ORR .................................................................. 124
9.4 Rail User Consultative Committeess ............................... 125
9.5 Health and Safety Executive ....................................... 125
9.6 Passenger Transport Executives .................................. 125
9.7 ROSCOs and Train Manufacturers ............................... 126
9.8 Equipment Manufacturers .......................................... 126
9.9 Infrastructure Service Companies ................................. 126

10. CONCLUSIONS AND NEXT STEPS

10.1 Conclusions ............................................................ 128
10.2 Programme for Implementation .................................... 130
<table>
<thead>
<tr>
<th>ANNEXES</th>
<th>Statement by the Secretary of State for Transport, dated 1 December 1993</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Communications and Consultation Activities</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>Technical Options Evaluated</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td>Market Demand Models</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>Efficiency Savings</td>
<td>16</td>
</tr>
<tr>
<td>E</td>
<td>Reliability</td>
<td>18</td>
</tr>
<tr>
<td>F</td>
<td>Risk Analysis</td>
<td>20</td>
</tr>
<tr>
<td>G</td>
<td>Economic Evaluation of the Removal of PSRs</td>
<td>23</td>
</tr>
<tr>
<td>H</td>
<td>Command and Control</td>
<td>25</td>
</tr>
<tr>
<td>I</td>
<td>Track</td>
<td>31</td>
</tr>
<tr>
<td>J</td>
<td>Structures</td>
<td>34</td>
</tr>
<tr>
<td>K</td>
<td>Traction Power</td>
<td>37</td>
</tr>
<tr>
<td>L</td>
<td>Operations Simulation</td>
<td>41</td>
</tr>
<tr>
<td>M</td>
<td>Rolling Stock</td>
<td>43</td>
</tr>
<tr>
<td>N</td>
<td>Piggyback</td>
<td>46</td>
</tr>
<tr>
<td>O</td>
<td>Safety</td>
<td>49</td>
</tr>
<tr>
<td>P</td>
<td>Piggyback</td>
<td>49</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>After Page Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig 1.1</td>
<td>Railtrack's Position in the New Railway Industry</td>
</tr>
<tr>
<td>Fig 1.2</td>
<td>Scope of Feasibility</td>
</tr>
<tr>
<td>Fig 2.1A, B</td>
<td>Route Schematic</td>
</tr>
<tr>
<td>Fig 2.2</td>
<td>OHLE Type and Date of Electrification</td>
</tr>
<tr>
<td>Fig 3.1</td>
<td>Piggyback Illustration</td>
</tr>
<tr>
<td>Fig 3.2</td>
<td>Piggyback Consortium Proposed Route</td>
</tr>
<tr>
<td>Fig 3.3</td>
<td>Overview of Sifting Process</td>
</tr>
<tr>
<td>Fig 4.1A,B,C</td>
<td>Types of Train Control System</td>
</tr>
<tr>
<td>Fig 4.2</td>
<td>Illustration of Tilting Trains</td>
</tr>
<tr>
<td>Fig 4.3</td>
<td>Linespeed/Train Performance</td>
</tr>
<tr>
<td>Fig 4.4</td>
<td>Study Proposal for Initial Piggyback Route</td>
</tr>
<tr>
<td>Fig 4.5</td>
<td>Development of an Overall Business Strategy</td>
</tr>
<tr>
<td>Fig 5.1</td>
<td>Route Sections of the Study</td>
</tr>
<tr>
<td>Fig 5.2</td>
<td>Total Engineering Estimates - Risk Analysis</td>
</tr>
<tr>
<td>Fig 6.1</td>
<td>Illustration of Train Control System</td>
</tr>
<tr>
<td>Fig 6.2</td>
<td>Proposed Cab Signalling Control Areas</td>
</tr>
<tr>
<td>Fig 6.3</td>
<td>Possible Power Supply Reinforcement for Market-Driven Options</td>
</tr>
<tr>
<td>Fig 6.4</td>
<td>Relationship of Different Gauges</td>
</tr>
<tr>
<td>Fig 7.1</td>
<td>Population Changes within the Counties covered by WCML (1981-91)</td>
</tr>
</tbody>
</table>
Rules of the Route

Power Signal Box
Permanent Speed Restriction
Passenger Transport Executive
Convention on Wetlands of International Importance
Especially as Waterfowl Habitat (Ramsar 1971)
Rail express systems
Railfreight Distribution
Rolling Stock Leasing Companies
Regional Railways, Central
Regional Railways, North East
Regional Railways North West
Regional Railways South Wales and West
Rules which provide a framework for determining the number of possessions which can be granted at any one time.
A set of parameters upon which the timetable is based.
Signalling and Telecommunications
Swap Body 1 Loading Gauge
System Control and Data Acquisition
Solid State Interlocking
Site of Special Scientific Interest
Trans European Network
Trainload Freight
Train Operating Company
Train Operating Unit
Temporary Speed Restriction
West Coast Main Line
WCML Development Company Ltd
CHAPTER 1

Background and Structure of the Report

1.1 WEST COAST MAIN LINE

The West Coast Main Line (WCML) is Great Britain's busiest mixed-traffic railway corridor. It runs from London's Euston Station to Birmingham, Manchester, Liverpool and Glasgow and also connects with Edinburgh. The line crosses 16 counties or regions in England and Scotland which have a population of approximately 16 million. It provides connections to most key towns and cities in the West Midlands, the North West, north Wales and western Scotland and also to the ports of Holyhead, Liverpool and Stranraer for Anglo Irish traffic. The line is used by more than 2,000 trains per day, carrying both passengers and freight, and represents around 12% of Railtrack revenue. Annual traffic is approximately 5 billion passenger-km and 5.5 billion freight gross tonne-km.

1.2 THE NEED FOR MODERNISATION

Originally built in the 1830s and 1840s, the WCML was the first intercity railway in the world. Parts of the line were widened, to four tracks, in the first half of this century, and electrified over the period 1955-75. There has been some subsequent replacement of signalling equipment as it has become life expired, and of track components as they wear out. In addition, work has been undertaken to enlarge tunnel and bridge clearances for European Passenger Services (EPS) and 'swap body' freight trains using the Channel Tunnel, and to construct international freight terminals at Lawley Street (Birmingham), Mossend (Glasgow), Trafford Park (Manchester), and Willesden (London).

Otherwise the line has not changed much in the last 20 years. There has, however, been an increasing recognition that the infrastructure is life expired and in need of major equipment renewal.

The need for modernisation arises also because of:
the deteriorating competitive position of the WCML in relation to air travel (particularly on the key London-Manchester route);

- the public policy need to encourage modal shift from road to public transport for environmental reasons, as recommended by the recent report of the Royal Commission on Environmental Pollution1;

- the opportunity for long-distance freight by rail opened up by the Channel Tunnel.

1.3 PREVIOUS STUDIES

Since the line was electrified there have been several proposals to reduce journey times, to improve reliability, and to increase capacity and clearances for freight. Most of the proposals have not been implemented, for a variety of different reasons.

In the late 1960s and early 1970s British Rail (BR) developed the 'advanced passenger train' (APT), designed to achieve faster speeds on existing track using 'active tilt' technology. The concept was sound but the APT was not brought into service due to unreliability, largely as a result of the less advanced control technology available at that time.

In the late 1980s BR Intercity developed a £750-900 million scheme for complete line modernisation, including resignalling, renewal of the overhead electrification, substantial track replacement and purchase of new Intercity 250 rolling stock. This culminated in a full competitive tender for the supply of new trains, but eventually did not proceed because of funding constraints.

BR Intercity later submitted a bid for new Intercity 225 trains for use on the WCML, but this was rejected in favour of a competing proposal for Networker trains.

1 Transport and the Environment, CM 2674, HMSO (1994)
1.4 WHAT HAS CHANGED?

There have been many changes since the last modernisation proposals were developed. The entire rail industry has been restructured as the first step towards privatisation. Ownership of the infrastructure has transferred to Railtrack, while passenger and freight train operations will become the responsibility of separate companies. An Office of Passenger Rail Franchising (OPRAF) has been created as the main channel for public subsidy, and a Rail Regulator (ORR) has been appointed to encourage competition within the industry, ensure fair play and protect the interests of the consumer. As Railtrack has responsibility for safety, inter-working within the network and the timetable, its position is central within the new structure of the industry. This is shown in Figure 1.1.

Figure 1.1: RAILTRACK'S POSITION IN THE NEW RAILWAY INDUSTRY
(arrows indicate principal funding flows)
In addition to the restructuring of the industry, other significant changes have taken place:

- The Government's Private Finance Initiative (PFI) facilitates greater private sector involvement in the funding of public sector projects.

- Private sector consortia have emerged who are prepared to take responsibility for the design, finance, building, maintenance and operation of large infrastructure projects.

- Advances have been made in technology in areas such as train control systems which offer wide-reaching benefits, new rolling stock concepts for freight operation and tilting passenger trains which are now proven and operating in several European countries.

- The Channel Tunnel created new opportunities for high-speed passenger flows and long-distance freight traffic where rail can compete better with road and ferry. The WCML has secured Priority 1 status on the European Commission's Trans European Network, in recognition of its importance in providing closer links, via London and the Channel Tunnel, between the member states and in reaching three Objective 1 regeneration areas.

- Motorway tolling and road congestion pricing have moved up the national agenda and, if implemented, would improve rail's competitive position. This is particularly pertinent in the light of the recent Royal Commission report on transport and environment (see footnote 1).

1.5 APPOINTMENT OF THE FEASIBILITY STUDY TEAM

The then Secretary of State for Transport, John MacGregor, announced in a statement on 1 December 1993 that:

"Railtrack will be responsible for project definition and will draw up performance standards for the line in association with the private sector. Railtrack will be inviting expressions of interest in the next few days."
Once the new performance standards have been set, a competition will be held...to select a private sector consortium to modernise the line and to maintain it for a definite period. The responsibility for project management and design will also rest with the successful consortium.

The successful consortium will be remunerated by service payments from Railtrack during the contract period. These payments will be subject to penalties and bonuses linked to the performance of the consortium in meeting the new performance standards and the consequential impact on revenue losses and gains on the line.

The new standards will stipulate minimum performance criteria. Where commercially justified, the InterCity West Coast franchisee (and, possibly, other train operators) will be able to contract for linespeed and other improvements in exchange for increased access charge payments.2

Following the statement from the Secretary of State, Railtrack began the search for a private sector partner with whom to carry out a feasibility study into the modernisation of the WCML. Of the 42 groups that expressed an interest in the Study, 14 were selected for detailed consideration. Six were invited to submit formal proposals, and interviews were held during March 1994. WCML Development Company Limited (WCML Dev Co) was selected on 24 March 1994.

WCML Dev Co is a consortium of private companies formed specifically to invest in modernising the WCML. Its members include: Babcock & Brown, specialists in transport project finance and leasing; Booz-Allen & Hamilton, management and technology consultants with particular experience in advanced train control, signalling and communication systems; Brown & Root, engineers and constructors with experience in managing major multi-disciplinary projects; and Sir Alexander Gibb & Partners, a leading civil engineering and railway consultancy.

The Study was undertaken by WCML Dev Co in partnership with Railtrack. Specialists from Railtrack were dedicated to the Study to form an integrated, co-located team. Direction and oversight were given by a joint steering committee comprising senior executives of the above four companies and Railtrack. This study thus represents an

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2 The complete text of Mr MacGregor's statement is provided in Annex A
outstanding example of the railway and the private sector working successfully together.

1.6 TERMS OF REFERENCE

The terms of reference for the Study as set out by Railtrack were to use a business-led approach, combined with a balance of managerial, commercial and technical skills, to assess all options for the privately financed modernisation and upgrading of the WCML and to provide innovative solutions. The extent of the network covered by the Study remit is shown in Figure 1.2.

Specifically, the Study team was to:

1. Identify the market demand for modernisation and upgrading, taking account of the structure of the new railway industry and the effect of competition among train operators;

2. Consider:
   - financial return,
   - business risk,
   - reliability,
   - capacity,
   - safety,
   - disruption,
   - environmental impacts,
   - user and non-user benefits;

3. Evaluate a range of business strategies and technology options;

4. Determine the most appropriate generic technologies to meet market needs for use in the modernisation and upgrading but without locking into proprietary products;

5. Define a financial and commercial structure that recognises and complements Railtrack's own long-term goals up to 2025, and enables it to earn a reasonable return on its assets;

6. Define an implementation programme to deliver benefits as soon as possible, while minimising costs and disruption to train services and business both on the WCML and on other routes in the Railtrack network;
FIGURE 1.2:
SCOPE OF FEASIBILITY STUDY

Key
- Scope of Study
- Other Lines
- Channel Tunnel
- Proposed Channel Tunnel Rail Link

Not to Scale
7. Consult widely and inform public opinion so that the chosen strategy can receive public and political support;

8. Complete the Study by the end of 1994, including preparation of outline specifications sufficient for Railtrack to award contracts for the implementation phase on a competitive basis.

Railtrack is the owner of the railway infrastructure but does not own or operate trains. As a result it cannot commit to actual operation of a railway service. However, Railtrack is strongly committed to meeting the needs of its customers, the Train Operating Units (TOUs), in providing high quality services to their passengers and freight customers. The Study therefore investigated the railway services that might reasonably be attractive if provided in a commercial partnership between the operators, rolling stock leasing companies (ROSCOs) and Railtrack.

1.7 REPORT STRUCTURE

Chapter 2 of this report reviews the WCML historically and as it is today. The route and its many aspects are described, as are the current and potential customers, both passenger and freight.

Chapter 3 discusses the potential business opportunities for the WCML. These opportunities were based upon the views of customers, which were ascertained through extensive consultations, referred to in Annex B. It goes on to introduce the four approaches to investment, Bedrock, Recovery, Cost-Driven and Market-Driven, which were used as a framework for the specification and testing of various technical options.

Chapter 4 reviews the technical content of Cost-Driven and Market-Driven strategies in depth and sets out packages of proposals for fuller evaluation.

Chapter 5 examines the financial and economic benefits of the alternative packages and recommends a scheme which draws on the best features of each of them. Sensitivity analysis of the revenue streams and quantitative risk assessment of the associated costs were employed to test the robustness of the proposals.

Chapter 6 describes the recommended scheme in depth, including technical definition, an implementation programme, and the
implications for railway users. This section also addresses safety issues, and methods for minimising disruption to services during the work. The specific impacts of the scheme on other organisations in the new railway industry are also discussed.

Chapter 7 examines the socio-economic, regional development and environmental impacts of the scheme on the areas served by the line, and the potential implications for policymakers at Brussels, Strasbourg, Westminster and Whitehall.

Chapter 8 examines contracting and funding options and the basis of a possible payment strategy.

Chapter 9 discusses the wider implications of the proposed project for the other players in the restructured railway industry and their interfaces with Railtrack.

Chapter 10 identifies the next steps for Railtrack to take towards implementation of the recommended strategy.

Further details on specialist aspects are included in annexes to this report.
CHAPTER 2

WCML - Evolution and Current Status

2.1 HISTORICAL PERSPECTIVE

The WCML was built in stages, beginning with the London and Birmingham Railway in 1836. The next three decades witnessed the extensive building of independently promoted lines, culminating in a network, more or less in its present form.

Many of the greatest names in railway engineering were involved in promoting and building the line, including Joseph Locke, William McKenzie and Robert Stephenson. Although the maximum speed was to be 65 km/h (40 mph), curve radii were rarely less than one mile, without which it would not have been possible gradually to increase speeds to the present limits. These railway pioneers built well and numerous bridges, retaining walls, tunnels and viaducts continue to serve today.

Beginning in the mid-1950s, the line was modernised in the manner of the day. This consisted of conversion from steam to electric traction, installation of power signal boxes in the most busy areas, complete rebuilding of several major stations including London Euston and Birmingham New Street, and the construction of a number of flyovers at perceived congestion points. However, at other places, existing track layouts were electrified without any rationalisation.

Once the work was completed, the WCML became the only direct passenger route from London to the West Midlands and North West England. The newly electrified passenger services, from London to Birmingham, Manchester and Liverpool, attracted additional customers. New air conditioned carriages and speeds of 145 km/h (90 mph) to 160 km/h (100 mph) were considered very attractive at the time. With a modest increase in the mid-1980s to a maximum speed of 175 km/h (110 mph), the services remain competitive with air travel for short and medium-length journeys between city centres. Two new stations were developed, at Birmingham International, serving both the airport and adjacent National Exhibition Centre (NEC), and at
Milton Keynes, adjacent to the new city centre. Both have attracted substantial traffic to the railway.

The market for rail freight has increasingly been subjected to competitive forces and has continued to lose market share to roads. However, in absolute terms, the value and tonnages carried by rail over the last 10 years have remained roughly constant, as the overall size of the market has been increasing. In the early 1960s BR progressively withdrew from the wagon-load freight business. Instead, it invested heavily, and successfully, in the development of Freightliner, a network of 'liner trains' carrying standard height containers between specially built terminals.

Recently, international freight services have commenced on the WCML to Wembley European Freight Operations Centre (EFOC), then via the West London Line to the Channel Tunnel. Structure gauge has been enlarged to accommodate the carriage of swap body intermodal freight units, and several 'freight villages' are being developed along the line.

### 2.2 THE WCML NETWORK TODAY

#### 2.2.1 The Route

The WCML is actually a network of lines extending from London Euston to Glasgow Central, with various branches and loops. Altogether, the WCML comprises roughly 1,100 km (690 miles) of route with some 3,000 km (1,900 miles) of track. Route maps including adjoining lines are shown in Figures 2.1A and 2.1B, including passenger and freight destinations respectively.

#### 2.2.2 Track and Formation

The original track formation dates from the early 19th century, although the line from London to Roade, north of Milton Keynes, was widened in the 1920s to four tracks. Extensive track and formation rehabilitation was undertaken as part of modernisation in the 1960s. However, there has never been a comprehensive reconstruction of the subgrade or refurbishment of the drains. As a consequence, the ballast depths are substandard over much of the route, and the formation remains susceptible to movement and subsidence, which makes it difficult to maintain a high-quality vertical alignment.
FIGURE 2.1A:
ROUTE SCHEMATIC

GLASGOW
Motherwell
Dumfries
Carlisle
Heysham
Blackpool
LIVERPOOL
Wigan
Warrington
Widnes
Crewe
Macclesfield
Kidsgrove
Stoke
Wolverhampton
BIRMINGHAM
Coventry
Rugby
Northampton
Roade
Milton Keynes
Bletchley
Oxford
Croxley Green
Watford
LONDON

Key
- Scope of Feasibility Study
- Other Lines
FIGURE 2.1B:
ROUTE SCHEMATIC

Key

▲ Existing Freight Depots
△ Possible Freight Depots
● Traction Depots
— Junctions
A high proportion of the track has been converted to continuous welded rail, with pre-cast concrete sleepers. Track replacement continues on roughly a 15-year cycle subject to funding constraints. Sleepers and ballast in many places are life expired. Replacement rates vary widely, depending upon the use of the line. Maximum linespeeds range from 145 km/h (90 mph) to 175 km/h (110 mph), depending upon other conditions including signalling, power supply and curvature.

The WCML was not built with any serious expectation that trains would ever operate at speeds above 100 km/h (60 mph). As a result, the distance between parallel tracks, the separation of tracks from retaining walls, and the size of tunnel bores are often below modern standards for current linespeeds, even though satisfactory for present operations.

A second consequence of the close track spacing is the lack of personnel safety clearance between the fast and slow lines. This means that even fairly basic maintenance work requires two or even three tracks to be shut down or a large number of lookout men to be employed, in order to provide adequate safety. This has an impact on both operating performance and maintenance costs.

2.2.3 Permanent Speed Restrictions

There are several locations where curvature determines the top speed at which trains can be operated. These locations give rise to permanent speed restrictions (PSRs). PSRs are also in place at some stations, junctions and tunnels.

There are opportunities at many PSRs to realign the track within the existing corridor but, in some instances, requiring land acquisition and consents. These works would provide journey time savings but are generally expensive.

The principal PSRs between London and Crewe are listed in Table 2.1.

Between Crewe and Lancaster there are a further seven PSRs. North of Lancaster there are long sections of track which are subject to speed restrictions because of the topography. On some of the branches and diversionary lines there are also substantial lengths of line affected by PSRs.
Table 2.1: PRINCIPAL PSRs BETWEEN LONDON AND CREWE

<table>
<thead>
<tr>
<th>Location</th>
<th>Speed Limit (km/h)</th>
<th>Cause of Speed Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euston Approach (0-4 km)</td>
<td>various</td>
<td>various; including curvature, air pressure in tunnel, track layout</td>
</tr>
<tr>
<td>Euston Approach (4-10 km)</td>
<td>various</td>
<td>various; including curvature, air pressure in tunnel</td>
</tr>
<tr>
<td>Berkhamsted</td>
<td>160</td>
<td>curvature</td>
</tr>
<tr>
<td>Linslade</td>
<td>145</td>
<td>curvature, air pressure in tunnel</td>
</tr>
<tr>
<td>Stowe Hill Tunnel and Weedon</td>
<td>160</td>
<td>curvature, air pressure in tunnel</td>
</tr>
<tr>
<td>Rugby Station</td>
<td>120</td>
<td>track layout</td>
</tr>
<tr>
<td>Nuneaton Station</td>
<td>160</td>
<td>track layout</td>
</tr>
<tr>
<td>Atherstone</td>
<td>145 (down direction)</td>
<td>curvature</td>
</tr>
<tr>
<td>Colwich to Stafford</td>
<td>120</td>
<td>curvature, air pressure in Shugborough tunnel</td>
</tr>
<tr>
<td>Norton Bridge</td>
<td>145</td>
<td>curvature</td>
</tr>
<tr>
<td>Crewe Station</td>
<td>125</td>
<td>track layout</td>
</tr>
</tbody>
</table>

2.2.4 Electrification

The WCML was the first main line railway in Great Britain to be electrified with the 25 kV overhead line system. The first stage of electrification was in the Manchester area in 1959-60. The main line south of Weaver Junction and the branches to Birmingham, Manchester and Liverpool, were electrified between 1960 and 1966. From Weaver Junction to Glasgow the line was electrified in the early 1970s. The types and dates of electrification are shown in Figure 2.2, from which it can be seen that much of the electrical equipment is now 30 years old.

The overhead gantries, catenary and most of the contact wire are generally still in reasonable order and, for the current linespeed, do not require immediate or comprehensive replacement. The feeder system, however, was not designed for the power demands of the most modern electric locomotives/multiple units. In addition, the electrical remote control equipment consists of obsolete technology and is becoming increasingly difficult to maintain in a reliable condition.

2.2.5 Signalling

Most of the line was resignalled at the same time as electrification was carried out. This was usually done by installing power signal boxes.
FIGURE 2.2:
OHLE TYPE & DATE OF ELECTRIFICATION

Key:
- Mark 1
- Mark 3A
- Mark 3B
- Not Electrified
(PSBs). Early PSBs were limited to a few route miles, but later designs cover up to 135 km (85 miles) of route. Numerous manual signal boxes remain, often controlling level crossings. Some of these are almost a century old, although they were modified at the time of electrification to protect against interference from electric traction. Altogether the line has 25 PSBs and a further 31 manual boxes, with a total of 350 signalling staff employed to give 24-hour coverage.

Several different types of PSBs were installed in the 1950-60s, and some are now suffering serious deterioration of wiring insulation. Many spare parts are no longer manufactured, which is making maintenance increasingly difficult.

Trains are detected by conventional track circuits. Although the technology is proven and safe, the thousands of track circuits on the WCML are expensive to maintain and a major cause of unreliability. The signals and associated track circuits constitute an extensive lineside infrastructure of equipment cabinets, power supplies, cables and cable routes. These are exposed to deterioration and vandalism, including theft, and are a considerable maintenance burden.

2.2.6 Control and Train Regulation

Control of today's WCML is distributed between the 56 signalling boxes referred to above, four electrical control rooms and an operations control centre located at Crewe. In all some 500 staff are required to provide continuous cover for the three disciplines including the 350 signalling staff referred to above.

The logistics of communicating managerial decisions in this environment is considerable and the process requires a large supporting infrastructure. This, too, is a major maintenance burden.

2.2.7 Points and Crossings (P&C)

There are over 2,000 units of P&C on the WCML. These were located to meet traffic patterns which have now changed. Some are now redundant, but have not been removed. Even when they have been, the signalling configuration often still reflects their presence. For example, there are some 157 points at Euston, arranged so as to allow trains arriving on any track to go into any platform, and to provide for carriages to be removed or added to any train and/or returned to the sidings. In practice, most trains now operate as fixed configurations, and platforms are dedicated to specific service groups which almost
always use the same lines.

The many redundant or under-used P&C units are a substantial maintenance burden. They are also a major contributory cause to unreliability.

2.2.8 Structures (Bridges and Tunnels)

The line includes some 60 tunnels totalling approximately 40 km in length, almost 1,400 overbridges, some 1,300 underbridges, and more than 100 viaducts. Many structures are in a poor state of repair and some of the older overbridges do not meet modern standards for highway loading or parapet strength.

If well maintained, the structures could have a reasonable life. It would, however, be prudent to maintain some of them in a better state of repair, to arrest decay and therefore avoid later replacement which would prove more costly.

2.2.9 Level Crossings

The WCML has relatively few road level crossings apart from in the Coventry and Wolverhampton corridor and on the Macclesfield to Colwich Junction line where they have significant safety implications. Permanent closure is not practical for a number of these, and the construction of grade separation would be difficult and might require extensive landtake.

2.2.10 Freight Infrastructure

The WCML is Britain's busiest rail freight artery carrying about 50 million gross tonnes of freight per year and over 200 freight trains per day. Besides the substantial traffic along the line, there are also many trains which cross it or which run on it only for a few miles between junctions.

2.2.10.1 Loading Gauge

Currently, the routes to main freight terminals are cleared to the Swap Body 1 (SB1) loading gauge, which allows the carriage of swap body intermodal units travelling through the Channel Tunnel. SB1 gauge also allows the operation of trains carrying International Standards Organisation (ISO) containers, such as those operated by Freightliner, and a wide range of specialised freight wagons, such as car carriers,
tankers, etc. As with the rest of the British railway network, there is not sufficient clearance for trains carrying standard lorry trailers such as piggyback or for the 9'6" high containers which are increasingly common on shipping routes.

2.2.10.2 Traction

Until quite recently, BR used electric traction wherever possible, even if this meant two or more changes of locomotive on a journey. Freight operators now have more freedom and are indicating a preference for the use of diesel locomotives on many routes, as they offer more versatility. However, there is a substantial investment in electric freight locomotives, including the new Class 92 multi-voltage locomotives purchased for operation through the Channel Tunnel, so electric freight traction is likely to continue.

2.2.10.3 Freight Depots

There are several freight depots on or close to the WCML, particularly in the West Midlands and the North West. Major terminals are located at Willesden (London), Lawley Street (Birmingham), Trafford Park (Manchester), Garston and Seaforth (Liverpool) and Mossend (Glasgow).

New international, intermodal freight facilities are proposed at Daventry (near Rugby), Hams Hall (West Midlands) and Leyland (Lancashire).

2.2.11 Passenger Rolling Stock and Motive Power Depots

There are numerous rolling stock and motive power depots on or close to the WCML.

The principal depots are located at Bletchley, Crewe, Edge Hill (Liverpool), Longsight (Manchester), Oxley (Wolverhampton), Polmadie (Glasgow), Wembley and Willesden.

2.2.12 Reliability

Compared with other modes of travel such as road or air, the rail services on the WCML are relatively reliable, with more than 90% of InterCity West Coast (ICWC) trains arriving within 10 minutes of schedule, inclusive of recovery time. However, public perception demands a higher level of reliability from railways than from other
modes.

The two dominant sources of delay are from civil engineering works and signalling faults, as shown in Table 2.2.

Table 2.2: SUMMARY OF INFRASTRUCTURE TECHNICAL FUNCTION DELAYS, CONTRIBUTING TO TIME LOSS TO OPERATORS, 17 MAY 1993 - 2 APRIL 1994 (Estimates)

<table>
<thead>
<tr>
<th>Cause</th>
<th>Total Minutes Delay</th>
<th>Number of Affected Trains</th>
<th>Average Delay in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil engineering</td>
<td>239,000</td>
<td>86,000</td>
<td>2.8</td>
</tr>
<tr>
<td>Signalling and telecomms</td>
<td>102,000</td>
<td>21,000</td>
<td>4.9</td>
</tr>
<tr>
<td>Electrification</td>
<td>23,000</td>
<td>2,000</td>
<td>9.5</td>
</tr>
<tr>
<td>Plant</td>
<td>&lt;500</td>
<td>&lt;50</td>
<td>7.0</td>
</tr>
<tr>
<td>Total</td>
<td>364,000</td>
<td>109,000</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Some 60% of the civil engineering causes of delay are the result of temporary speed restrictions and planned maintenance works.

Most faults are minor in consequence, whether civil engineering or signalling and telecommunicating (S&T), but severe delay can arise from time to time, for example from a broken rail or signal power supply failure. On the four-track railway, civil faults can usually be by-passed, whereas S&T faults often affect all lines at the same time.

2.2.13 Safety

The WCML is an extremely safe transport system. Railtrack has developed a comprehensive safety case which has been independently validated and approved by the Health & Safety Inspectorate. Railtrack's commitment to continuous improvement in the safety of the WCML has been reflected throughout the Study.

2.3 EXISTING RAILTRACK CUSTOMERS

2.3.1 Passenger and Freight Customers

As part of BR's restructuring, passenger train services are now provided by semi-independent TOUs. These currently remain owned by BR, but will be transferred over the next few years as franchises to
the private sector when they will become train operating companies (TOCs). Freight services are provided by freight operating companies (FOCs) which are in the process of being privatised. The Study team consulted widely with the existing TOU and FOC managements, and with other parties interested in bidding for the franchises. The Study team also consulted with some prospective open-access train operators. The details given in this section are as understood by the Study team, based on these consultations.

There are 16 operators who currently use the WCML either in whole or in part. Three of the operators also run services on behalf of four passenger transport executives (PTEs). The TOUs and FOCs are listed in Tables 2.3 and 2.4.

Table 2.3: TRAIN OPERATING UNITS

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>TOU Reference</th>
<th>Annual Passenger Vehicle Miles on Study Routes * (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>InterCity West Coast</td>
<td>ICWC</td>
<td>64,664</td>
</tr>
<tr>
<td>2.</td>
<td>InterCity Cross Country</td>
<td>ICXC</td>
<td>15,348</td>
</tr>
<tr>
<td>3.</td>
<td>North London Railways</td>
<td>NLR</td>
<td>12,824</td>
</tr>
<tr>
<td>4.</td>
<td>European Passenger Services</td>
<td>EPS</td>
<td>Services planned to commence in 1996</td>
</tr>
<tr>
<td>5.</td>
<td>Regional Railways Central</td>
<td>RRC</td>
<td>9,269</td>
</tr>
<tr>
<td>6.</td>
<td>Regional Railways North West</td>
<td>RRRNW</td>
<td>4,127</td>
</tr>
<tr>
<td>7.</td>
<td>InterCity East Coast</td>
<td>ICEC</td>
<td>2,867</td>
</tr>
<tr>
<td>8.</td>
<td>Scotrail</td>
<td>Scotrail</td>
<td>240</td>
</tr>
<tr>
<td>9.</td>
<td>Regional Railways South Wales and West</td>
<td>RRSW&amp;W</td>
<td>53</td>
</tr>
<tr>
<td>10.</td>
<td>Regional Railways North East</td>
<td>RRNE</td>
<td>120</td>
</tr>
<tr>
<td>11.</td>
<td>London Underground Limited</td>
<td>LUL</td>
<td>390</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td>109,902</td>
</tr>
</tbody>
</table>

* Planned 1994-95
Table 2.4: FREIGHT OPERATING COMPANIES

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>FOC Reference</th>
<th>Annual Gross Tonnes Miles * (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Railfreight Distribution</td>
<td>RfD</td>
<td>2,666</td>
</tr>
<tr>
<td>2.</td>
<td>Trainload Freight West (Transrail)</td>
<td>TLFW</td>
<td>325</td>
</tr>
<tr>
<td>3.</td>
<td>Trainload Freight South East (Main Line Freight)</td>
<td>TLF SE</td>
<td>75</td>
</tr>
<tr>
<td>4.</td>
<td>Trainload Freight North East (Loadhaul)</td>
<td>TLF NE</td>
<td>35</td>
</tr>
<tr>
<td>5.</td>
<td>Rail Express Systems</td>
<td>Res</td>
<td>374</td>
</tr>
</tbody>
</table>

TOTAL: 3,475

* Contracted 1994-95

2.3.2 Passenger TOUs

2.3.2.1 InterCity West Coast TOU

ICWC TOU is Railtrack's largest single customer on the WCML, operating air conditioned trains from London to major cities along the corridor. The services are well used by business travellers who contribute strongly to revenues, although they are outnumbered by leisure travellers.

Table 2.5 shows the general weekday service pattern.

Table 2.5: ICWC WEEKDAY SERVICE PATTERN

<table>
<thead>
<tr>
<th>London To</th>
<th>Train Frequency</th>
<th>Journey Time</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birmingham</td>
<td>half hourly</td>
<td>1h 37m</td>
<td>Additional trains to and from London during peak periods</td>
</tr>
<tr>
<td>Manchester</td>
<td>hourly</td>
<td>2h 32m</td>
<td>Four trains via Crewe, and 12 via Stoke</td>
</tr>
<tr>
<td>Liverpool</td>
<td>hourly</td>
<td>2h 40m</td>
<td></td>
</tr>
<tr>
<td>Glasgow</td>
<td>seven per day</td>
<td>4h 59m</td>
<td></td>
</tr>
</tbody>
</table>
2.3.2.2 Intercity Cross Country TOU

Intercity Cross Country (ICXC) TOU operates long-distance trains from south and south-west England, across and along sections of the WCML, to the North West, the North East and Scotland; plus a service from Manchester Airport to Edinburgh. Average journeys are long, typically 100 miles, appealing mostly to leisure travellers. Virtually all ICXC trains pass through Birmingham New Street Station which is the hub of the network. Given the geographical coverage of the services operated, both reliability and ride quality are of key importance to ICXC.

2.3.2.3 North London Railways

North London Railways (NLR) operates frequent trains between London and Northampton, serving numerous small and medium sized stations with electric multiple unit trains. The Northampton service traditionally runs trains on the slow lines but has access to the fast lines. Some semi-fast services operate beyond Northampton via Coventry to Birmingham. This service may be enhanced as the TOU moves towards privatisation, in competition with ICWC. Between Euston and Watford, a local service operates every 20 minutes, using separate tracks from Camden northwards (referred to locally as the 'DC electric lines' because they are equipped with a third-rail power supply system), although these lines are outside the scope of this Study. Currently some 60% of the NLR passenger market is commuter based. NLR are in competition with London Underground Limited's Bakerloo Line from Queen's Park into Euston.

2.3.2.4 European Passenger Services Limited

EPS is an open-access operator with no subsidy from OPRAF. It will commence through services to continental Europe using the WCML in 1996. Daytime services using special 'North of London' Eurostar trains are expected to run from Manchester and Birmingham New Street over the WCML to Paris and Brussels. EPS is also the major shareholder in European Night Services Limited (ENS) which will run sleeper trains from Glasgow and Manchester to Paris and Brussels, via the WCML.

EPS is to be sold by the Government in a package with the Channel Tunnel Rail Link (CTRL) project. The current proposal for the CTRL includes a connection just north of St Pancras, which is to be the London terminus, to allow access from the CTRL onto the WCML, via Camden Junction. (St Pancras is the only main line London station not
2.3.2.5 Regional Railways Central TOU, West Midlands PTE

Regional Railways Central (RRC) TOU operates local and inter-urban express passenger trains in a network centred on Birmingham, using both diesel and electric multiple unit trains, and is a prime user of the Coventry-Birmingham-Wolverhampton corridor. Many services are subsidised by the West Midlands PTE (Centro). Centro's investment proposals include a single control centre for the West Midlands and remodelling the approaches to Birmingham New Street Station at Proof House Junction.

2.3.2.6 Regional Railways Northwest TOU, Greater Manchester PTE /MerseyTravel

Regional Railways Northwest (RRNW) TOU operates local and inter-urban express passenger trains in a network centred on Manchester, using both diesel and electric multiple units and a small number of locomotive hauled trains. Many services are sponsored by the Greater Manchester PTE (GMPTE).

RRNW is expanding services to Manchester Airport via the new link which opened in 1993. GMPTE is preparing extensions to its Metrolink light rail system including new branches to Salford Quays and Trafford Park.

GMPTE investment proposals include a control centre at Stockport, electrification of the Manchester-Blackpool route (via Wigan and Chorley) and remodelling of Manchester Piccadilly Station to improve the use of platforms 13 and 14, which are through rather than terminus platforms.

RRNW also operate services under the name of MerseyRail, which are supported by MerseyTravel, the Merseyside PTE. MerseyTravel has proposed the electrification of the North Trans-Pennine Line from Liverpool to York, and other routes which involve parts of the WCML.

MerseyTravel is also studying improved rail links to Speke (Liverpool) Airport.
2.3.2.7 **InterCity East Coast**

InterCity East Coast (ICEC) TOU principally operates services over the East Coast Main Line (ECML) between London Kings Cross and Edinburgh.

Further, it operates services through to Glasgow via Carstairs, on part of the WCML.

2.3.2.8 **Scotrail TOU, Strathclyde PTE**

Scotrail TOU has the largest urban railway network in the UK outside of London. The WCML route to Glasgow Central forms one part of this network. The Strathclyde PTE has responsibility for the City of Glasgow, the nine surrounding districts, and Cumbernauld and Kilsyth District.

Services on the Argyle line (Rutherglen-Newton; Newton-Uddingston; Motherwell-Law), the Whifflet line (Glasgow Central-Rutherglen), and the Shotts line (Glasgow Central-Uddingston) are supported by the PTE.

2.3.2.9 **Regional Railways South Wales and West TOU**

Regional Railways South Wales and West (RRSW&W) TOU operates an hourly express diesel multiple unit service from Cardiff via Shrewsbury to Manchester. This service travels over the Crewe-Wilmslow-Stockport-Manchester section.

2.3.2.10 **Regional Railways North East TOU**

Regional Railways North East (RRNE) TOU operates services between Newcastle and Glasgow via Carlisle and Dumfries. This service traverses the WCML between Carlisle and Gretna Junction, a distance of approximately 13 km.

2.3.2.11 **London Underground Limited**

London Underground Limited (LUL) operates tube services on the DC electric lines between Harrow and Wealdstone and Queen's Park, then on into central London via the Bakerloo Line. These lines are outside the scope of the Study. (In the past LUL has operated as far out as Watford.)
LUL is also promoting a scheme to build a new short rail connection from the Watford branch of the Metropolitan Line, via Croxley Green. This would allow Metropolitan Line services to run into Watford Junction and attract additional business and leisure traffic to train services on the WCML from the areas served by the Metropolitan Line.

2.3.3 Freight Operating Companies

2.3.3.1 Trainload Freight

Trainload Freight (TLF) includes all services carrying bulk commodities for a single customer, such as coal, steel, petro-chemicals, construction and metals.

TLF has been divided into three companies in preparation for privatisation. These will cover the existing business and assets in three geographic areas but will be free to compete with each other once they are sold. Transrail is the name adopted by Trainload Freight West, which operates mostly on and around the WCML.

TLF also owns and operates engineering trains used in railway infrastructure works.

2.3.3.2 Railfreight Distribution

Railfreight Distribution (RfD) operates trains carrying mostly higher-value freight, including automotive and intermodal services. Much of this traffic operates over the WCML.

RfD's Freightliner division operates a national network of trains and terminals carrying ISO containers. Nearly 80% of Freightliner activity is over WCML.

RfD has invested heavily to carry Channel Tunnel freight traffic, mostly to enable carriage of swap bodies which are larger and lighter than ISO containers.

2.3.3.3 Rail express systems

Rail express systems (Res) operates dedicated trains carrying letter mail for the Post Office, under a long-term contract. Royal Mail has recently ordered new, electric multiple unit trains for Res to operate mainly on the WCML. Res is developing a new terminal at Willesden where the line crosses London's North Circular Road. Res also operates the
Special Trains Unit, which is to be privatised in 1995 and which runs various charter trains including steam-hauled excursions.

Reliability is very important to meeting Post Office contractual terms so potential disruption during the WCML modernisation is a serious concern to Res.
CHAPTER 3

Business Opportunities and Framework for Strategy Development

3.1 OPPORTUNITIES

All stakeholders in the railway industry have a common goal of a safe, reliable, and cost-effective transportation system. Working towards this goal will generate new business opportunities for each stakeholder.

The opportunities for Railtrack include cost reduction, service improvement, and revenue enhancement for both passenger and freight markets. These were arrived at following extensive consultations with the TOUs, FOCs and other interested parties.

3.1.1 Cost Reduction

Railtrack's present track access charges reflect the actual long-run costs of maintaining and operating the railway infrastructure as it is today. A reduction in these costs will be of substantial benefit not only to Railtrack but also to its various stakeholders and customers.

Railtrack's annual costs on the WCML are shown in Table 3.1.

Table 3.1: RAILTRACK'S COST BUDGET ON WCML, 1994-95 FINANCIAL YEAR

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>£ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure maintenance</td>
<td>112</td>
</tr>
<tr>
<td>Operations (production)</td>
<td>49</td>
</tr>
<tr>
<td>Management expenses</td>
<td>25</td>
</tr>
<tr>
<td>Depreciation</td>
<td>64</td>
</tr>
<tr>
<td>Total costs</td>
<td>250</td>
</tr>
</tbody>
</table>
Technology change offers the potential for reductions in infrastructure maintenance costs. Operations comprise Railtrack's activities required for the running of trains on the infrastructure. The £49 million operations costs include the charge for electric current for traction at £28 million which is passed on directly to the train operators. The opportunity exists to reduce the remaining operating costs by consolidation of the existing signalling, power supply, and route management functions.

Railtrack's management expenses are also targeted for improvement.

3.1.2 Reliability

There is a major opportunity for Railtrack to enhance market image and competitiveness through genuine improvements in reliability. This would have a direct effect in attracting more passengers and increasing the TOUs' revenues. Railtrack also has an interest in improving reliability in that its track access contracts specify a level of reliability below which compensation must be paid to train operators.

New technology can greatly improve reliability by removing some of the most common types of failure notably in civil engineering and signalling.

3.1.3 Increased Ride Comfort

Particularly for the large business passenger market, ride quality is an important feature. The freedom to read, write, use laptop computers, eat and drink uninterrupted by disturbance from the ride is highly valued by such passengers. Bogie design and maintenance plays a large part in creating these conditions, but the fundamental requirement is for the track to be in a state of good repair.

3.1.4 Faster Journey Times

Certain train operators and passengers desire faster journey times. Some groups have lobbied for reconstruction of the line for top speeds of 300 km/h. However, the benefits of journey time enhancement are limited and will not repay the costs of building an entirely new line.

3 The consultants to the "West Coast Rail 250" group have accepted that the economic and financial benefits of an entirely new 300 km/h line similar to the French TGV lines could not support the costs of construction. See Development of the West Coast Main Line - Preliminary Assessment, Steer Davies Gleave June 1994.
Others have suggested a more modest objective of 200 km/h (125 mph), comparable to that achieved on the ECML and on the Great Western.

With faster journey times:

- Existing passengers will save time which can be valued in monetary terms.
- New passengers will be attracted from air and road, and there will also be some people attracted to make entirely new journeys.
- Train operators will be able to achieve better use of staff and rolling stock.
- There will be some 'non-user' benefits, for example to remaining road users who will face marginally less congestion, and also less pollution from road traffic.

The financial value of time savings varies along the line, with passenger flows. The benefits of faster journey times accrue in the first instance to the TOUs and their passengers. Railtrack will require to negotiate a formula to transfer some of the benefit of these faster journey times into higher track access charges in order to repay the necessary investment.

3.1.5 Increased Structure Gauge

Various groups have proposed increasing the load and structure gauge along the WCML to enable use by trains carrying lorry trailers (piggyback) as illustrated in Figure 3.1. Although clearances along the line have already been enlarged for swap body trains, there may be a significant additional freight business which can be tapped by further enlargement, if this can be done at reasonable cost. The same works will allow carriage of 9'6" containers.

The Piggyback Consortium has estimated that a piggyback service from the West Midlands, north west England and Scotland, and an Irish Sea port service would capture a significant share of the total UK-mainland

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4 A speed of "at least 125 mph" is suggested by the West Midlands Regional Rail Forum in its rail strategy paper of Autumn 1993.
5 The Piggyback Consortium includes county and regional councils and associations, shippers, freight operators, French Railways and Eurotunnel, as well as Railtrack.
FIGURE 3.1:
PIGGYBACK ILLUSTRATION
Europe market, generating additional freight train paths for Railtrack. Its proposed route is shown in Figure 3.2. Most of these trains would originate north of London, with destinations in France, Germany, Italy or Spain. Investment to provide the piggyback clearances from the Channel Tunnel to the UK terminals on the WCML is clearly a potential business opportunity for Railtrack.

A larger structure gauge would also allow the introduction of double-deck passenger trains. These are now widely used on commuter routes in Australia, continental Europe and North America and are being introduced in Japan. Capital costs of double-deck rolling stock are likely to be higher on a per-carriage basis, but the overall cost per seat mile is less, and peak hour capacity could be improved.

### 3.1.6 Increased Capacity

An increase in line capacity would help to accommodate possible growth in freight traffic and to allow competition by open-access passenger operators. Centro has made a specific request for capacity to operate additional trains between Coventry and Birmingham.

RfD has also indicated a desire to operate longer freight trains, up to 750 m long, for traffic to the Channel Tunnel. This would not require extra capacity, but would need some investment in longer passing loops.

### 3.1.7 Station and Property Opportunities

A comprehensive review of station improvements and development prospects was not part of the feasibility Study. Railtrack's policy is, over the years, to improve the environment of stations. The Study's approach has been consistent with this policy.

### 3.1.8 Other Opportunities

Other opportunities exist such as development of new freight terminals, construction of faster trains, and improved connections to the CTRL. Although these fall outside the main scope of this study, and are not always strictly the responsibility of Railtrack, they have been noted and have been taken into consideration when appropriate in developing investment proposals.
FIGURE 3.2: PIGGYBACK CONSORTIUM PROPOSED ROUTE

Key:
- Piggyback Consortium Proposed Route
- Other Lines Within Scope of Study
- Other Lines
- Existing Intermodal Terminals
- Other Intermodal Terminal Options
3.2 FRAMEWORK FOR STRATEGY DEVELOPMENT

In light of the business opportunities identified above, four approaches to investment were established as an incremental framework in which to develop, test and refine promising options, and hence to build up a single recommended investment scheme.

The approaches were:

- **Bedrock**
  minimum investment to maintain existing services, much as at present;

- **Recovery**
  incremental investment to modernise the railway with conventional technology, bring it gradually into a better state of repair and maintain existing services with greater reliability;

- **Cost-Driven**
  major investment in new technology to reduce the capital, operating and maintenance costs of the infrastructure over the period considered to 2025;

- **Market-Driven**
  major investment providing opportunities to improve services and revenues, or reduce train operators' costs.

The infrastructure was considered under four principal headings: trackwork, structures, traction power, and train control. Other technical areas of key relevance to strategy development were operations, rolling stock, safety, environment, and construction management. On the business side, possible investments were considered in the light of market demand, product development opportunities, commercial issues and funding options.
3.3. BEDROCK AND RECOVERY INVESTMENT APPROACHES

Under these approaches, no increases in service levels or performance would be targeted, but current technologies are assumed to be used when renewals are made, which would result in some benefit. The capability would be maintained to run the May 1994 timetable and the planned Channel Tunnel traffic, including Eurostar and freight trains. These approaches also assume that existing rolling stock, or similar, would continue to be used on the WCML.

3.3.1 Bedrock

This 'make-do and mend' approach to investment maintains the infrastructure at its current standard. The works would also be deferred until as late as possible, while maintaining the current service patterns. However, some further degradation of reliability may occur over time, and the risk of a major failure leading to loss of operation for a significant period would increase. Safety levels would be unchanged from now. The approach assumed:

- **Trackwork**
  maintain existing as-constructed standards, methods and materials;

- **Structures**
  continue traditional levels of inspection and programmed maintenance; enhance day-to-day maintenance to prevent further deterioration;
  respond to trends in structural deterioration as they appear;

- **Traction Power**
  renewal or replacement of equipment to address poor condition, overloading, poor system performance and wear;

- **Command and Control**
  identify safety deficiencies (e.g. dry wire degradation) and invest to eliminate them;
initiate a long-term rolling programme of renewal to replace existing signalling.

3.3.2 Recovery

Using this approach, Railtrack would invest gradually to bring the WCML into a better state of repair, using current standards, and to maintain it in that condition thereafter. Achievement of this condition would lead to a progressive reduction in maintenance expenditure. Safety would be marginally improved as fewer visits to trackside equipment by maintenance staff would be required. An improvement in overall reliability would be expected if Recovery investment was to be undertaken.

The approach assumed:

- **Trackwork**

  as Bedrock but with some additional renewals targeted at improving reliability;

- **Structures**

  as Bedrock;

- **Traction Power**

  minor renewal or replacement additional to Bedrock to ease supply point unbalance and address inadequate suppression of interference to other parties' telecommunications systems;

- **Command and Control**

  resignal line using conventional signalling technology.

This approach to investment would maintain current levels of capacity and linespeed.
3.4 COST-DRIVEN AND MARKET-DRIVEN INVESTMENT APPROACHES

A large number of possible technical options for modernising and upgrading the WCML were considered taking account of developments in railway technology worldwide. Some 60 distinct options were developed, 34 focusing principally on reducing the railway's costs (Cost-Driven) and 26 on potential customer service improvements (Market-Driven).

3.4.1 Cost-Driven

Some of the principal technical options considered as part of the Cost-Driven approach were:

- **Trackwork**
  - Improved track components;
  - New plant for undertaking track renewals;
  - Removal of obsolete equipment;

- **Structures**
  - Removal of redundant structures;

- **Traction Power**
  - New plant for undertaking overhead line equipment (OHLE) renewals;
  - Rationalisation of Mk I OHLE;
  - Additional remote sectioning facilities;
  - Rationalisation and remote monitoring of points heating equipment;

- **Command and Control**
  - Integrated control;
Alternative types of train control (initially proposed as part of the Market-Driven studies but transferred to Cost-Driven as their cost effectiveness was demonstrated);

* Operations
  
  Catering for longer trains;
  
  Route/layout rationalisation;
  
  Improved possession/cross-over strategy.

3.4.2 Market-Driven

Key technical options considered under this approach addressed the opportunities for reducing journey times, improving reliability and comfort and increasing the structure gauge for freight:

* Trackwork
  
  Changes to track geometry standards;
  
  Track condition;
  
  Lifting of permanent speed restrictions;
  
  Improved linespeeds;

* Structures
  
  Increased load and structure gauge for freight and passenger trains;
  
  Elimination of level crossings;
  
  Heavier and faster freight trains;

* Traction Power
  
  Reinforced power supply system for faster, longer (heavier) or more frequent trains;
  
  Upgraded OHLE for higher speeds;
Command and Control

Technologically advanced train control systems (transferred to Cost-Driven as their cost effectiveness was demonstrated);

Operations

Increased route capacity;
Changed configuration (e.g. up/up/down/down);

Rolling Stock

Diesel and electric high speed passenger trains;
Tilting trains.

3.5 OPTION EVALUATION AND SIFTING PROCESS

These options were evaluated within a progressive sifting process. Those options that were clearly not viable, either because of technical factors, unacceptably high risks, or costs exceeding conceivable benefits, were not developed further.

Other options rejected for further development within the Study are not necessarily non-viable. In some instances options were found to be promising but not of particular significance for the Study. Some of these may be investigated further by Railtrack outside the Study. Others may be taken up by the implementation contractor.

The sifting process is shown in Figure 3.3. A full list of the possible technical options, and their disposition during the sift process, is provided in Annex C.

Chapter 4 describes the technical features and costs of the key alternative investments in the Cost-Driven approach leading to the selection of the preferred options. It concludes by combining the options into investment packages. The Market-Driven options are described and the means of taking them forward are discussed. Financial data on the Bedrock, Recovery and Market-Driven approaches and other investment packages are set out in Chapter 5, which covers the investment appraisal.
FIGURE 3.3:
OVERVIEW OF SIFTING PROCESS

- Business Needs Interface
- Consultation with Opinion Formers
- Technical Development
- Supplier Data
- Perceived Market Needs
- Lead Discipline Interface Identification

Generation of Technical Options

- Technical Incompatible High Cost/Low Benefit

Cost/Benefit Assessment

- Synergies
- Measured Market Needs

Overview Analysis

- Review Team

- Discard • Technically Incompatible • High Cost/Low Benefit

Consistency Check

- Viable Options
- Risk Assessment

Financial & Economic Appraisal of Investment Packages

- Optimised Packages of Investment
- Sensitivity Analysis

- Political Factors
- Single Business Case for WCMF

- Funding Issues
- Cost Risk Assessment
CHAPTER 4

Evaluation of Technical Options and Development of Investment Strategy

4.1 COST-DRIVEN INVESTMENTS

Technical options were analysed to establish their relative costs and benefits and to enable choices to be made. The main areas of benefits to emerge were:

- train control system;
- control centre;
- possession strategy.

4.1.1 Train Control System Replacement

4.1.1.1 Options

The maintenance burdens and unreliability associated with the current signalling installations and the opportunities for exploiting developments in technology were considered. Three different train control systems were examined, as illustrated in Figures 4.1A, 4.1B and 4.1C:

- Conventional Colourlight Signalling

  This involves using technology with lineside signals and track circuits, as today. It would involve modernising essentially on a like-for-like basis. This was considered to be the Recovery case and was not pursued as part of a Cost-Driven approach, but is included here for comparison.

- Track-circuit Cab-signalling

  This technology is used on the French and German high-speed lines, on the north-east corridor in the USA and on LUL's Victoria Line. With this system, lineside signals would not be
FIGURE 4.1A:
TYPES OF TRAIN CONTROL SYSTEM

1. CONVENTIONAL SIGNALLING

1. Driver Instruction by colour light signals.
2. Instruction Enforcement by AWS sending an audible warning to the driver which must be acknowledged. There is no update facility after the magnets; consequently cannot enforce a stop once warning acknowledged.
3. Train Detection by track circuits (or axle counter blocks).
2. TRACK-CIRCUIT CAB SIGNALLING

1. Driver Instruction displayed in cab, a continuous system with no loss of capacity. Issues appropriate speed commands through track circuits to train. Controls lineside signals (where provided).

2. Instruction Enforcement of permanent/temporary speed restrictions and movement authority - inherent.

3. Train Detection by track circuits (or axle counter blocks).
1. Driver Instruction displayed in cab, a continuous system with no loss of capacity. Receives movement authority and permitted speed for a specified distance. Process repeated at intervals and with all trains.
2. Instruction Enforcement of permanent/temporary speed restrictions and movement authority - inherent.
3. Train Detection by reading the transponder's identity and sending the information to the control centre - distance measurement between transponders.
used, drivers receiving authority to proceed from equipment mounted in the cab. Much lineside infrastructure, including track circuits, would, however, still be required to determine the location of the train and communicate instructions to it.

*Transmission-based Cab Train Control*

This technology would give train drivers authority to proceed through a cab-signalling unit, communicating by digital radio with the control centre. Train location would be determined using passive transponders enabling the existing track circuits, signals and trackside cables to be eliminated. A draft standard for a system of this type is being researched under the European Train Control System (ETCS) project funded by the European Union (EU). It is likely that ETCS will be adopted as the European network inter-operability standard.

4.1.1.2  Technical Evaluation

Since 1989, as a result of the recommendations of the Hidden Inquiry, BR has been examining the possibility of installing Automatic Train Protection (ATP) on a network-wide basis, in order to prevent collisions arising from trains passing signals set at danger. Only the second and third options provide this.

Key features including ATP of the three alternative systems are compared in Table 4.1.

**Table 4.1: TECHNICAL EVALUATION OF TRAIN CONTROL SYSTEMS**

<table>
<thead>
<tr>
<th>Features</th>
<th>Conventional Resignalling</th>
<th>Track-circuit Cab-signalling</th>
<th>Transmission-based Train Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Unchanged</td>
<td>Allows slightly closer headways</td>
<td>Headways constrained by train braking performance only</td>
</tr>
<tr>
<td>Linespeed</td>
<td>200 km/h maximum</td>
<td>Not constrained by train control system</td>
<td>Not constrained by train control system</td>
</tr>
<tr>
<td>ATP</td>
<td>Not included</td>
<td>Inherent</td>
<td>Inherent</td>
</tr>
<tr>
<td>Bi-directional working</td>
<td>Difficult to provide</td>
<td>Difficult to provide</td>
<td>Easily provided</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Unchanged</td>
<td>Slight improvement</td>
<td>Major improvement</td>
</tr>
<tr>
<td>On-track safety</td>
<td>Unchanged</td>
<td>Slightly improved</td>
<td>Greatly improved</td>
</tr>
</tbody>
</table>
Maintainability and on-track safety are improved with transmission-based cab-signalling because of the reduction in trackside equipment and thus the need for workers to go onto the line to maintain it.

4.1.1.3 Financial Evaluation

The comparative capital and maintenance costs and net present costs (NPC) of the alternatives are set out in Table 4.2.

Table 4.2: COMPARATIVE COSTS OF TRAIN CONTROL SYSTEMS (£ million)

<table>
<thead>
<tr>
<th></th>
<th>Conventional Resignalling</th>
<th>Track-Circuit Cab-signalling</th>
<th>Transmission-Based Train Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total capital spend</td>
<td>(600)</td>
<td>(720)</td>
<td>(470)</td>
</tr>
<tr>
<td>30-year maintenance cost</td>
<td>(600)</td>
<td>(600)</td>
<td>(520)</td>
</tr>
<tr>
<td>Grand total</td>
<td>(1,200)</td>
<td>(1,320)</td>
<td>(990)</td>
</tr>
<tr>
<td>Present value of costs*</td>
<td>(630)</td>
<td>(760)</td>
<td>(560)</td>
</tr>
</tbody>
</table>

4.1.1.4 Selection of Preferred Option

Both technical and financial comparisons of conventional, track-circuit and transmission-based cab-signalling favour a transmission-based system. It is recognised that significant development of the latter system would be needed, using a number of readily available and mature 'building blocks'.

While transmission-based train control may introduce additional risks during development, these are offset by substantial reductions in implementation risk and by improvements in performance and safety.

Concerns about adopting such a new system are acknowledged, however, and risk mitigation has been considered. Brief details are set out in Table 4.3.

A major advantage of transmission-based train control, over the other two systems, is that it can be installed without disturbing the complex system of trackside installations. The existing signalling can therefore continue in use during pre-commissioning background operation of the new system.
These concerns can be mitigated through good management of the development and implementation process. The longer-term benefits are considered to be very significant and transmission-based train control will therefore be the 'model' for the future. There is a strong case for taking advantage of this powerful opportunity on the WCML.

Table 4.3: MITIGATION OF CONCERNS REGARDING TRANSMISSION-BASED TRAIN CONTROL

<table>
<thead>
<tr>
<th>Potential Concerns</th>
<th>Method of Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software development schedule</td>
<td>Parallel development, Rapid prototyping, Case tools, High-level language, Existing technologies used</td>
</tr>
<tr>
<td>Development and dependability of digital radio link</td>
<td>Early trials, parallel development by other European railways and maximum use of commercial equipment</td>
</tr>
<tr>
<td>Development budget</td>
<td>Dedicated programme office</td>
</tr>
<tr>
<td>Cab fitting costs</td>
<td>Fixed by the contractor's tender</td>
</tr>
<tr>
<td>Cab fitting disruption</td>
<td>Programmed to suit rolling stock maintenance schedules</td>
</tr>
<tr>
<td>Delay to Euro standards</td>
<td>Britain can lead and guide standards</td>
</tr>
<tr>
<td>Safety approval</td>
<td>Concurrent with project</td>
</tr>
<tr>
<td>Automated design tools</td>
<td>Develop concurrently</td>
</tr>
<tr>
<td>Operating rule book</td>
<td>Update during development and test</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Phased; overlay on current system and fully tested before use</td>
</tr>
</tbody>
</table>

4.1.2 Control Centre

4.1.2.1 Options

The condition of the existing signal boxes and other control centres and the opportunity to consolidate train, power and operational control has been discussed in Chapters 2 and 3.

Three options were considered for integrating control:

- a single centre supported by a back-up and training facility
located nearby;

- two centres each capable of taking over from the other;
- multiple centres.

Each of these options would provide similar functionality to an integrated electronic control centre (IECC), including automatic route setting. The first two options would also provide controllers with high-integrity possession control and traction control. In addition they would facilitate better asset management (control of infrastructure maintenance) and regulatory control for TOUs operating vehicles on the line.

4.1.2.2 Technical Evaluation

A single control centre would raise concerns about security and the possibility of catastrophic failure. Trains carrying passengers must be able, at least, to proceed safely to the next station. For commercial reasons Railtrack would also need to restore services to its customers within a reasonable time, perhaps two hours.

To address this concern the proposed back-up facility would be located at a sufficient distance from the main centre to prevent common-mode failure, such as a major fire or gas leak, flood, etc., yet close enough for personnel to be 'rotated' regularly with the main centre to keep all operators 'current'. The back-up could also serve as a training, simulation, planning and software maintenance centre. The secondary site would take over in the event of a catastrophe at the main centre, allowing passengers to be de-trained promptly, limited services to be restarted within hours and full services in a few days.

Consolidating control at a single centre with a 'hot' standby such as this would enhance coordination leading to improvements in:

- safety levels;
- possession and isolation management;
- management of disruption to services;
- infrastructure maintenance/asset management.
Two centres, each manned and fully capable of controlling the line, would perhaps achieve an initial response to a major failure at a slightly higher level but this advantage would be quickly lost. A lesser enhancement in coordination would be achieved and not all of the programme benefits listed above would be gained.

With multiple centres there would be no significant changes in contingency planning, and the cost and performance benefits of the above options would not be achieved.

4.1.2.3 Financial Evaluation

The capital and maintenance costs of the new facilities, and the savings in staffing, compared with running numerous existing centres have been evaluated and are set out in Table 4.4.

<table>
<thead>
<tr>
<th>Description</th>
<th>Single Centre and Backup</th>
<th>Two Identical Centres</th>
<th>Multiple Centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and maintenance costs for new centres</td>
<td>(29)</td>
<td>(39)</td>
<td>Higher costs</td>
</tr>
<tr>
<td>Operating savings over present situation</td>
<td>66</td>
<td>58</td>
<td>and lower savings</td>
</tr>
<tr>
<td>Net Benefit</td>
<td>37</td>
<td>19</td>
<td>Small</td>
</tr>
</tbody>
</table>

4.1.2.4 Selection of Preferred Option

A single control centre with a back-up offers double the NPV of two identical centres. The technical evaluation shows no reason to prefer the two centres. Multiple centres offer no cost or technical benefits. The selection of the single centre with a backup facility is therefore supported on both technical and financial grounds.

4.1.3 Possession Strategy

The WCML is in use 24 hours a day, seven days a week. Track and OHLE maintenance is currently carried out either in short eight-hour possessions during weekday nights with little disruption to services, or in longer 16, 32 or 56-hour possessions at weekends causing rather more disruption. Significant renewal work is only feasible in the longer possession periods.
Maintenance work on power supply equipment, structures and signalling equipment is, in the main, either done under the cover of a longer possession taken for trackwork or can be done within an eight hour possession with little effect on services. For these disciplines there is usually little to be gained from longer possessions as the activities do not make intensive use of on-track plant. When major renewal of the power supply equipment is required this can usually be achieved without significant possessions or delays to trains. Structures and signalling do, however, need occasional long possessions for major renewals to be carried out.

The present Rules of the Route, within which possessions are granted, are designed to cater for a steady-state maintenance and renewal programme. More extensive possessions are inevitably required for an accelerated programme, catching up on the backlog, and for improvement works.

4.1.3.1 Options

The Study looked at three different possession scenarios:

- continue the existing strategy of shorter possessions with a restricted number of 56-hour possessions;
- adopt long weekend (32/56-hour) possessions as the norm for the bulk of the work accepting that there could be an increase in disruption costs;
- use continuous possessions until the required work on a section of line is completed.

It will be for Railtrack and the implementation contractor to decide which scenario (or mix of scenarios) is to be adopted to meet the customers' needs and make a return for Railtrack. For the purposes of this evaluation, current technology and working methods were assumed for a basic modernisation programme.

4.1.3.2 Evaluation

In considering the merits of the different possession strategies, it is assumed that all existing train services, including the proposed Channel Tunnel services, must continue to be pathed.
The existing short possession strategy leads to the highest unit costs because the set-up and handback times are a high overhead resulting in short working periods. The impact on the number of trains is, however, minimised and longer journey times are timetabled to compensate for the disruption.

Adopting long weekend possessions as the norm would allow a given volume of work to be completed much more quickly. Moreover, because of the more intensive use of plant and staff, unit costs are also lower. It is likely that Saturday and Sunday services during periods of extended works would be slower than at present. North of Preston, which is a two-track railway without acceptable diversionary routes, special consideration will have to be given to the possession strategy. A potential solution is a 12/16-hour blockage of both tracks (2200 Saturday to 1400 Sunday) followed by a 16/20-hour single-track blockage (until 0600 Monday). Revised Rules of the Route would be required to ensure that the disruption is kept to the minimum and that the revised timetable is met.

Continuous possessions would be ideal, if they could be achieved economically, because they would enable the work to be completed in the shortest possible time. They would however pose two particular challenges:

- The minutes of delay caused by continuous possessions would be considerable because there are many more trains per day on weekdays. Table 4.5 illustrates the number of trains between London and Rugby affected by each type of possession.

- Daytime train paths for the necessary ballast, spoil and OHLE construction/maintenance trains during weekdays, when the railway is running at greater traffic levels, would cause additional delays.
### Table 4.5: TYPICAL NUMBERS OF TRAINS THAT COULD BE DELAYED - LONDON TO RUGBY (per possession per week)

<table>
<thead>
<tr>
<th>Possession</th>
<th>Eight-Hour</th>
<th>16-Hour</th>
<th>32-Hour (A)</th>
<th>32-Hour (B)</th>
<th>56-Hour</th>
<th>168-Hour (Continuous)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Day</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
</tr>
<tr>
<td>Finish Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monday-Friday</td>
<td>0600</td>
<td>1400</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>2200</td>
</tr>
<tr>
<td>Tuesday-Saturday</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>2200</td>
</tr>
<tr>
<td><strong>Train type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICWC</td>
<td>12</td>
<td>36</td>
<td>124</td>
<td>160</td>
<td>280</td>
<td>1,044</td>
</tr>
<tr>
<td>EPS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>NLR</td>
<td>24</td>
<td>34</td>
<td>82</td>
<td>148</td>
<td>210</td>
<td>932</td>
</tr>
<tr>
<td>Empty</td>
<td>12</td>
<td>10</td>
<td>22</td>
<td>24</td>
<td>36</td>
<td>212</td>
</tr>
<tr>
<td>Res</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Freight</td>
<td>40</td>
<td>0</td>
<td>6</td>
<td>60</td>
<td>66</td>
<td>356</td>
</tr>
</tbody>
</table>

### 4.1.3.3 Selection of Preferred Option

When all factors are taken into account, the balance between getting work completed as quickly as possible, and minimising direct and disruption costs, favours the long weekend possession.

It is recognised that much work needs to be done on optimising the possession strategy in conjunction with the train operators.

### 4.1.4 Other Cost-Driven Options

Many of the detailed options considered for reducing costs, as indicated in Annex C, were found to be worthwhile, although not of major significance in the context of this Study. These options have either been incorporated directly in the outline performance specification for the modernisation or recorded for later use at the discretion of the implementation contractor.

### 4.2 MARKET-DRIVEN PASSENGER INVESTMENTS

Several enhancements have been identified which would benefit passengers. These relate to increased ride comfort, faster journey times, improved capacity at constrained locations on the line and the possibility of double-deck passenger trains. The first two are discussed below and the last in Section 4.3.1.
4.2.1 Faster Journeys

4.2.1.1 Background

Journey time savings are not only achieved by raising the top linespeed, but also by other measures which are discussed in Section 4.2.1.2 below. For convenience, improvements in linespeeds were considered in steps: 175 km/h (110 mph) as existing, 200 km/h (125 mph), 225 km/h (140 mph), 250 km/h (155 mph), and 300 km/h (186 mph).

TOUs could reduce journey times between the major cities by reducing intermediate stops on some services, but the Study has assumed the existing stopping pattern.

Currently, ICWC TOU operates passenger carriages and electric locomotives rated for speeds of either 160 km/h (100 mph) or 175 km/h (110 mph) as well as diesel high-speed trains to Holyhead. Appropriate investment by TOUs in higher-speed trains would need to be coordinated with investment in the railway infrastructure.

Tilting trains have been introduced successfully on several European railways as illustrated in Figure 4.2. These offer the potential for faster train operation, saving journey time without the extensive easing of curves needed for conventional high-speed trains - although certain transitions would have to be lengthened.

In addition to any alignment improvements, faster speeds require reinforcement of the power supply system, modified signalling, an upgraded OHLE system, measures to reduce pressure effects in tunnels and to protect people from slip-streaming effects on station platforms. The costs of each of the factors change in a different way as speeds rise.

4.2.1.2 Key Infrastructure Issues

Investment in upgrading Railtrack’s infrastructure would contribute to faster journey times in a number of ways:

- Track Quality and Alignment

The track is continually being replaced as part of the normal renewals process. On the fast lines the material design standards are suitable for 200 km/h operation. However, if trains are to be operated at higher speeds, and ride comfort is to be maintained
FIGURE 4.2:
ILLUSTRATION OF TILTING TRAINS

source: Fiat Ferroviaria

source: Asea Brown Boveri
within technical limits, it will be necessary to modify the track geometry on some curves and to maintain track condition in an upgraded state of repair. Track maintenance costs will also rise because of high speeds.

An economic analysis was used to identify the most cost-effective locations for removing PSRs. This is further discussed in Section 4.2.1.5 and in Chapter 5.

**Traction Power**

Upgrading of the power supplies and OHLE would be necessary to allow the use of electric traction at higher speeds. Works required range from the strengthening of the existing power supply system and upgrading the OHLE for 200 km/h operation, to additional reinforcement of the power supply system and new OHLE for 225 km/h, and the introduction of a 25-0-25kV auto-transformer system for 250 km/h or above.

**Train Control**

The existing signalling was designed for 160 km/h maximum speed. Since that time, trains with enhanced braking characteristics have been developed. Better braking permits a linespeed of 200 km/h using the signalling in essentially unmodified form, a few local improvements being necessary where existing sighting distances are short. At present, the fastest trains on the WCML have a maximum speed of 175 km/h, limited by the locomotives, the capacity of the power supplies and the Mk I OHLE, rather than the signalling system.

At speeds above 200 km/h, sighting distances and reaction times will be further compromised and ATP will probably be a mandatory requirement. A new lineside signalling system with ATP could in theory suffice but it would be at the limit of its capability and would have exceptionally high costs, when ATP is included. A cab-signalling system with inherent ATP is therefore considered to be the only practicable solution for linespeeds over 200 km/h.

**Level Crossings**

A number of level crossings would need to be eliminated (or modified to provide closed-circuit television surveillance, where
not already provided) to allow for higher-speed operations. It would generally be difficult to justify the cost of replacing road crossings with bridges, although some opportunities may emerge during detailed development. Footpath crossings would need to be replaced with footbridges where alternative routes are not available.

**Aerodynamic Factors**

Higher-speed operation increases aerodynamic pressure effects which have to be mitigated to maintain standards of safety and passenger comfort. These effects occur in tunnels and when trains pass each other on open lines. They also occur when trains pass close to people on station platforms, and those working on the track. Measures are available to ameliorate most of these effects, including pressure relief shafts in tunnels, locomotive streamlining, safety screens on platforms, and safety improvements to the lineside access for workers. Experience in Germany suggests that with the current track spacing, some difficulties may remain with high-speed trains passing freight trains carrying soft-sided containers. More research would be needed to resolve this issue.

### 4.2.1.3 Improvement Packages

The increased revenue that will result from faster journeys will accrue to the TOUs in the first instance. Therefore Railtrack, on its own, cannot select a single speed enhancement option. The choice of Market-Driven options has to be made together with the train operators and OPRAF.

An option for 300 km/h running was rejected early in the Study as it would require the construction of extensive lengths of new railway. Indeed, the nature of the WCML means that substantial and costly realignment would be needed even for 225 km/h conventional rolling stock, and this option was also dropped.

Estimates have therefore been developed for packages of infrastructure improvements that would enable operation of conventional trains at 200 km/h, and for tilting trains at 225, and 250 km/h. The estimates would be confirmed through competitive bidding. OPRAF and the TOU franchise bidders could then indicate their preferred options.
The upgrading of trackwork condition from the Recovery state is a requirement for achieving reduced journey times through higher linespeeds. This has been labelled Option A. The higher linespeed options have been labelled Options C, D and E respectively and have to be additional to Option A. (Option B is the running of additional trains at the existing 175 km/h.)

4.2.1.4 Time Savings

For reference, the speed options and implied journey times are presented in Table 4.6, including comparison with Bedrock and Recovery times.

Table 4.6: JOURNEY TIMES FOR ALTERNATIVE INVESTMENTS

<table>
<thead>
<tr>
<th>Alternative Investments</th>
<th>Birmingham (two stops)</th>
<th>Manchester (four stops)</th>
<th>Liverpool (four stops)</th>
<th>Glasgow (three stops)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock (existing)</td>
<td>1h 37m</td>
<td>2h 32m</td>
<td>2h 40m</td>
<td>4h 59m</td>
</tr>
<tr>
<td>Recovery (reduced engineering allowances) or Option A or B</td>
<td>1h 35m</td>
<td>2h 29m</td>
<td>2h 36m</td>
<td>4h 53m</td>
</tr>
<tr>
<td>Option C 200 conventional</td>
<td>1h 23m</td>
<td>2h 18m</td>
<td>2h 23m</td>
<td>4h 35m</td>
</tr>
<tr>
<td>Option D 225 tilting</td>
<td>1h 18m</td>
<td>2h 7m</td>
<td>2h 12m</td>
<td>4h 16m</td>
</tr>
<tr>
<td>Option E 250 tilting</td>
<td>1h 15m</td>
<td>2h 3m</td>
<td>2h 7m</td>
<td>4h 11m</td>
</tr>
</tbody>
</table>

All the journey times for Options A, B, C, D and E assume the existing station stopping pattern. A two-hour London to Manchester journey would be possible in Option C without stops, in Option D with two stops, and in Option E with three stops.

4.2.1.5 Removal of PSRs

As shown in Table 2.1 in Chapter 2 there are currently 11 lengths of line between Euston and Crewe over which linespeeds of 175 km/h cannot be achieved. At higher linespeeds the curvature of the line will create a greater number of PSRs. The easing of nine of these for the higher linespeed options was chosen on the basis of the infrastructure costs and the revenue benefits arising from reduced journey times. Table 4.8 gives details of the PSR removals proposed and their effects.
for different linespeeds, with costs (relative to time saved) shown in Table 4.9.

The economic rationale for the choice of these PSRs, in terms of costs and revenues associated with minutes of journey time saved, is discussed further in Section 5.4.3. The significance of PSRs for journey times is indicated in Figure 4.3, showing typical linespeed/train performance profiles for the existing and higher speeds. This makes plain the difference between the theoretical linespeed over any section of line, dictated by curvature, tunnels, etc., and the speed achievable by a train with particular acceleration and braking characteristics. It can be seen that, at the higher linespeeds, the benefits of removing single PSRs cannot be realised if other PSRs are not also removed.

The costs for achieving the indicated time savings can be justified on the basis of the revenue increases to be derived. At other locations, costs were found to be in excess of the potential for revenue gain. As previously indicated, the benefits are referred to in Chapter 5 (and are more fully set out in Annex H).

It should be noted that the selection of PSRs for removal in this analysis has been driven by requirements in the high-speed passenger market. However, such works would also have synergy with other Market-Driven options, such as enabling piggyback traffic and double-deck passenger trains to be accommodated.
FIGURE 4.3:
LINE SPEED/TRAIN PERFORMANCE

Speed (km/h)

Direction of travel

Key
- 250 km/h tilting rolling stock option
- 225 km/h tilting rolling stock option
- 200 km/h conventional rolling stock option
- Existing profile (175 km/h)

Full line indicates maximum line speed
Dashed line indicates actual line speed of train

Note 1 Line speed can be governed by curvatures (e.g. at Bushey); transition lengths (e.g. at Hemel Hempstead); cess width (e.g. on existing profile at Hemel Hempstead); or other restriction

Note 2 Tilting Rolling Stock can achieve higher speeds on the same curve for given comfort levels

Note 3 Acceleration/deceleration characteristics based upon traction performance of previously proposed Class 93 (IC250) train
Table 4.8: EFFECTS OF REMOVAL OF PERMANENT SPEED RESTRICTIONS (minutes saved)

<table>
<thead>
<tr>
<th>Line Section</th>
<th>200 km/h Conventional or Tilting</th>
<th>225 km/h Tilting</th>
<th>250 km/h Tilting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euston Approach (0-4 km)</td>
<td>1.56</td>
<td>1.56</td>
<td>1.56</td>
</tr>
<tr>
<td>Euston Approach (4-10 km)</td>
<td>0.34</td>
<td>0.44</td>
<td>0.52</td>
</tr>
<tr>
<td>Watford Tunnel</td>
<td>0.08</td>
<td>0.31</td>
<td>0.55</td>
</tr>
<tr>
<td>Northchurch Tunnel</td>
<td>0.04</td>
<td>0.12</td>
<td>0.17</td>
</tr>
<tr>
<td>Linslade Tunnel *</td>
<td>0.38</td>
<td>0.53</td>
<td>1.15</td>
</tr>
<tr>
<td>Stowe Hill Tunnel</td>
<td>0.12</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Kilsby Tunnel</td>
<td>0.30</td>
<td>0.56</td>
<td>0.66</td>
</tr>
<tr>
<td>Rugby Station **</td>
<td>1.13</td>
<td>1.42</td>
<td>1.52</td>
</tr>
<tr>
<td>Shugborough Tunnel</td>
<td>0.21</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>Total minutes saved</td>
<td>4.16</td>
<td>5.30</td>
<td>6.50</td>
</tr>
</tbody>
</table>

Notes:  
* Pressure relief works at 200 km/h and 225 km/h, and opening out at 250 km/h if combined with Option F (piggyback gauge)  
** Birmingham direction

Table 4.9: COSTS OF REMOVING PERMANENT SPEED RESTRICTIONS (Costs)

<table>
<thead>
<tr>
<th></th>
<th>200 km/h Conventional</th>
<th>225 km/h Tilting</th>
<th>250 km/h Tilting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital cost (£ million 1994 prices)</td>
<td>(29)</td>
<td>(31)</td>
<td>(41)</td>
</tr>
<tr>
<td>Cost (£ million NPC)</td>
<td>(19)</td>
<td>(21)</td>
<td>(27)</td>
</tr>
<tr>
<td>Cost/time saved (£ million NPC/minutes)</td>
<td>(4.6)</td>
<td>(4.0)</td>
<td>(4.2)</td>
</tr>
</tbody>
</table>

4.2.2 Increased Capacity for Passenger Services

Significant improvements in capacity are possible using the proposed new train control system as demonstrated in operational simulations undertaken by the Study. With remodelling at Euston, fast passenger...
services from London could be doubled, as far north as Crewe, enabling increased frequencies to all destinations. This is, however, subject to the traction power system being adequate. Additional power supply reinforcement is required to allow operation of extra high speed and commuter services, and this is considered as one of the improvement packages (Option B).

The principal operational constraint to capacity on the WCML is the Coventry/Wolverhampton corridor. As referred to in Section 3.1.6, Centro wishes to increase the frequency of the twice hourly stopping service to three or four trains per hour, preferably without major investment. The Study has considered ways to achieve this while also increasing the speed and frequency of the fast services.

Most of WCML from Coventry to Wolverhampton via Birmingham New Street has only two tracks. The fast services are not currently timetabled to pass the stopping services at either Birmingham International or New Street and, although traffic is not especially dense, the difference in journey times between the fast and slow services causes significant timetabling constraints.

One solution would be to create a four-track railway. However, the capital costs of four-tracking only a part of the route from Lea Hall to Berkswell, two stations on either side of Birmingham International, a distance of about 13 km, are estimated to exceed £95 million. This approach could thus probably not be justified.

The addition of only one track was also considered. A three-track scheme can give capacity benefits where traffic flows are tidal, the bulk of the flows in the morning and evening peaks being in opposite directions. Little benefit is obtained where flows are evenly divided in each direction, and the flows in the Coventry-Wolverhampton corridor were found to be of this type.

The timetabling implications of introducing simple station loops at Tile Hill and Stechford were considered. However, further investigation revealed that the wish for increased service levels could be accommodated without infrastructure works.

Two possible timetabling changes were investigated which would enable the frequency of both the stopping and the fast services to be increased without any four-tracking being required, once transmission-based train control is installed.
In the first alternative, three stopping all-stations trains per hour could be run, without timetabling fast trains to pass them. This would be possible given either an increase to three ICWC trains per hour between Coventry and Birmingham, or the retiming of one of the existing two ICWC trains by ten minutes. This alternative would prevent any significant improvements to the journey times of fast trains and reduce operational flexibility to a minimum over this section.

Another, preferred alternative would be to timetable three or four fast trains per hour to run past the all-stations services at either Birmingham International or New Street Station. An additional five to ten minutes would be added to the journey time of the all-stations services from Coventry to Wolverhampton, as a result of the extended dwell time at either Birmingham International or New Street Station for the fast services to pass. This would be compensated for by the extra frequency of local services and immediate cross-platform interchanges which would be provided between the fast and all-stations services.

A modest reinforcement of the power supply system between Rugby and Birmingham would be required to allow operation of the extra Centro services. This is allowed for within the proposed Recovery power supply works in this area.

In addition to greater frequency as a means of increasing capacity, there is also the possibility of operating longer or double-deck passenger trains. Double-deck trains are discussed in Section 4.3.1 below as these have synergies with freight gauge enhancement.

4.3 MARKET-DRIVEN FREIGHT INVESTMENTS

Several investment opportunities were identified which might be justified on the basis of potential freight revenues. These include gauge enhancements and increases in the length, speed and axle loads of freight trains. Piggyback gauge was identified as the most favourable gauge enhancement and an increased length of trains was also found to show promise for WCML. Both of these options relate to Channel Tunnel traffic, which is expected to be the primary source of market growth in railfreight over the next few years.
4.3.1 Increased Gauge

One of the fastest growing and most valuable freight markets is intermodal traffic. Deep-sea traffic is generally by containers, traditionally 8' or 8'6" high, which fit the existing British W6 gauge on standard railway wagons, but increasingly 9'6" high, which cannot at present be carried by rail in the UK. From Europe, the bulk of traffic is by roll-on/roll-off ferries using lorry tractors hauling semi-trailers which cannot be carried by rail.

For the Channel Tunnel, swap bodies can be lifted onto either special road trailers or standard railway wagons. Gauge enhancement works have been undertaken on selected routes to allow swap body railfreight services between terminals in UK and Europe. Because hauliers have to invest in swap bodies which they otherwise would not require, there are limitations on the development of the swap body market.

The Channel Tunnel may open the opportunity to develop piggyback services on the WCML on a commercial basis. The advantage of piggyback is that standard-size road trailers are used, although modified wagons are required to allow them to be lifted on to the railway. The market for this mode amongst hauliers is therefore likely to be less limited and the potential to take traffic off the roads greater.

Initially, a piggyback service on the WCML could be developed to Daventry in the Midlands, but also capturing road trailers for Europe from a wider area. The route of the initial clearance works to permit this on the WCML is indicated in Figure 4.4 and embraces some of the more difficult parts of the network. Further extensions could then more readily be achieved to Scotland and Irish Sea ports. The first stage works required on the WCML to provide the enhanced structure gauge and adequate traction power are included in Option E.

If the structure gauge were increased to allow for the carriage of piggyback trailers and 9'6" containers, the incremental investment required for the operation of double-deck passenger trains is included in Option F. The investment might then be supported by cost savings to the NLR franchise for the Northampton service.

4.3.2 Increased Capacity for Freight

The opportunity for cost efficiency and capacity increase was examined for the longer freight trains, up to the 750m maximum length, operated on French railways and through the Channel Tunnel. This would
require the lengthening of some passing loops to maintain operational flexibility on the WCML. Construction costs would be very modest, and work could be done within existing railway lands except at one location as discussed in Section 7.6.4.3. The works are included in Option G.

Modifications would also be required to the train control system but, if the trackside signalling is to be replaced in any case, there would be no incremental cost to make the necessary changes. The availability of sufficient power supplies to permit longer electric trains to be hauled would depend, firstly, on the timing of services and, second, on what, if any, power supply upgrade works are undertaken for faster passenger services. No improvements to power supplies are proposed solely to allow longer freight trains to operate, but these could be added if appropriate.

The benefits of longer freight trains, which more than offset the infrastructure costs, are that they would allow through working between the Continent and the Midlands/North West/Scotland without the need to call at Wembley European Freight Operating Centre (EFOC); thereby helping to avoid capacity problems at EFOC. This would also allow a reduction in crews and numbers of locomotives, with consequent savings to train operators. Such trains would also assist in pathing more freight via the WCML without causing negative impacts on passenger services.

4.4 CONCLUSIONS

In Section 4.1.1 it has been demonstrated that, on cost-efficiency grounds alone, transmission-based cab-signalling is preferred both to the conventional system included in Recovery and to the alternative track-circuit cab-signalling. Furthermore in reviewing journeys of speeds greater than 200 km/h it becomes a prerequisite.

As noted in Section 4.2.1.3, Railtrack cannot, on its own, decide to invest in any Market-Driven approach. It needs instead to establish business partnerships with OPRAF and the train operators which allow an adequate rate of return on these investments.

These factors suggest an approach to investment which would combine elements of the three modernisation strategies, Bedrock, Recovery and Cost-Driven, into a package of works with which Railtrack can proceed immediately. This would include an optimised programme of works
to structures based on the Bedrock strategy, and to the track and traction power system based on the Recovery strategy. There would be some additional power supply strengthening to permit extended possessions. The works on the dispersed command and control system assumed in the Bedrock and Recovery approaches would not be undertaken but, instead, the integrated control centre and transmission-based train control system taken from the Cost-Driven approach would be installed. For convenience, this programme of modernisation works has been given the name *Core Investment Programme*.

Once partnerships have been established to enable Railtrack to undertake any of the Market-Driven investment options, set out in Sections 4.2 and 4.3, those could be added to the implementation programme. This process is indicated in Figure 4.5.

In Chapter 5 the various alternative investment strategies are compared in financial and economic terms, including Bedrock, Recovery and the Core Investment Programme, on their own and in combination with the Market-Driven investment options.
FIGURE 4.5
DEVELOPMENT OF AN OVERALL BUSINESS STRATEGY

Bedrock Investment

Recovery Investment

Cost-Driven Investment

Market-Driven Investment

Optimised Trackwork Structures & Power Proposals

Train Control System Proposals

Control Centre Proposals

Core Investment Programme

Improved and Expanded Services

Market-Driven Investment Options

Implementation Recommended Immediately

Progressive Implementation under Agreement with ORR/PRAF, TOLs/FOCs
CHAPTER 5

Investment Appraisal

5.1 INTRODUCTION

Financial and economic appraisals of alternative investment packages were undertaken in order to prioritise options and to make recommendations on the preferred strategy. Options for the modernisation works have been packaged and appraised as follows:

- **Bedrock**
  
  A minimum investment strategy to maintain existing services, requiring a slightly higher level of renewals than at present;

- **Recovery**
  
  Incremental investment, where cost-effective, to modernise the railway with conventional technology, gradually bringing it into a better state of repair;

- **Core Investment Programme**
  
  Combining modernisation works, as in Recovery, with the introduction of radio transmission-based signalling and an integrated control centre.

Separate appraisals of the various passenger and freight Market-Driven upgrade options have been undertaken. As noted in Chapter 4, these have been designed as additions to the modernisation programme, for implementation subject to suitable partnerships being established.

The Market-Driven options appraised are defined as follows:

- upgrade the track by increased level of renewals to improve ride quality and permit higher linespeed options to be exercised (Option A);

- increase in capacity at existing linespeeds (Option B);
reduce journey times with 200 km/h conventional trains, or with 225 or 250 km/h tilting trains (Options C, D, and E);

- increases in loading gauge to allow for operation of trains carrying piggyback trailers and 9'6" high containers (Option F) and double-deck commuter passenger trains (Option G);

- works to permit the operation of longer freight trains (Option H).

5.2 APPRAISAL METHODOLOGY

5.2.1 Introduction

Both financial and economic appraisals of the investment alternatives have been undertaken. In order to reflect the new commercial relationships within the railway industry, financial and economic appraisal has been considered at four levels, as follows:

- impact on Railtrack alone;

- impact on the rail industry as a whole (Railtrack, TOUs, ROSCOs);

- impact on the rail industry and its customers;

- impact on the rail industry, its customers and the community as a whole (including external costs and benefits).

The cost and benefit items included at each level of appraisal are described in Table 5.1 below.
Table 5.1: APPRAISAL CRITERIA

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Level of Appraisal</th>
<th>Impacts Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Railtrack</td>
<td><strong>Infrastructure capital costs</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Infrastructure fixed maintenance costs</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Railtrack production costs</strong></td>
</tr>
<tr>
<td>Financial</td>
<td>Rail industry as a whole</td>
<td>As above, plus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Rolling stock costs</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Passenger revenues</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Operators’ production costs</strong></td>
</tr>
<tr>
<td>Financial and</td>
<td>Rail industry and its users</td>
<td>As above, plus:</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td><strong>time savings of existing users</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>reliability benefits to existing users</strong></td>
</tr>
<tr>
<td>Financial and</td>
<td>Rail industry, its users and the wider</td>
<td>As above, plus</td>
</tr>
<tr>
<td>Economic</td>
<td>community</td>
<td><strong>time savings of highway users</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>road vehicle operating cost saving</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>road accident savings</strong></td>
</tr>
</tbody>
</table>

5.2.2 Revenue Benefits

Financial analysis for Railtrack considers the effects of the investment programme on Railtrack’s costs and revenues within the regulated industry framework. In the Core Investment Programme, it has been assumed that there are no direct revenue benefits to Railtrack, as existing track charges are already set to cover asset renewal and maintenance. There will however be opportunities for cost savings. Railtrack’s infrastructure capital, maintenance and production costs have been estimated at a detailed level for the 15 line sections comprising the Study area as shown in Figure 5.1.

In considering the effects of proposals on the railway industry as a whole, it is apparent that some of the Market-Driven options will require expenditure both by Railtrack and the TOUs. For example, reduced journey times through higher line speeds would require new rolling stock, and would result in additional costs for traction energy. These have been taken into account in the analysis, with costs estimated from current manufacturers’ prices, and on the basis of traction power simulations. Faster speeds may allow some reduction in the rolling stock fleet, as asset utilisation may improve (and consequently there may be opportunities for staff savings). In the appraisal these possible benefits have been ignored.
FIGURE 5.1:
ROUTE SECTIONS OF STUDY

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Euston - Trent Valley Jcn</td>
</tr>
<tr>
<td>2</td>
<td>Trent Valley Jcn - Weaver Jcn</td>
</tr>
<tr>
<td>3</td>
<td>Weaver Jcn - Gretna</td>
</tr>
<tr>
<td>4</td>
<td>Gretna Jcn - Glasgow Central</td>
</tr>
<tr>
<td>5</td>
<td>Hanlopte Jcn to Rugby 5th Jcn</td>
</tr>
<tr>
<td>6</td>
<td>Trent Valley Jcn - Stafford, Trent Valley Jcn No 1</td>
</tr>
<tr>
<td>7</td>
<td>Crewe North Jcn - Manchester Piccadilly</td>
</tr>
<tr>
<td>8</td>
<td>Wilmalow - Manchester Piccadilly</td>
</tr>
<tr>
<td>9</td>
<td>Weaver Jcn - Liverpool</td>
</tr>
<tr>
<td>10</td>
<td>Grand Jcn Line</td>
</tr>
<tr>
<td>11</td>
<td>Norton Bridge Branch</td>
</tr>
<tr>
<td>12</td>
<td>Colwich Jcn - Manchester Piccadilly</td>
</tr>
<tr>
<td>13</td>
<td>Manchester Piccadilly - Euxton Jcn</td>
</tr>
<tr>
<td>14</td>
<td>Liverpool Lime Street - Springs Branch Jcn</td>
</tr>
<tr>
<td>15</td>
<td>Carstairs East Jcn - Edinburgh Waverley</td>
</tr>
</tbody>
</table>

Note: Colours are only to differentiate route sections.
The increase in passenger revenues resulting from improvements in service levels has been estimated using a demand forecasting model. Further details are given in Annex D. Forecasts of additional traffic volumes have assumed no increase in average fares.

5.2.3 User Benefits

Existing rail passengers enjoy significant benefits from the Core Investment Programme and the various upgrade options. These include improved reliability, shorter journey times, improved safety and better information on trains. User benefits are assessed as non-financial, and are included in the economic analysis in Sections 5.3.3 and 5.3.4. However, it is reasonable to assume that operators will capture a proportion of these benefits in increased revenues.

Although there is no clear basis for estimating the share of user benefits captured by train operators, some will be captured and then returned to the Government through decreased subsidy. In the long term, competition may well force all benefits to be passed on to passengers. In this analysis, user benefits from time saving and reliability are presented assuming no change in average fares. The extent to which these benefits might be captured by operators is considered separately in Annex D.

5.2.4 Non-user Benefits

Non-user benefits arise as a result of the impact of improved railway services on competing modes. Benefits accrue to highway users remaining on the roads, as a result of highway decongestion following the diversion of traffic (passengers) from road to rail. These benefits have been assessed conventionally, using a highway evaluation model which is also described in Annex D. Benefits have been assessed only on inter-urban highway links where the principal benefits will derive, ignoring the effects of any changes in traffic volumes in urban areas. No benefits have been assumed to accrue within the M25, for example.

Non-user benefits considered in the analysis are those resulting from:

- time savings to highway users;
- reduced vehicle operating costs;
- reduced road accidents.

Although there may be other non-user benefits accruing to the project, for environmental reasons (reduced pollution, emissions from
diversion of road users to rail) and from reduced airport congestion, these are likely to be minor and have been ignored in the appraisal.

5.2.5 General Assumptions

The appraisal has been carried out in 1994 prices over a 30-year period. Costs and revenues have been discounted to the financial year 1995-96, the project decision date for tender letting. This is in accordance with DoT/Treasury convention. An 8% real discount rate has been applied, reflecting Railtrack's rate of return targets and recent experience of the real cost of capital for project finance.

Thirty years is a common evaluation period for transportation projects. Given that the revenue benefits only commence some way into the 30-year period this is effectively over a shorter period than most evaluations.

5.3 APPRAISAL OF MODERNISATION OPTIONS

5.3.1 Impact on Railtrack

The financial impacts on Railtrack of the three alternative modernisation options, Bedrock, Recovery and the CIP, have been assessed in terms of cost effectiveness; no direct revenue impacts have been assumed.

5.3.1.1 Bedrock Investment

Capital costs for this option amount to some £69 million per annum on average throughout the 30-year period. These costs include works on all 15 sections of the WCML and are based on current Infrastructure Services (BRIS) rates for track renewals, with signalling and OHLE/power costs based on current private sector contract prices. The average annual capital costs are made up of £39 million investment in track renewals, £22 million in signalling renewals, £5 million in structures and £3 million in power supply equipment.

Maintenance costs average £83 million per annum over the period. These costs have been based on current BRIS contract rates with efficiency savings. This is discussed further in Annex E.

Production costs, which average £48 million per year under the Bedrock option, are those costs associated with operating the signalling
and control functions including electricity costs "passed through" to train operators.

The estimates for the Bedrock option are consistent with an extrapolation of Railtrack's 1994-95 maintenance budget and depreciation but allowing for an increased rate of renewals which is necessary to maintain the average age of track and ballast at current levels.

The unit costs of both track renewal and maintenance are assumed to reduce as the BRIS companies become more efficient. Productivity increases are all broadly in line with existing contract targets. They are:

- 20% spread over six years, in unit maintenance costs;
- 13% spread over three years, in track renewal costs.

5.3.1.2 Recovery Investment

Total capital costs of Recovery over 30 years are £1,010 million NPV, some £40 million more than for the Bedrock option. This increase in costs relates primarily to the accelerated programme of signalling and power supply renewal.

Savings are achieved in maintenance costs; however, these are offset by capital expenditure to bring certain elements of the railway into a better state of repair. Production costs under this option are the same as those for Bedrock.

Efficiency gains are assumed to be achieved by BRIS under all modernisation options. However, in Recovery and the CIP, it is envisaged that a single maintain, design, build, maintain (MDBM) contract would be awarded for some 15-25 years. Additional efficiencies should result from a single contractor's ability to organise and plan capital and maintenance works together and to manage the required possessions. An additional efficiency saving of 5% over that achieved in Bedrock has been assumed for both track renewals and maintenance expenditure. This is further discussed in Annex E.

5.3.1.3 Core Investment Programme

In the CIP, track and electrical engineering works are as in Recovery. For track this includes an additional £30 million capital investment above the Bedrock investment, targeted where it is most needed.
Structures are maintained as in Bedrock. However, the existing track-based signalling is replaced with radio transmission-based train control, and a single control centre is provided. These investments were shown in Chapter 4 to have substantial technical and financial benefits.

Total capital costs of the programme are £970 million NPV over the 30-year evaluation period. The CIP is lower than Bedrock by less than £10 million largely due to the lower costs of transmission-based train control over the life of the project. During the key period 1996-97 to 2003-04, when the majority of the work will be undertaken, the CIP is estimated to require capital expenditure of some £960 million (1994 prices, undiscounted). This is shown in Table 5.2, along with the discounted NPV figures for the same period.

Table 5.2: CAPITAL COSTS IN PERIOD 1996-97 TO 2003-04

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Track</td>
<td>385</td>
<td>305</td>
</tr>
<tr>
<td>Structures</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Power</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Train Control</td>
<td>425</td>
<td>300</td>
</tr>
<tr>
<td>Control Centre</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>960</td>
<td>730</td>
</tr>
</tbody>
</table>

Average annual maintenance costs are less than in Bedrock, reflecting cost savings both to signalling and indirectly to other maintenance because of increased flexibility, especially with possessions.

Production costs are lower than for the Bedrock and Recovery cases. Estimation of these costs has been based on the experience in Denmark, the UK and the USA of large resignalling and control centre projects.

Additional efficiency gains (on top of Recovery) are assumed in the CIP after the introduction of transmission-based signalling between 2001 and 2005. Benefits of the new signalling system include: increased capacity, bi-direction operations, improved possession management and reduction in track circuits. These benefits will result in estimated cost savings of 5% in track maintenance and renewals. These are
discussed further in Annex E.

5.3.4.4 Treatment of ATP

ATP is included in the CIP, as it is an inherent feature of the proposed transmission-based train control system and has no significant additional cost. It is not, however, included in the Bedrock or Recovery strategies because it is considered that it is not a cost effective way of improving safety with conventional signalling technology.

For the purposes of comparison, the benefits of ATP can be considered in two ways.

First, the direct financial benefits of ATP can be included in an evaluation of the CIP. These are estimated to be in the order of £12.5 million NPV. This is made up of reduced damage and disruption to plant and equipment, plus saving on average of 0.4 lives per year. These estimates have been developed pro rata from national rail accident data. Most of these benefits would be received by train operators, who are responsible for leasing and operating trains, and not by Railtrack.

Second, the cost of providing ATP in Recovery is estimated to be £50 million NPV.

ATP cannot realistically be provided in Bedrock, as it would require comprehensive replacement of the signalling infrastructure. The provision of ATP, other than in the CIP, would require an increase in track access charges.

5.3.4.5 Summary of Costs

The cost streams discounted to present values are shown in Table 5.3. In both the Recovery and CIP options, capital costs in the early years are much higher than for Bedrock, although both capital and maintenance costs are substantially reduced in later years.

In terms of cost effectiveness for Railtrack, the CIP is the preferred strategy, with the NPV of total costs amounting to £190 million less than that for Bedrock.

---

6 See Automatic Train Protection, British Railways Board July 1994. See especially table 2. WCML is assumed to represent 15% of the entire network in terms of passenger-km
The financial appraisal of the modernisation strategies from the perspective of the rail industry as a whole is shown in Table 5.4.

The programme of infrastructure modernisation in Recovery and the CIP will:

- permit reductions in engineering and operating allowances in the timetable;
- contribute to an improvement in train punctuality.

These benefits, described further in Annex F, will enable TOUs to offer faster journey times and more reliable services. This will attract new passengers, generating additional income for the TOUs. Additional revenues have been included assuming no change in average fares, and also assuming no increased costs to TOUs to carry the increased traffic. The methodology for estimating additional traffic and revenues is described in Annex D.

TOUs will also be the main beneficiaries of ATP, which is inherently provided in the CIP and can be included in Recovery at additional cost.

There will also be some operating and possible fleet cost savings to TOUs, because of increased reliability. These have been ignored in this analysis.

Table 5.3: IMPACT ON RAILTRACK

<table>
<thead>
<tr>
<th>Option</th>
<th>£ Million 1994 Capital</th>
<th>Capital</th>
<th>Maintenance</th>
<th>Production</th>
<th>Total Cost</th>
<th>Savings over Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>(2,050)</td>
<td>(970)</td>
<td>(1,070)</td>
<td>(590)</td>
<td>(2,630)</td>
<td>-</td>
</tr>
<tr>
<td>Recovery</td>
<td>(1,990)</td>
<td>(1,010)</td>
<td>(980)</td>
<td>(590)</td>
<td>(2,580)</td>
<td>50</td>
</tr>
<tr>
<td>Core Investment Programme</td>
<td>(1,850)</td>
<td>(970)</td>
<td>(950)</td>
<td>(520)</td>
<td>(2,440)</td>
<td>190</td>
</tr>
</tbody>
</table>

5.3.2 Impact on the Rail Industry as a Whole
Table 5.4: IMPACT ON THE RAIL INDUSTRY (£ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Railtrack Costs</th>
<th>Revenue Benefit from Reduced Allowances</th>
<th>Revenue Benefit from Improved Punctuality</th>
<th>Benefits to TOUs of ATP</th>
<th>Net Benefits to TOUs</th>
<th>Total Costs and Revenues</th>
<th>Benefits and Costs over Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>(2,630)</td>
<td>-</td>
<td>N/A</td>
<td></td>
<td></td>
<td>(2,630)</td>
<td>-</td>
</tr>
<tr>
<td>Recovery</td>
<td>(2,580)</td>
<td>6</td>
<td>4</td>
<td>N/A</td>
<td>10</td>
<td>(2,570)</td>
<td>60</td>
</tr>
<tr>
<td>Core Investment Programme</td>
<td>(2,440)</td>
<td>15</td>
<td>12</td>
<td>13</td>
<td>40</td>
<td>(2,400)</td>
<td>230</td>
</tr>
</tbody>
</table>

The CIP is also the preferred option for the rail industry as a whole: the decrease in cost between Bedrock and the CIP increases to £230 million NPV.

5.3.3 Impact on the Rail Industry, and its Customers

Passengers will also benefit from faster and more reliable rail services. User benefits are estimated assuming no increase in average fares, with passengers retaining the benefits as increased consumer surplus.

Table 5.5: IMPACT ON THE RAIL INDUSTRY AND ITS CUSTOMERS (£ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Railtrack Costs</th>
<th>Net Benefits to TOUs</th>
<th>Benefits to TOUs of ATP</th>
<th>Total Benefits</th>
<th>Net Costs and Benefits</th>
<th>Net Benefit over Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>(2,630)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(2,630)</td>
<td>-</td>
</tr>
<tr>
<td>Recovery</td>
<td>(2,580)</td>
<td>10</td>
<td>70</td>
<td>30</td>
<td>(2,550)</td>
<td>80</td>
</tr>
<tr>
<td>Recovery with ATP</td>
<td>(2,630)</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>(2,590)</td>
<td>40</td>
</tr>
<tr>
<td>Core Investment Programme</td>
<td>(2,440)</td>
<td>40</td>
<td>30</td>
<td>70</td>
<td>(2,370)</td>
<td>260</td>
</tr>
</tbody>
</table>

5.3.4 Impact on the Rail Industry, its Customers and the Wider Community

Road users will benefit from the diversion of passengers and traffic to rail, because of the improved reliability and shorter journey times. These benefits are not very significant and amount to £2 million NPV in Recovery and the CIP.
Overall, the economic appraisal confirms that the CIP is the preferred option, not only for Railtrack, but for the train operators, railway passengers, and the wider community. As can be seen from Table 5.5, the benefits of the CIP total £260 million over Bedrock and £220 million more than Recovery with ATP.

5.3.5 Sensitivity Analysis

One of the key assumptions in the cost estimates for the modernisation options is that the contracting strategy proposed in Recovery and the CIP is able to achieve efficiency gains in excess of those achievable under the Bedrock strategy.

This assumption has been relaxed in sensitivity analysis and the investment appraisal undertaken assuming that no contracting efficiencies can be secured beyond those in Bedrock. Relaxation of the efficiency assumption increases the present costs of the Recovery and the CIP as given in Table 5.6.

Table 5.6: SENSITIVITY ANALYSIS WITH EFFICIENCY ASSUMPTIONS (£ million NPV)

<table>
<thead>
<tr>
<th></th>
<th>Costs with efficiency gains</th>
<th>Costs without efficiency gains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>N/A</td>
<td>(2,630)</td>
</tr>
<tr>
<td>Recovery</td>
<td>(2,580)</td>
<td>(2,620)</td>
</tr>
<tr>
<td>Core Investment Programme</td>
<td>(2,440)</td>
<td>(2,510)</td>
</tr>
</tbody>
</table>

Even with the relaxation of the efficiency assumptions, there is still a saving to Railtrack of £120 million NPV in the CIP over Bedrock.

5.3.6 Risk Assessment

A risk assessment of capital and maintenance costs was carried out on the engineering estimates for Bedrock and the Core Investment Programme. A detailed description of the methodology can be found in Annex G, including what elements of the overall estimates have been analysed.

The results of the risk assessment are shown in Figure 5.2 in the form of S-curves for Bedrock and the Core Investment Programme. The S-curves indicate the probability that a given cost will not be exceeded.
FIGURE 5.2:
RISK ASSESSMENT

Total Engineering Estimates
(Undiscounted Capital and Maintenance 1995/96 to 2024/25)

20-Dec-94

Cost not to exceed (£M)

Probability

Bedrock Total
Base £5,319M
Core Total
Base £5,115M
Costs in the S-curves are 1994 based, not discounted, and cover the 15-year period evaluated in the risk assessments.

The risk assessment indicates that, based on the engineering estimates, the CIP carries a lower spread of risk about 20% compared with 23% for Bedrock but Figure 5.2 shows that the probability of exceeding the base costs for CIP (40%) is higher than for Bedrock (30%), as would be expected because of the greater uncertainty in the estimates. The worse case scenario for the CIP is an overrun of 10%. (This analysis is based on the engineering estimates only and does not take into account the efficiency improvements.) Further work on an overall risk assessment is necessary as specified in Annex G.

The cost estimates for the CIP include the cost of developing the transmission-based train control system. The major risks associated with the introduction of the new system relate to the programme and the development of functional safety-validated software. The risk assessment includes an estimate of the uncertainty anticipated with the development programme. The quality of functional software can be greatly enhanced using structured programming methods, CASE tools and the use of high level languages. Software in the interlocking computers must be validated to Level 4 safety requirements. Impact on schedule can be minimised by involving the safety validation team at the beginning of the development process.

5.4 APPRAISAL OF MARKET-DRIVEN OPTIONS

5.4.1 Introduction

Railtrack derives no direct benefits from upgrading the infrastructure and will only achieve enhanced revenues to the extent that it can negotiate higher track access charges with train operators. The selection of infrastructure upgrading options must therefore be customer-driven, with TOUs agreeing to pay the costs to Railtrack through adjustments to the access charges. In appraising upgrading options, therefore, the analysis has been made from the perspective of the railway industry. If an option is viable at industry level, it is in the interests of all parties to negotiate a mutually satisfactory charging arrangement.

Market-Driven options have all been incrementally costed on the optimum modernisation option, demonstrated in Section 5.3 above to be the CIP. The transmission-based train control system included in
the CIP inherently provides for an increase in capacity (train paths), and allows for increases in linespeeds without any further expenditure on train control. Other works are required to track, power supply, structures and electrification to implement the upgrade options.

5.4.2 Improved Track Quality (Option A)

Upgrading the track, above existing achieved standards, would allow improvement in ride quality, reliability and punctuality. This would require increases in capital spending, to achieve the higher standards, but would lead to savings in maintenance costs. Track might be upgraded only on:

- the trunk route between London and Crewe (Sections 1 and 2);
- all the routes between London and Birmingham, Manchester and Liverpool (Sections 1, 2, 6, 7, 9, 12);
- all the routes between major cities including Glasgow and Edinburgh (Sections 1, 2, 3, 4, 6, 7, 9, 12, 15);
- the entire WCML network.

Incremental costs to the CIP for alternative packages are presented in Table 5.7.

Table 5.7: COST OF TRACK UPGRADE OPTIONS INCREMENTAL TO CIP (£ million NPV)

<table>
<thead>
<tr>
<th>Sections</th>
<th>Incremental Capital Costs</th>
<th>Savings in Maintenance Costs</th>
<th>Total Incremental Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>(68)</td>
<td>17</td>
<td>(51)</td>
</tr>
<tr>
<td>1,2,6,7,9,12</td>
<td>(121)</td>
<td>25</td>
<td>(96)</td>
</tr>
<tr>
<td>1,2,3,4,6,7,9,12,15</td>
<td>(181)</td>
<td>40</td>
<td>(141)</td>
</tr>
<tr>
<td>All</td>
<td>(194)</td>
<td>44</td>
<td>(150)</td>
</tr>
</tbody>
</table>

Benefits from track upgrade resulting from improved reliability and punctuality are summarised in Table 5.8.
Upgrading of the track cannot be justified on the revenue benefits alone. However, taking account of passenger (user) benefits, upgrade of Sections 1 and 2 and also of the main routes to Birmingham, Liverpool and Manchester can be justified.

There is, currently, no basis for estimating how much passengers might be willing actually to pay for improved track quality, or what revenue could be generated through new customers.

5.4.3 Increase in Capacity (Option B)

Option B provides for enhancement of the power supply to allow an increase in passenger train frequency, which would be possible with the new train control system.

The CIP includes works for power supply strengthening principally between London and Birmingham. This modernisation will accommodate Centro's desire for two additional trains per hour between Birmingham and Coventry, and also GMPTE's proposals for extra services between Manchester Airport and Manchester Piccadilly.

The following increased peak service scenario has been considered:

* **InterCity**
  
  one additional train London-Manchester per hour;
  one additional train London-Liverpool per hour;
  one additional train London-Birmingham per hour;
North London

additional fast trains London-Northampton;
increase in size of sets to 8 and 12 cars.

The capital cost of providing additional power supply reinforcement to accommodate these increases is estimated at £13 million.

The increased service frequencies permitted by upgraded power supplies will result in increased passenger patronage; the revenue benefits of this have not been incorporated in the evaluation at this stage.

5.4.4 Reductions in Journey Times (Options C, D and E)

5.4.4.1 Introduction

Infrastructure investments to achieve reductions in journey times have been tested for three linespeed options, ranging from 200 km/h, through 225 km/h to 250 km/h on all the principal city to city routes. This covers sections 1, 2, 3, 4, 6, 7, 9, 12 and 15 on Figure 5.1. Linespeed increases have not been considered for other sections of track.

A limited number of speed upgrade packages have been considered. However, it could be that the optimum investment would include a different combination of rolling stock and infrastructure improvements, with speeds of, for example, 250 km on certain core routes, with other routes operated at 175 km/h or 200 km/h.

5.4.4.2 Costs

Incremental capital costs for Railtrack comprise those for pressure relief shafts in tunnels, improved track quality, improved track alignment, upgrading of OHLE, and reinforcement of power feeds where required. The upgrade of track for reduced journey times is dependent on, and is in addition to, track being upgraded in Option A.

The capital costs are set out in Table 5.9, excluding TOU costs. These are incremental on CIP.
Table 5.9: CAPITAL COSTS INCREMENTAL ON CIP (£ million 1994 prices)

<table>
<thead>
<tr>
<th>Item</th>
<th>Option C 200 km/h Conventional</th>
<th>Option D 225 km/h Tilting</th>
<th>Option E 250 km/h Tilting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures</td>
<td>0</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Track and formation</td>
<td>(30)</td>
<td>(59)</td>
<td>(80)</td>
</tr>
<tr>
<td>Permanent speed restrictions*</td>
<td>(29)</td>
<td>(31)</td>
<td>(41)</td>
</tr>
<tr>
<td>Power supply and OHLE</td>
<td>(178)</td>
<td>(244)</td>
<td>(275)</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control centre</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total capital cost to Railtrack</td>
<td>(237)</td>
<td>(334)</td>
<td>(396)</td>
</tr>
</tbody>
</table>

* Costs included in PSRs
** Selection based on cost-benefit analysis

There will be significant costs to the TOUs of running trains at higher linespeeds. New rolling stock needs to be acquired, with ROSCOs needing to find new customers for existing stock or to write it off. A possible rolling stock replacement plan has been devised for relevant ICWC and NLR TOUs, based on the life profile of existing assets and current estimates of new rolling stock prices and residual values.

The TOUs will also incur incremental costs of traction energy, and track wear and tear (depending on bogie design), both of which increase at higher speeds. These have been estimated for representative rolling stock using a power simulation model described in Annex L, and methods similar to the mini-MARPAS formulae respectively. Both costs are passed through to TOUs in the access charges.

Incremental costs of increasing linespeeds are shown in Table 5.10 below. These include the cost of easing some PSRs, as described in section 4.2.1.5 above, where this has proved financially viable from the perspective of the rail industry as a whole. The methodology used to select PSRs for removal is described in Annex H, based on a simple comparison of costs with revenue benefits.
5.4.4.3  Revenue Benefits

Benefits to the rail industry accrue through increased rail patronage. Increasing linespeeds allow a reduction in journey times on train services. The usual journey time for London-Manchester, for example, reduces from 2 hours 32 minutes at 175 km/h to 2 hours and 3 minutes at 250 km/h with a tilting train, with the existing four intermediate stops. Two hours would be achieved with three intermediate stops. Similarly, the usual journey time for London-Birmingham New Street reduces from 100 minutes at 175 km/h to 87 minutes at 250 km/h with a tilting train.

The forecast increase in passenger carryings for ICWC TOU is shown in Table 5.11. The increase in passenger loading is as much as 22% on the London-Manchester route with 250 km/h tilting trains.

Table 5.10: COSTS OF MARKET-DRIVEN LINESPEED UPGRADES (Incremental costs on the CIP and Option A, £ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Incremental Costs to Railtrack</th>
<th>Incremental Costs to TOUs/ROSCOs</th>
<th>Total Incremental Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 200 km/h</td>
<td>(141)</td>
<td>(93)</td>
<td>(234)</td>
</tr>
<tr>
<td>conventional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 225 km/h</td>
<td>(198)</td>
<td>(135)</td>
<td>(333)</td>
</tr>
<tr>
<td>tilting trains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E 250 km/h</td>
<td>(235)</td>
<td>(178)</td>
<td>(413)</td>
</tr>
<tr>
<td>tilting trains</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.11: SUMMARY OF INCREASED PASSENGER CARRYINGS FROM INCREASED LINESPEEDS (Increases over existing rail carryings)

<table>
<thead>
<tr>
<th>Route</th>
<th>Option C 200 km/h Conventional</th>
<th>Option D 225 km/h Tilting Train</th>
<th>Option E 250 km/h Tilting Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>London &amp; Glasgow</td>
<td>5%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>London &amp; Manchester</td>
<td>10%</td>
<td>19%</td>
<td>22%</td>
</tr>
<tr>
<td>London &amp; Birmingham</td>
<td>10%</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>London &amp; Liverpool</td>
<td>8%</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>London &amp; north Wales</td>
<td>7%</td>
<td>12%</td>
<td>13%</td>
</tr>
</tbody>
</table>
The estimated additional revenue accruing to the TOUs from reductions in journey times are set against the additional costs incurred in providing services at higher linespeeds in Table 5.12. These additional cost and revenue figures are incremental on the CIP and Option A, described in Section 5.4.2 above.

Table 5.12: FINANCIAL APPRAISAL FOR THE RAIL INDUSTRY OF INCREASED LINESPEED OPTIONS INCREMENTAL ON CIP AND OPTION A (£ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Incremental Costs</th>
<th>Additional TOU Revenue</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 200 km/h conventional</td>
<td>(234)</td>
<td>104</td>
<td>(130)</td>
</tr>
<tr>
<td>D 225 km/h tilting</td>
<td>(333)</td>
<td>207</td>
<td>(126)</td>
</tr>
<tr>
<td>E 250 km/h tilting</td>
<td>(413)</td>
<td>231</td>
<td>(182)</td>
</tr>
</tbody>
</table>

Clearly, passenger revenues increase with speed, as journey times are reduced and the service is made more attractive to passengers. Even so, from the perspective of the rail industry as a whole, the forecasts of increased revenue suggest that none of the speed options looks financially viable. However, it should be noted that no premium fare pricing strategies have been tested and that the forecast of extra patronage is based on the standard Passenger Demand Forecasting Handbook (PDFH) elasticity value which is, strictly speaking, only applicable to small journey time reductions. (Different assumptions may result in positive NPVs.) What is clearly apparent from Table 5.12 is that 250 km/h shows little TOU revenue benefit over 225 km/h, which in turn implies that over the route as a whole, the maximum speed of 250 km/h is rarely achieved.

The need for additional capacity to accommodate the higher patronage resulting from each option has not been assessed at present. (Any higher frequencies needed to supply the capacity would result in higher patronage again and require a re-run of the demand forecasting model. This iterative effect will be assessed once the preferred speed option has been agreed with all parties.) Furthermore, TOUs may choose alternative methods of handling increased demand, such as increasing load factors, train capacity or frequency or by changes in pricing policy.
5.4.4.4 Economic Benefits

Summary results of the user and non-user benefits are shown in Table 5.13.

Table 5.13 BENEFITS TO RAIL USERS AND NON-USERS FROM HIGHER LINESPEED OPTIONS (£ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Passenger Benefit</th>
<th>Non-user Benefit</th>
<th>Total Non-financial Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 200 km/h - conventional</td>
<td>178</td>
<td>11</td>
<td>189</td>
</tr>
<tr>
<td>D 225 km/h - tilting</td>
<td>342</td>
<td>20</td>
<td>362</td>
</tr>
<tr>
<td>E 250 km/h - tilting</td>
<td>380</td>
<td>23</td>
<td>403</td>
</tr>
</tbody>
</table>

It can be seen that the total passenger (user) benefits are significant particularly for the higher-speed options. Thus the scope of premium pricing for the speed options is confirmed enabling higher revenues to be achieved. Non-user benefits on the other hand are small. This is because of the relatively small numbers of passengers attracted from car to rail (and to a lesser extent coach) in relation to the total traffic volumes on the competing highway network. For example, on the M6 north of Birmingham it is estimated that approximately 1,300 car trips will be removed from the highway against a Do-Minimum flow of approximately 104,000 vehicles per day.

Adding these benefits to the additional revenue earned by the TOUs from extra patronage, the total benefits to the rail industry, its users and the wider community substantially exceed the incremental costs of increasing linespeeds, as shown in Table 5.14.

Table 5.14: APPRAISAL OF HIGHER LINESPEED OPTIONS FOR THE RAIL INDUSTRY, USERS AND THE WIDER COMMUNITY (£ million NPV)

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Incremental Costs</th>
<th>Total Incremental Benefits</th>
<th>Net Present Value</th>
<th>Internal Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 200 km/h conventional</td>
<td>(234)</td>
<td>293</td>
<td>59</td>
<td>9.6%</td>
</tr>
<tr>
<td>D 225 km/h tilting</td>
<td>(333)</td>
<td>569</td>
<td>236</td>
<td>12.5%</td>
</tr>
<tr>
<td>E 250 km/h tilting</td>
<td>(413)</td>
<td>634</td>
<td>221</td>
<td>11.9%</td>
</tr>
</tbody>
</table>
It can be seen that the 225 and 250 km/h options have similar NPVs, but the 225 km/h has the highest benefit to cost ratio and internal rate of return. However, it must be recognised that there are risks associated with these options as they require tilting trains.

5.4.5 Increases in Loading Gauge (Options F and G)

Two of the Market-Driven options would require an increased loading gauge: piggyback freight and 9'6" high containers (Option F) and double-deck rolling stock for passengers (Option G).

Investigations concerning the economic viability of a piggyback freight network in the UK are ongoing. There may be a commercial case for such a network linking Scotland, Irish Sea ports and the North West to mainland Europe via the WCML and the CTRL. For the purposes of the present analysis, a more modest initial investment has been considered, that of gauge enhancement between a junction with the CTRL in North London and Daventry, near Rugby, which should be seen as a step towards a complete network.

The analysis indicates that such a scheme could offer substantial financial returns to Railtrack. Total capital costs of gauge enhancement over the North London to Daventry line sections are estimated to be £47 million (1994 prices, undiscounted), equivalent to £26 million NPV, compared to incremental annual revenues in excess of £10 million. Increased gauge in tunnels for freight traffic would also reduce aerodynamic pressures for higher speed passenger trains. In addition, removal of road trailers from the highway network in the South East would produce some modest non-user benefits of some £3 million NPV.

The Piggyback Consortium's demand forecasts may be conservative, and it is recommended that Railtrack further examine the piggyback concept in association with private sector partners.

With gauge enhancement to the Midlands, there is the prospect of operating double-deck commuter rolling stock from London at least to Northampton. This would require minor additional gauge enhancement to accommodate the rolling stock, which could be achieved at a total capital cost of £73 million. If the OHLE is to be replaced in any case for a high-speed option, the incremental capital cost would be only £40 million (capital costs are 1994, undiscounted).
Use of double-deck rolling stock would offer to franchisees savings in train operating and maintenance costs. Although the cost, per seat, to acquire double-deck carriages is similar to that of single-deck stock, the operating cost per seat is substantially reduced.

5.4.6 Increased Capacity for Freight Trains

Option G includes modifications to allow operation of freight trains of up to 750 metres in length between Scotland and London (and hence to mainland Europe via CTRL). This would offer benefits to Railtrack and the train operators in terms of operating cost efficiency and additional train capacity. Fewer locomotives and train crews would be required, and there might be less need to break and join trains as currently happens at Wembley.

The capital investment required to achieve this is limited to the lengthening of some passing loop, and associated changes to signalling. Capital costs are estimated to be £3 million (1994, undiscounted), assuming the requisite power strengthening has been undertaken as part of another upgrade option, or that diesel trains are used.

If currently scheduled Channel Tunnel intermodal services were operated with 750 m long trains, there would be a significant cost saving to operators.

It is recommended that Railtrack further develop this option in conjunction with the FOCs.

5.5 OVERALL CONCLUSIONS

There is a clear business case for modernising the WCML through the Core Investment Programme. Cost savings to Railtrack would be £190 million NPV, compared with the Bedrock alternative over the 30-year discounting period. Savings compared with Recovery would be £140 million NPV. Although the CIP requires a commitment of more up front capital investment, this is entirely offset by savings in maintenance and production costs at the 8% real discount rate.

The CIP can be funded within the current track access charge regime. Also there will be benefits to the railway industry, passengers, and road users totalling £260 million NPV. Of this, the revenue benefits to the TOUs are estimated at some £40 million and user benefits at some £30 million.
The recommendation to implement the CIP is robust, over a range of alternative assumptions, and is the preferred strategy from the perspective of Railtrack, the rail industry, its users and the community as a whole.

A number of Market-Driven investment opportunities have been appraised, including options which offer the prospect of reduced journey times and additional capacity. Many of these options do not appear to be financially viable but do appear to be economically viable as can be seen from Table 5.15, which shows costs and benefits incremental on CIP and Option A.

Table 5.15: SUMMARY OF ECONOMIC APPRAISAL FOR HIGHER LINESPEED OPTIONS (£ million, NPV, incremental on CIP and Option A)

<table>
<thead>
<tr>
<th>Options</th>
<th>Costs</th>
<th>Benefits</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Railtrack</td>
<td>TOUs</td>
<td>Revenue</td>
</tr>
<tr>
<td>C 200 km/h</td>
<td>(141)</td>
<td>(93)</td>
<td>104</td>
</tr>
<tr>
<td>conventional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 225 km/h</td>
<td>(198)</td>
<td>(135)</td>
<td>207</td>
</tr>
<tr>
<td>tilting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E 250 km/h</td>
<td>(235)</td>
<td>(178)</td>
<td>231</td>
</tr>
<tr>
<td>tilting</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Development of the Market-Driven options, however, depends upon suitable partners being identified and mutually satisfactory financial relationships being established. It is recognised that the new TOCs will have their own strategies for future service development, and therefore no final selection of Market-Driven options can be made at this stage.
CHAPTER 6

The Recommended Strategy

6.1 OVERVIEW

The recommended strategy is to implement the Core Investment Programme as soon as reasonably possible. This modernisation will reduce costs, and can be funded from the existing track access charges. It will significantly improve reliability and safety and marginally reduce journey times.

In addition, Market-Driven investment options for upgrading the WCML have been identified which permit significant journey time reductions for passengers and improvements to freight services. These options show overall economic benefits, but will only become attractive to Railtrack if it receives additional revenue. A series of options is therefore presented, from which a choice can be made during negotiations with the TOUs and OPRAF.

The extent of investment by others, such as ROSCOs, FOCs and TOUs, and the costs and benefits to them, have been identified in Chapter 5. It is recognised that these companies will need to form their own assessments before negotiations can be completed.

The Study team has prepared an outline performance specification for Railtrack, which defines the detailed technical requirements of the recommended strategy. A general description of the scheme is given in Section 6.2 below, with greater detail of the Core Investment Programme and upgrade options in Sections 6.3 and 6.4 respectively.

6.2 THE SCHEME

6.2.1 The Core Investment Programme

The Core Investment Programme comprises the optimum works for Railtrack to carry out on the WCML. It includes:

- the introduction of transmission-based train control;
• the construction of a new control centre, with staff carrying out train control, power control and production functions for the whole WCML;

• the construction of a training and back-up control centre on a site sufficiently remote from the main centre to prevent common-mode failure but close enough for common staffing;

• upgrading the infrastructure to allow longer and more productive possessions;

• keeping the quality of track and structures in a satisfactory condition;

• upgrading the traction power system to meet performance standards.

This package of work reduces the present value of costs of running the existing service levels over the period to 2025 and beyond. It ensures a level of service to train operators that will satisfy OPRAF and the ORR.

6.2.2 Market-Driven Enhancement Options

The options for upgrading the infrastructure, in ways which can be exploited by train operators, have been described in Chapter 4. The additional costs of each option over the Core Investment Programme have been estimated. The maximum linespeed and the time savings which can be achieved on the London-Manchester services, compared with the May 1994 timetable, are shown for illustrative purposes in Table 6.1. Other services to the West Midlands, Liverpool, the North West and Scotland will also benefit and journey times have been given in Table 4.7. Options F, G and H can be additional to the Core Investment Programme or to Options A, B, C, D or E, though the costs may vary accordingly.

Tilting trains offer the possibility of higher speeds around curves which restrict speed with conventional rolling stock. Active rather than passive tilting is preferred to react quickly and comfortably to the relatively short reverse curves on the WCML. ABB and Fiat currently manufacture successful active tilting trains, though changes to size to fit the British structure gauge would be required. ROSCOs and TOCs, the likely purchasers of new rolling stock for higher speeds, must also be convinced of the commercial case for such operations.
Table 6.1: SUMMARY OF MARKET-DRIVEN INVESTMENT OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Maximum Speed (km/h)</th>
<th>Railtrack Capital Cost (1994 £ million)</th>
<th>Time Saved ** (minutes)</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>175</td>
<td>(416) Incremental on CIP</td>
<td>3</td>
<td>Track relaying accelerated to improve ride comfort and enable higher speed options to be exercised</td>
</tr>
<tr>
<td>B</td>
<td>175</td>
<td>(13) Incremental on CIP</td>
<td>0</td>
<td>Reinforced power supply to allow more frequent trains (London-Birmingham largely included in Core Investment Programme)</td>
</tr>
<tr>
<td>C</td>
<td>200</td>
<td>(237) Incremental on CIP plus Option A</td>
<td>14</td>
<td>Improved track alignment on all principal routes for conventional trains; OHLE upgraded or, in some places replaced; power supply reinforced</td>
</tr>
<tr>
<td>D</td>
<td>225</td>
<td>(334) Incremental on CIP plus Option A</td>
<td>25</td>
<td>Tilting trains on track similar to that of Option B on all principal routes; OHLE replaced for 225 km/h linespeed and extra power supply reinforcement</td>
</tr>
<tr>
<td>E</td>
<td>250</td>
<td>(396) Incremental on CIP plus Option A</td>
<td>29</td>
<td>Track alignment improved on all principal routes for 250 km/h tilting trains and power supply and OHLE converted to 25-0-25kV auto-transformer system</td>
</tr>
<tr>
<td>F</td>
<td>-</td>
<td>(47) Incremental on CIP</td>
<td>-</td>
<td>Piggyback freight from Camden Junction to Daventry freight terminal enabled through increase in height of structure gauge; OHLE needs to be raised with minimal power supply reinforcement; if work for 225 km/h higher-speed trains is assumed, cost reduces to £44 million</td>
</tr>
<tr>
<td>G</td>
<td>-</td>
<td>(40) Incremental on CIP, plus Options A, E and F</td>
<td>-</td>
<td>Double-deck trains from Euston to Northampton enabled through further increase in height of 170 mm over piggyback at a cost of £40 million if work for higher linespeeds is assumed; if such work is not assumed, costs rise to £73 million</td>
</tr>
<tr>
<td>H</td>
<td>-</td>
<td>(3) Incremental on CIP</td>
<td>-</td>
<td>Five passing loops extended to allow a service between London, Liverpool, Manchester and Glasgow with 750 m long freight trains; if only London, Liverpool and Manchester cost drops to £0.8 million; assumes diesel traction or power reinforcement has already been carried out</td>
</tr>
</tbody>
</table>

* £150M NPC, allowing for maintenance savings over 30 years
** London-Manchester routes

6.3 ENGINEERING COMPONENTS OF CORE INVESTMENT PROGRAMME

The principal engineering components of the Core Investment Programme are as follows.
6.3.1 Transmission-Based Train Control

A transmission-based train control system is the preferred option broadly in line with the European Train Control System Level 3 proposals. The principal features of this system are as follows:

- The train determines its position by interrogating passive transponders in the track, and interpolating between transponders.

- The train communicates its position and completeness to the control centre by digital radio (together with train type, speed, direction and other information as required).

- The control centre, on the basis of data received from all trains, issues movement authority by radio to train cabs, as indicated in Figure 6.1.

- Lineside telecommunications are restricted to radio and fibre optic cables which could be suspended from the overhead line masts, virtually eliminating ground level cables alongside the track.

- Track circuits are eliminated throughout and axle counters used to deadlock points.

- A broken rail detection system is to be developed which will equal or out-perform the current technology including the contribution made by track circuits.

- Lineside signals are to be eliminated in most areas and trains using significant parts of the WCML will be fitted with cab-signalling. However, in areas where many trains 'cross' the WCML without using a significant length of it, 'islands' of dual lineside signalling and in-cab train control will be created. In a few areas where west coast traffic is a minority, lineside signalling will continue to be employed. The extent of in-cab train control, and the islands where lineside signalling will be retained are shown in Figure 6.2.

- ATP is an integral part of the proposed transmission-based train control.
FIGURE 6.1: ILLUSTRATION OF TRAIN CONTROL SYSTEM

Digital Radio Data Link

Position Transponder

Speed/Distance Measurement
FIGURE 6.2:
PROPOSED CAB SIGNALLING - CONTROL AREAS

Key:
- Cab Signalling
- Dual System
- Conventional Signalling
- Other Lines
Development, installation and commissioning can be carried out with minimal disruption to the existing signalling and train services.

Greater line capacity is released, which can be used to advantage (e.g. during possessions) if traction power supplies are sufficient.

Whereas the hardware for this train control system already exists on some railways, the software for an operation as complex as the WCML will need to be developed. This and the secure digital radio are the highest risk elements of the project, and will require active risk management. Further details of transmission-based train control and the integrated control centre discussed below in Section 6.3.2 are included in Annex I.

6.3.2 Control Centre

A single control centre will be built to combine the train control, production and traction power control functions. Staff from each of the control disciplines will be co-located to reduce costs and optimise flexibility in the event of an incident; however, the possibility of multi-skilling in the future will not be precluded. The centre will provide state of the art communications to FOCs, TOUs and maintenance contractors.

Control can be transferred to the back-up installation a few kilometres away. The back-up is a hot standby which, in the event of the control room being disabled, would quickly and safely allow evacuation of trains. It will be staffed to provide at least a 50% service within one to two hours. The back-up will normally be used for training and software development.

Security of the control room will be achieved by system and building design, and diverse communications routes and power supplies.

6.3.3 Track

Renewal of track will be undertaken at a rate to maintain or improve its present overall condition. To facilitate this, and to increase productivity, new possession strategies have been developed. These will allow either longer weekend possessions or continuous possessions to be taken on two tracks of a four-track section, while all services run on the other two tracks with a small time penalty. For busy sections this approach requires the higher capacity of the
transmission-based train control, derived from closer headways, while for other sections it can be achieved with the existing signalling. A similar approach can be adopted on two and three-track routes but, in some cases, use of a diversionary route is more appropriate. Disruption to train services and the costs of renewals and maintenance are both significantly reduced as a result.

Track components will, as at present, be suited to 200 km/h running to allow for future upgrade. No realignment of curves will be carried out unless an upgrade option has been agreed between Railtrack, OPRAF and train operators.

More details regarding trackwork are given in Annex J.

6.3.4 Structures

The backlog of inspection and repair will be made up over a four-year period. Redundant structures will be removed where this is cost-effective. If a bridge over the WCML is to be reconstructed for any reason, it will generally be built to Department of Transport (DoT) standard structure gauge to allow for piggyback and double-deck trains, and possible future European structure gauge harmonisation.

Level crossings will be removed where possible, to improve safety. The procedures of the Transport and Works Act 1992 will be used.

Works to stations are outside the scope of this Study. Further details regarding structures are included in Annex K.

6.3.5 Traction Power

Renewal or refurbishment of supply points, and associated distribution equipment reconfiguration, will be performed to address locations where physical condition, overloading or service supply unbalance result in inadequate system performance and the potential for major failure. Additional power supply reinforcement will be provided to cater for additional services in the Coventry/Wolverhampton corridor and longer possessions. In addition, immediate and phased renewal of distribution and OHLE equipment, and minimum interference suppression works will be performed. No new electrification of route Sections 13 and 14, as shown on Figure 5.1, will be included.

The traction power remote control system (SCADA) will be completely replaced, the control room elements being integrated into the single
control centre.

Further details are given in Annex L, which also describes the power supply simulation modelling used in the analysis.

6.3.6 Operations

In order to gain the maximum benefit from these proposals, a number of changes to methods of operation will be needed:

- modifications to Railtrack, where appropriate, rules governing safe working alongside the track to reflect the continuity and intensity of renewal works and greater use of purpose-designed plant (the Railway Inspectorate has indicated that it is willing to consider such changes);

- changes to the Rules of the Route to allow more productive possessions which bring key reductions in cost;

- adaptation of signalling and control room practices and rules to suit the new situation;

- changes to the Rules of the Plan to reflect the reduced headways of the new signalling.

The capability to run the May 1994 timetable plus Channel Tunnel services will be maintained. This has been tested using simulation modelling which is described in Annex M.

6.3.7 Rolling Stock Issues

Cab-signalling has to be fitted to some 1,780 cabs to serve the WCML. Many existing locomotives and multiple units have been modified in the past, leading to variations in the location of existing equipment and wiring. The Study team has ensured in its planning that any difficulties in fitting cab-signalling equipment and emergency braking connections are minimised.

Passenger rolling stock is owned by ROSCOs and operated by the TOUs. A programme for installing cab-signalling will therefore be agreed with them. Further discussion of rolling stock issues is included in Annex N.
6.3.8 Environment

Only minor environmental impacts are anticipated from the Core Investment Programme, as discussed in Section 7.6.4.1. Some environmental improvement will result from the transfer of passengers from other, less fuel-efficient modes of travel.

6.3.9 Summary

The Core Investment Programme will provide for the May 1994 timetable to be run more efficiently and with greater reliability and safety than at present.

6.4 ADDITIONAL WORK FOR THE MARKET-DRIVEN INVESTMENTS

Investment to meet increased demand for passenger or freight services may be attractive, and a number of options have been set out from which a choice can readily be made after negotiation with OPRAF and the TOUs. These are all additional to the Core Investment Programme.

The high-speed options have been developed for the principal routes as described in Section 5.4.2. Other sections of line do not carry sufficient InterCity traffic to justify an increase in speed. However, journeys over such sections will be able to benefit from the time savings on upgraded sections of their routes, and possibly from higher performance from the faster trains.

6.4.1 Option A - Accelerated Track Renewals Programme

Accelerated renewals of track is included in Option A as a means of providing improved ride comfort, and also as a prerequisite for the higher-speed operations allowed by Options C, D and E.

6.4.2 Option B - Power Supplies for Extra Trains at 175 km/h

Transmission-based train control in the Core Investment Programme provides for shorter headways and thus more train paths than at present. The essential power supply reinforcement works included in the Core Investment Programme will provide for some increase in services between Euston and Birmingham, but not elsewhere.
In Option B further power supply reinforcement is proposed to permit an increase in the number of commuter, local, or Intercity trains that can be run within the existing linespeeds. The additional strengthening is likely to include new power feeds at Northampton West and Stafford South.

A plan showing the locations of reinforcements to the power supplies for this and other Market-Driven options is given in Figure 6.3.

6.4.3 Option C - 200 km/h Linespeed for Conventional (or Tilting) Trains

To run the present number of Intercity trains at 200 km/h over the principal routes will require improvements above the Core Investment Programme and Option A.

Additional power supply reinforcement will be required north of Rugby, with new/reinforced feeds likely at Bulkington, Stafford South, Harecastle, Edgeley, Catterall and Harker. The OHLE will be replaced at a greater tension to provide good electric current collection at the pantograph/contact wire interface, for the higher speeds. Masts and portals will be retained except where increased contact wire tension requires their replacement for structural reasons, as is the case for welded rod portals which form the majority of the OHLE supports in the southern part of the WCML.

Some PSRs will be removed or eased by improving layout or relieving aerodynamic constraints. Major curve realignment is not commercially justified. The most cost-effective PSRs, allowing both tilting and conventional trains to run at maximum speed, are:

- 10 km of line on Euston approaches (remodel layout);
- Watford Tunnels (build pressure relief airshafts);
- Northchurch Tunnel (build pressure relief airshafts);
- Linslade Tunnels (build pressure relief airshafts) where realignment in cutting is desirable but only justifiable at 250 km/h if some of the costs are paid for by the increased structure gauge for piggyback or double-deck trains (see Options F and G below);
- Stowe Hill Tunnels (build pressure relief airshafts);
FIGURE 6.3:
POSSIBLE POWER SUPPLY REINFORCEMENT FOR
MARKET DRIVEN OPTIONS

KEY
Control Centre

▲ Existing 4 Centres
▲ Proposed Single Centre
(Location to be determined)

Feeder Stations
- 23 Existing for 175 km/h at 25KV
- Additional Requirements Possible for 225 km/h at 25KV
- 4 Existing Feeder Stations will Become Redundant under the proposals

GLASGOW
LONDON
BIRMINGHAM
MANCHESTER
LIVERPOOL
EDINBURGH
- Kilsby Tunnel (build pressure relief airshafts);
- Rugby Station and Trent Valley Junction (remodel layout);
- Shugborough Tunnel (build pressure relief airshafts).

Elsewhere, the cost of removing PSRs was found to exceed the revenue benefits generated by the reduction in journey time.

6.4.4 Option D - 225 km/h Linespeed for Tilting Trains

The PSRs listed in Option C are the only ones which justify improvement, even at 225 km/h, though additional work (e.g. more pressure relief airshafts) will be needed for the higher speed.

Work to widen the cess walkway to improve the safety of lineside staff will be necessary with speeds over 200 km/h.

Train speed past station platforms, where passengers or staff may be standing, is restricted to 200 km/h for safety reasons. Platforms will be closed on the fast lines where they are not used, or platform doors about 1.5 m from platform edge will be constructed. In the latter case, the doors will normally only open while a train is stationary at the platform.

The OHLE will have to be completely reconstructed with new wiring to cater for increased pantograph speeds. Further power supply reinforcement is needed north of Rugby, with feeds additional to those in Option C likely to be required at Rugeley and Acton Bridge.

6.4.5 Option E - 250 km/h Linespeed for Tilting Trains

The PSRs to be eased for Options C and D will also require easing for Option E, but with further work necessary. At Linslade Tunnel this may include not only additional airshafts, but the opening out of the tunnel and local realignment provided piggyback gauge (Option F) is also adopted.

For 250 km/h, an auto transformer power supply and OHLE system, employing 50 kV distribution with new supergrid supply feeds, will be required to meet the high power draw between London and Crewe on the main lines. On the rest of the WCML, additional power supply reinforcement and OHLE as for Option D, but to higher standards, will
be required.

Platforms will be as for Option D. When trains travelling at 250 km/h pass other trains, especially soft-sided freight trains, the aerodynamic effect becomes significant. These effects are magnified in tunnels and by the close track spacing of the WCML. Although this is at the limit of current research, a 6.5-7m long train nose is expected to reduce the pressure transients to acceptable limits for the substandard track spacing which occurs on the WCML. More research is needed, however, into the effect of trains passing soft-sided freight trains at high speeds.

6.4.6 Option F - Initial Piggyback Gauge Clearance Works

The minimum structure gauge and its relationship to other gauges to be adopted for piggyback freight is shown in Figure 6.4. The proposal in Option F is to undertake clearance works for piggyback gauge on the WCML initially between Camden Junction and the proposed Daventry freight terminal. This will then allow connection to the Channel Tunnel via the North London Line and the CTRL, or via Willesden, the West London Line and Redhill as proposed by the Piggyback Consortium. Extension to the whole of the WCML could follow. Piggyback gauge will also allow 9'6" containers, which are increasingly used on deep-sea routes, to be carried on flat wagons. Option F will involve enlarging the structure gauge of WCML bridges, tunnels and OHLE.

Modest power supply reinforcement will be required to meet the proposed levels of piggyback service, probably including a new power supply feed at Northampton West.

Improvements at Linslade Tunnel are important for Options F and G, the piggyback and double-deck train options. These options would benefit from the extra clearance which would be created if, for linespeed reasons, major PSR works were undertaken instead of pressure relief air shafts. Financial analysis of Option F assumes £8.6 million is provided towards improvement works to be carried out for higher linespeeds.

Further details regarding piggyback are included in Annex O.
6.4.7 Option G - Gauge Clearance Works for Double-deck Passenger Trains

Running double-deck trains between Euston and Northampton will require the works identified in Option F and additional increases in structural clearances between Euston and Camden Junction. The OHLE will be reconstructed to provide the necessary clearances. No power supply reinforcement work in addition to that for Option F will be required.

6.4.8 Option H

Five passing loops will be lengthened to allow through working of 750m freight trains from Birmingham, Glasgow, Liverpool and Manchester to the Continent. These are:

- Tring (adjacent to up slow track);
- Northampton (up and down);
- Lancaster (up and down);
- Tebay (down);
- Beattock Summit (up and down).

Train control and hot axle box detection (HABD) in the CIP would be designed to allow for the running of 750 m long trains.

6.5 CONTRACT STRATEGY

6.5.1 Assumptions

The key characteristics of the contract strategy are that infrastructure and network operations will remain with Railtrack, funding arrangements should be consistent with the PFI requirements, and there will be appropriate transfer of risk to the private sector as discussed in detail in Chapter 8. The strategy is to be in the best interests of Railtrack and its customers.

A MDBM contract has been proposed. Its principal features are expected to be as follows:
A single concession contract will be let for the entire WCML.

The concession contract will cover a period of some 15-25 years.

Responsibility for maintaining the existing railway and for designing, building and maintaining the new work will pass to the contractor.

This responsibility will come into force some 10 months after award of the contract. This period is to allow the contractor to assemble a suitable team, with proper safety validation, as well as to undertake design work.

The advantages of this form of contract are:

- It will minimise interfaces for Railtrack to manage.
- It will simplify management of operations during the work.
- It will encourage design for optimum life cycle costs.
- It will transfer performance, availability and design risk to the private sector.
- Maintenance of the existing and new infrastructure will be combined, giving single point responsibility for all works on the line, encouraging early efficiency gains on existing maintenance work, and giving potential for early transfer of risk to the private sector.

6.5.2 Continuing Work

Railtrack is continuing work in the following areas as part of the preparation of tender documentation:

- negotiations with DoT and BR Vendor Unit regarding the role of BRIS units in the modernisation;
- development of a database to define to tenderers the existing infrastructure;
- the timetable for tender, evaluation, negotiation and award of modernisation contract;
the modifications to Railtrack safety rules to allow more efficient working and lower tender prices, without reduction in safety levels;

- precise specification of track rationalisation and remodelling schemes;

- definition of Railtrack's role in managing the concession contract to ensure it meets its contractual obligations to the TOUs and other customers.

### 6.6 IMPLEMENTATION AND POSSESSION STRATEGY

The aim of the development strategy is to minimise disruption to services while keeping construction costs low. This will be achieved by the adoption of a train control system which can be installed and commissioned without significantly impacting the existing signalling equipment, and a possession strategy which will permit more productive working than at present.

The transmission-based train control system recommended can be developed, installed and commissioned with minimal interference to the existing track circuits or control systems. Interfaces with the existing systems are limited in number, e.g. point machines and the boundaries of the new system.

As discussed in Section 4.1.3 above, it is proposed that long weekend possessions of up to 56 hours should generally be the adopted strategy. The concession company will, however, employ a mix of methods to suit the works in hand and deliver the best possible system availability to the TOUs.

### 6.7 CONSTRUCTION PROGRAMME

The construction programme will require close coordination with the TOUs and FOCs. Nevertheless, the main objectives sought are:

- a period of about 10 months between the appointment of a concession company and its taking responsibility for maintenance and starting construction, to be used to set up the maintenance organisation with the necessary safety validations, and to carry out design work.
a five-year programme for the development of a fully working new train control system including design, installation and commissioning on the first section of track.

- cab equipment progressively fitted to nearly 1,800 cabs during the five-year train control development programme.

It is anticipated that the modernisation programme can be completed by 2003-04.

6.8 SAFETY

The introduction of transmission-based train control, as part of the recommended Core Investment Programme, will provide the WCML with ATP as an inherent feature of the train control system. This will reduce the risk of death or injury to passengers and train staff.

Based on accepted methods, as described in Annex P, it is estimated that 13 equivalent fatalities, together with the costs of damage and disruption, will be saved over a 30-year period. (On a 'willingness to pay' calculation, this would represent a net benefit of £12 million NPV.)

In addition to ATP, other significant safety benefits which the new train control system will provide are as follows:

- secure radio communication between the train and control centre;
- visibility of signals (through fog and OHLE);
- minimal equipment on the track reducing risk to signalling and telecommunications staff;
- improved possessions management using electronic tokens, with improved early warning of trains approaching trackside staff;
- minimal trackside equipment reducing risk of damage from vandalism;
Critical hazards associated with the transmission-based train control system have been identified, and are capable of elimination or mitigation 'as low as reasonably possible' by careful design and validation. It is concluded therefore that, after modernisation, the WCML will be capable of meeting the current Railtrack safety objectives, with potential for significant improvement. It will provide a sound basis for further improvement of safety on the whole railway network.

Railtrack's Railway Safety Case will need updating to reflect the introduction of transmission-based train control but no particular problems are anticipated. Equipment and project safety cases will have to be prepared by the successful bidder. The Railway Inspectorate of the Health & Safety Executive is aware of the proposals and has no objection in principle.

Safety is discussed in more detail in Annex P.

6.9 THE CONTRIBUTION OF OTHER RAILWAY INDUSTRY STAKEHOLDERS TO THE STRATEGY

As described in Figure 1.1, Railtrack has relationships with many other organisations in the new railway industry. Specific technical impacts of the recommended scheme on these stakeholders are discussed here. The wider implications are described in Chapter 9.

6.9.1 TOUs

The introduction of a new train control system and integrated control centre will require a number of joint actions by Railtrack and the TOUs:

- retraining of train crews and their managers to use cab-signalling;
- scheduling of rolling stock for the installation of cab-signalling units and subsequent maintenance;
- involvement in the new control centre in terms of both location and method of operation.

In addition, TOUs would have the opportunity to:

- develop new forms of train service information for display to passengers, if desired;
- develop vehicle health information on a real-time basis, if desired;
- make use of communication between control and train for Driver Only Operation throughout the cab-signalled area, if desired.

Exploitation by TOUs of higher maximum linespeeds will require:
- introduction of new rolling stock, probably with different maintenance requirements and higher power costs;
- payment of higher access charges for a superior product;
- changes to working practices of the train staff.

During the modernisation process, there will be timetable changes to cater for possessions and increases in journey times for some trains. These negative effects have been minimised by the approach adopted, and will be offset after completion by a more reliable service with reduced journey times.

6.9.2 FOCs

The FOCs will be affected by the new signalling and control in the same ways as the TOUs, except that the FOCs also own their rolling stock.

Higher linespeed for passenger trains can, in some circumstances, act against freight interests because the increased disparity in speed between the fastest and slowest trains reduces line capacity. Analysis of WCML timetables indicates that, with the new train control system, this will not be a significant problem.

The proposals for modifications to passing loops to permit longer freight trains, and for increasing structure gauge to carry piggyback trailers, will require negotiation with one or more FOCs before implementation can proceed.

6.9.3 ROSCOs

The ROSCOs, as owners of the passenger trains, must allow cab-signalling units to be fitted. Fitting may take place during the major overhauls (such as Level 5 heavy maintenance) that the ROSCOs will
carry out. The programme allows for the likely difficulties in scheduling.

The need for faster trains to serve the higher linespeeds may be catered for by ROSCOs. It is also possible that manufacturers will lease direct to TOUs, or even that TOUs will buy their own rolling stock.

6.9.4 BRIS

Railtrack subcontracts the construction and maintenance of the infrastructure to others. At present, maintenance and track renewal is undertaken by BRIS, but competitive tendering will be introduced within a few years. The involvement of BRIS in the modernisation programme is under discussion between Railtrack, DoT and BR Board.

The areas of new technology will require new skills to be developed by whichever company is employed to undertake the maintenance.

6.9.5 HSE Railway Inspectorate

The Railway Inspectorate has to approve any significant changes to the railway before they can be licensed for passenger use. Discussions have been held with the Railway Inspectorate during the Study to agree concepts and principles, but approval will only be given to the revised infrastructure as constructed. Railtrack will need to continue liaison with the Railway Inspectorate on this project, and the contractor will need to liaise during design and obtain approval after construction. This is further discussed in Section 9.3.

6.10 SUMMARY

The recommended strategy is innovative and challenging. The successful concession company will require first-rate project its own management to achieve its own and Railtrack's commercial and technical aims.

'Leading-edge' technology has been chosen where it provides the best commercial and technical solution to renewing the train control system. The risks involved in its development for application to the WCML are known and manageable. For track, power and structures, work will be undertaken to increase reliability and service levels. An outline performance specification has been prepared defining all the technical requirements for the recommended strategy, which will
provide a safer railway in a better state of repair at lower cost than at present.

Upgrades for higher-speed passenger services and new freight services are attractive, but they will require commitment from other railway stakeholders before investment can start.
CHAPTER 7

Socio-Economic And Environmental Impact

7.1 INTRODUCTION

This chapter examines the potential of the WCML project to generate economic activity and its environmental impact. Both direct and indirect effects are considered: direct as a result of the project works themselves, and indirect as a result of the project on the wider economy. These effects will tend to increase with the more ambitious Market-Driven options.

7.2 LOCAL AUTHORITY POLICIES

As part of the demand forecasting process, local authority structure plans and transport policy documents were reviewed to provide the background for how regional economies might develop over the next 30 years.

The local authorities served by the WCML are shown in Figure 7.1.

Significant increases in future population levels along the WCML corridor have been identified in Buckinghamshire, Cheshire, Cumbria, Hereford, Lancashire, Northamptonshire, Staffordshire, Warwickshire and Worcester. The trend towards migration from major cities to surrounding shire counties is expected to continue, leading to increased pressure on transport links, particularly roads which are already congested. In addition, regeneration plans for Birmingham, Glasgow, Liverpool and Manchester are likely to increase urban employment levels, which will further reinforce increases in transport requirements.

The availability of a more reliable and faster rail service will encourage transfer of this increased demand to the WCML, with major economic and environmental benefits.
FIGURE 7.1
POPULATION CHANGES WITHIN THE COUNTIES COVERED BY WCML (1981 - 91)

Key
-350,000 TO -150,000
-150,000 TO -100,000
-100,000 TO -50,000
-50,000 TO 0
0 TO 10,000
10,000 TO 55,000

WALES
47. CLWYD
48. DYFED
49. GWENT
50. GWYNEDD
51. MID GLAMORGAN
52. POWYS
53. SOUTH GLAMORGAN
54. WEST GLAMORGAN

SCOTLAND
55. BORDERS
56. CENTRAL
57. DUMFRIES & GALLOWAY
58. FIFE
59. GRAMPIAN
60. HIGHLAND
61. LOTHIAN
62. STRATHCLYDE
63. TAYSIDE

ENGLAND
1. GREATER LONDON
2. GREATER MANCHESTER
3. MERSEYSIDE
4. SOUTH YORKSHIRE
5. TFNE AND WEAR
6. WEST MIDLANDS
7. WEST YORKSHIRE
8. AVON
9. BEDFORDSHIRE
10. BERKSHIRE
11. BUCKINGHAMSHIRE
12. CAMBRIDGESHIRE
13. CHERSHIRE
14. CLEVELAND
15. CORNWALL
16. CUMBRIA
17. DERBYSHIRE
18. DEVON
19. DORSET
20. DURHAM
21. EAST SUSSEX
22. ESSEX
23. GLOUCESTERSHIRE
24. HAMPSHIRE
25. HEREFORD & WORCESTER
26. HUMBERSIDE
27. HERTFORDSHIRE
28. ISLE OF WIGHT
29. KENT
30. LANCASHIRE
31. LEICESTERSHIRE
32. LINCOLNSHIRE
33. NORFOLK
34. NORTHAMPTONSHIRE
35. NORTHUMBRLAND
36. NORTH YORKSHIRE
37. NOTTINGHAMSHIRE
38. OXFORDSHIRE
39. SHROPSHIRE
40. SOMERSET
41. STAFFORDSHIRE
42. SUFFOLK
43. SURREY
44. WARWICKSHIRE
45. WEST SUSSEX
46. WILTSHIRE
The major cities served by the WCML will clearly gain benefits from enhanced attractiveness for inward investment and employment generation through improved InterCity services. In addition, commuter towns and villages will gain by improved local services spreading economic activity and employment effects.

7.2.1 Specific Developments

Significant developments are planned which will affect business travel, especially in Birmingham (such as expansion of office space, extension of the NEC and the airport) and at other commercial centres. The WCML project will support such developments through an improved quality of service and (with the Market-Driven options) faster rail journey times to the major corridor cities and through the Channel Tunnel to mainland Europe.

Growth is planned in light industrial and commercial activity at various locations along the corridor. This can be expected to result in an expansion in distribution activity. New facilities are being developed in Birmingham, Buckinghamshire, Cheshire, Cumbria, Glasgow, Lancashire, Liverpool, Manchester, Northamptonshire and Warwickshire. These activities will be supported by the WCML project through improvements in rail service reliability, and through enhancements to freight loading gauge.

In the medium term, the effect of the Channel Tunnel may radically change distribution patterns within Europe. The existence of a fast and reliable service from mainland Europe to the population centres of the Midlands, the North West and Scotland would cause new distribution centres to be set up, particularly for perishable goods. These will have both a direct and multiplier employment effect.

Although there are a number of important road schemes planned, including widening of the M1 and M6, and motorway relief/ring roads around Birmingham and Manchester, many local authorities are interested in encouraging a modal shift from road transport to public transport, as a means of containing future traffic congestion. Accordingly there are plans for the development of light rail systems, local rail service improvements, 'parkway' stations, and railfreight terminals. The WCML project would support these initiatives.

The modernisation and potential upgrading of the WCML will also benefit other projects currently under consideration. The Study was made aware of a number of potential projects adjoining the WCML
during the consultation exercise, such as the electrification of the Crewe-Holyhead and Manchester-Blackpool lines and a number of lines in the Midlands. Improvement to the WCML will bring benefits to all such projects and should enhance the economics of these proposals. If the core spine is in good condition, other projects can gain benefits and take advantage of increased opportunities.

### 7.2.2 Statements of Need

During consultations, details of which are given in Annex B, specific statements of need were received from county councils in Cheshire, Cumbria, Hertfordshire, Staffordshire, Warwickshire and Dumfries and Galloway Regional Council. These local authorities have been keen to stress the requirement for improvements in both passenger and freight services on the WCML, in terms of shorter journey times, higher service frequencies, improved reliability, improvements to intra-regional as well as inter-regional passenger services and improvements to freight services (including loading gauge enhancements). In addition, the local authorities have stressed the need to ensure that services will not be degraded during the modernisation works. These requirements have been taken into account by the Study team.

### 7.3 IMPACT ON REGIONAL ECONOMIC DEVELOPMENT

The importance of transport investment in stimulating regional economic growth is well accepted, although precise quantification is difficult.

The WCML project will promote cost efficiency on the railway leading to benefits to customers through a potential reduction in their transport costs.

While transport costs are typically a small proportion of industry costs, changes in transport costs can have a large effect on profitability. In addition, transport costs are significant in two of the major growth industries in the corridor, distribution and tourism:

- Changes in freight technology have encouraged the location of distribution centres close to markets. Reductions in transport costs will encourage this trend and improve the viability of additional sites at the northern end of the corridor.
The potential market for tourism, particularly business tourism and the exhibition/conference market, will be expanded by faster rail services.

There are many forces which affect local development apart from transport costs. A single infrastructure investment alone can rarely make a major change to the economic development prospects of an area, although a coordinated programme will have an effect. The impact of the project on regional economic development may therefore be best characterised as providing one part of a regional/local policy package to promote growth.

A scheme such as the WCML project will have an economic generation effect through improvement in business confidence, local publicity and general well being caused by a major public/private sector partnership being seen to be working and producing tangible improvements. While it may be difficult accurately to quantify such effects, they can often be a more positive catalyst for regeneration and growth than many more easily measurable factors.

7.4 EMPLOYMENT IMPACT

The WCML project is large, with capital works estimated at around £900 million in the period 1996-2003 for the CIP alone and is likely to have an impact on employment levels in two ways:

- The direct construction works on the line will require a sizeable workforce.
- More important in economic terms, employment related to procurement orders for materials, components and services will provide additional jobs.

7.5 PROJECT OVERLAP

One other issue which needs to be addressed in the context of employment impacts is potential skills shortages. Despite the possible coincidence of railway construction activity on the CTRL during the WCML project implementation, there are unlikely to be shortages of skills in the labour market, as the construction and the railway supply industries are not yet near capacity working levels. The possible exception is in the development and application of software for the
new train control system, although this could possibly be shared with the CTRL. The development work will require a team of programmers skilled in the writing of safety critical software. This team could come in part from the signalling industry and in part from other high-technology industries to overcome any shortage problems. The application design will be easily handled by existing industry resources as the high-level, expert system design tools, that are envisaged, are available.

7.6 ENVIRONMENTAL IMPACT ASSESSMENT

7.6.1 Introduction

The objectives of the preliminary environmental assessment were to identify major constraints within the Study area, and compare the major environmental impacts of options considered. At this stage the scope of the assessment was limited to major heritage and ecological constraints and property/social impacts which could be identified from 1/25000 scale mapping.

7.6.2 Legislative Requirements for Environmental Impact Assessment

Planning consent will be needed for those investment options that require change of landuse and/or landtake from outside the existing railway boundary. This could be sought directly from the Secretary of State under the Transport and Works Act 1992, or from local planning authorities in accordance with normal planning procedures. It will probably be necessary to carry out an environmental impact assessment for the scheme, or components of it, if significant environmental impacts are anticipated.

7.6.3 Major Environmental Constraints Within the Study Area

7.6.3.1 Heritage Features

There are numerous heritage features, such as items of archaeological, architectural or historical value, associated with the WCML which reflect its size and antiquity. Two scheduled ancient monuments (the wall of a Roman fort at Manchester Knolt Mill and a stone circle at

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7 The 1, 2* and 2 listings in England are replaced by the A, B and C listings in Scotland, based on comparable but separate regulations.
Shap Station) and over 100 listed buildings/structures are present on Railtrack property within the Study area. Listed buildings/structures are mainly Grade 2 or equivalent and range from signal boxes to stations, viaducts, tunnel portals and statues.

7.6.3.2 Ecological Features

Nineteen statutory sites for nature conservation abut the boundaries of the WCML, and a further 22 sites are located within 500 m of the railway. Of the sites on adjoining land, 16 are sites of special scientific Interest (SSSIs) designated by English Nature and Scottish Natural Heritage, and three are local nature reserves (LNRs) designated by local planning authorities under the provisions of the National Parks and Access to the Countryside Act 1949. One of these sites, namely the Upper Solway Flats and Marshes SSSI is also a 'Nature Conservation Review Site', and meets criteria for Ramsar/Special Protection Area designation under the provisions of the Ramsar Convention and the European Union (EU) Directive on the Conservation of Wild Birds, respectively.

It is possible that this and other sites within the Study area will be designated as special areas for conservation (SAC) under the recently adopted Conservation (Natural Habitats etc.) Regulations 1994. Sites designated under these regulations will be afforded additional protection beyond the provisions of the Wildlife and Countryside Act 1981. The regulations broadly apply to sites of international nature conservation value, although the selection criteria have still to be established. It is understood that English Nature and its counterparts in Wales and Scotland aim to have compiled a provisional listing within the next 12 months.

There are also numerous non-statutory sites for nature conservation within the WCML corridor.

7.6.4 Major Environmental Impacts of the Investment Recommendations

7.6.4.1 The Core Investment Programme

As the Core Investment Programme would require very little or no landtake, and would not involve track realignment or significant modifications to current operations and timetabling, no major long-term environmental impacts are predicted over and above those that occur at present. The Core Investment Works would, however, have
various operational impacts which are significant in the local context, for example visual intrusion from the proposed new control centre. Such impacts cannot be predicted at this stage, but would need to be considered, and, if necessary, mitigated during detailed design. This scheme would also have various construction-phase impacts common to other major construction works, the significance of which will vary according to their nature and location. These potential impacts will also need to be considered, and if necessary mitigated, on a site-by-site basis.

7.6.4.2 **Removal of PSRs**

In order to increase linespeeds track realignments have been proposed at certain locations to remove existing PSRs. Some of the proposals would necessitate land-take from outside the existing railway boundary, and therefore planning consent will be required. The majority would not require property demolitions, although some would have significant heritage impacts. None of the options would have major ecological impacts. The results of the assessment are summarised in Table 7.1.

7.6.4.3 **Extension of Freight Loops**

Freight loop extensions have been recommended at five locations to accommodate longer 750 m freight trains. The majority would not require landtake from outside the railway boundary. No major environmental impacts have been predicted, other than a potential heritage issue at Beattock Summit because of its proximity to a Roman camp. The results of the assessment are summarised in Table 7.2.
Table 7.1: MAJOR ENVIRONMENTAL IMPACTS FROM PSR REMOVAL

<table>
<thead>
<tr>
<th>Option</th>
<th>Landtake Requirement</th>
<th>Property Impacts</th>
<th>Heritage Impacts</th>
<th>Ecological Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euston Approach (0-4 km)</td>
<td>No</td>
<td>No</td>
<td>No - two bridges affected but neither listed</td>
<td>No</td>
</tr>
<tr>
<td>- Options C, D and E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euston Approach (4-10 km)</td>
<td>No</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>- Options C, D and E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watford Tunnel - Options C, D and E</td>
<td>Yes - new air shafts</td>
<td>No</td>
<td>South portal of tunnel is listed, but would not be affected</td>
<td>No</td>
</tr>
<tr>
<td>North Church Tunnel - Options C, D and E</td>
<td>Yes - new air shafts</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Linslade Tunnel - Option C, D</td>
<td>Yes - new air shaft</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>- Option E</td>
<td>Yes - opening out tunnel</td>
<td>2-3 property demolitions</td>
<td>Re working of Linslade Tunnel portals which are listed</td>
<td>No</td>
</tr>
<tr>
<td>Stowe Hill Tunnel - Options C, D and E</td>
<td>Yes - new air shafts</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Kilsby Tunnel - Options C, D and E</td>
<td>Yes - new air shafts</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Rugby Station - Options C, D and E</td>
<td>Possible minor land-</td>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>take</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shugborough Tunnel - Options C, D and E</td>
<td>Yes - new air shafts</td>
<td>No</td>
<td>No - but note tunnel portals are listed</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 7.2 MAJOR ENVIRONMENTAL IMPACTS OF THE FREIGHT LOOP EXTENSIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Land-take Requirement</th>
<th>Property Impacts</th>
<th>Heritage Impacts</th>
<th>Ecological Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Beattock Summit - Option H</td>
<td>Yes - minor land-take may be necessary</td>
<td>No</td>
<td>Potential archaeological impact owing to proximity to Roman Camp</td>
<td>No</td>
</tr>
<tr>
<td>2. Tebay - Option H</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3. Lancaster - Option H</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>4. Northampton - Option H</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>*</td>
</tr>
<tr>
<td>5. Tring - Option H</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

* None is predicted despite proximity to Kinsthorpe LNR which is a statutory site for nature conservation. The LNR comprises a watercourse and associated marshland upstream of the proposed works and would not therefore be susceptible to water borne construction-phase impacts.

7.6.4.4 Piggyback Gauge

The initial proposal as described in Chapter 6 as Option F is to upgrade the railway between Camden Junction and Daventry. The scheme would have various environmental benefits relating to the subsequent increase in freight transfer by rail compared to road. These are significantly lower emission rates of carbon monoxide, nitrous oxide and carbon dioxide; better energy efficiency; potential decrease in road congestion;\(^8\) and lower risk of accidental releases of hazardous substances during transit. Inevitably there would be some adverse environmental impacts, the most important being damage/demolition of listed structures to obtain the necessary clearances, and nuisance noise/vibration associated with increased freight traffic. It has been estimated that 28 structures (overbridges, footbridges, tunnels, etc.) would be affected in the recommended works, of which two are listed. It is not possible to determine the location or magnitude of noise impacts at this stage, but it should be possible to mitigate significant impacts in most locations using on-line noise barriers or other means of insulation.

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\(^8\) Except in vicinity of railfreight terminals where large goods vehicle movements are likely to increase significantly
Global Issues and Concluding Comments

There is increasing scientific and public concern over the environmental impact of major highway improvement/construction schemes and the continuation of current trends in car ownership. In the recent study by the Royal Commission on Environmental Pollution of the long-term environmental implications of road-based transport policies it was concluded that these were unsustainable. The Royal Commission recommended much greater investment in convenient, reliable public transport systems. The recommended Core Investment Programme and other investment options are consistent with this, and would not incur major environmental impacts during their implementation over and above those common to all major civil works.

SUMMARY

This chapter has presented a review of the wider socio-economic and environmental impacts of the project. There will be some generation of direct employment as a result of the project. The longer-term employment effects after the construction phase and the wider regional economic development impacts are more difficult to predict. Overall, the project is broadly supportive of local economic development initiatives. Furthermore the effect of the dispersal of affluent long-distance commuters and the potential for new distribution centres, for perishable goods travelling long distances to their markets, should have a positive effect on regions traversed by the WCML.

There is increasing support for greater investment in public transport systems to make them more convenient, reliable and efficient and thereby more attractive to road users. The WCML Study proposals are consistent with these aspirations, and would not incur major environmental impacts during the construction phase over and above those common to all major civil works. These impacts cannot be predicted at present but will need to be considered during detailed design. Notwithstanding the findings of component studies of environmental impact assessments which may be required, Railtrack is committed to taking appropriate action to avoid or mitigate significant impacts, in consultation with the relevant authorities and the general public.

Ibid (Footnote 1)
CHAPTER 8

Funding

8.1 REVENUE AND COST CONSIDERATION

8.1.1 WCML Cost Structure

Railtrack’s costs are split into three principal components:

- production costs, relating primarily to the train control system and the operation/control of the infrastructure;
- costs associated with maintenance of the track, the train control system and power supplies;
- capital renewal costs associated with maintaining the network.

Based on the West Coast zone’s 1994-95 budget, total annual production costs for the WCML are estimated at £49 million. Production costs are made up of three components: staffing, electrical current for traction (which accounts for just under half) and telecommunications charges paid to BR Telecommunications. Staffing costs are primarily accounted for by the manning of PSBs and the related central control functions for electrical power and train movements.

The WCML, in common with other parts of the rail network, at present incurs large expenditures on maintenance, estimated at £112 million for 1994-95; all of this work is carried out under contract by BRIS and others. Over half of the maintenance work and most of the £50 million renewals budget is concerned with track and structures.

8.1.2 WCML Future Costs

The recommended Core Investment Programme involves significant investments in a new train control system and capital renewals involving power supply and track. Once completed this higher level of investment and new technology is expected to result in overall reduction in costs over time for the WCML. The lower costs will be across all areas of production, maintenance and telecommunications.
The Core Investment Programme will require substantial increases in capital expenditure levels. Overall capital expenditure in the initial eight years will amount to some £960 million (1994 prices, undiscounted).

8.1.3 Possible Contract Payment Structure

In the MDBM contract strategy, the selected concession company would maintain the existing railway, design a specified series of investments to the infrastructure and subsequently take responsibility for construction and maintenance until the end of the concession period. The initial concession period could be 15-25 years, with further renewal at the option of Railtrack. The payment terms could be designed to meet the requirements of the Private Finance Initiative (PFI) and to ensure that Railtrack meets its EFC obligations.

It is important that contract payments to the concession company should provide sufficient incentives for it to want to achieve the anticipated level of cost reductions. The concession company would be required to fund all capital costs in the first few years of the contract specifically relating to the train control system. Upon safety validation of the new system, capital expenditures would be reimbursed. This part of the capital fee payment would be in addition to a declining payment made for the reducing maintenance and production costs.

It is intended that each of the private sector bidders be asked to price a matrix of upgrade options in addition to the CIP. The concession contract would thus include provision for these Market-Driven options which could be exercised within a defined period, based on requirements established by OPRAF and the TOUs. In order to provide a degree of flexibility in the exercise of the options, a matrix of the costs of the seven individual upgrade options, and the four disciplines (track, train control, structures and power) for each of the 15 separate route sections would be included. For example, subject to the business interests of the TOUs, a set of options which combines a taller loading gauge for freight with faster speeds for the sections of the route south of Weaver Junction could be selected, improving journey times to all destinations.

8.2 PROPOSED FUNDING STRUCTURE

As recently announced by the Government, Railtrack's flotation is to take place "within the life of the current Parliament". The impact of
this on the funding and contractual arrangements for the modernisation has yet to be determined, but is outwith the remit of the Study. The remit of the Study was to consider funding which would be able to satisfy the requirements of the PFI.

The type of contract payment terms under consideration generate a funding requirement for the concession company, as a result of the initial phase of capital renewals and the overall cap imposed on Railtrack’s fee payments.

8.2.1 PFI Considerations

Railtrack is at present under public ownership. While this remains the case, the Treasury is, in principle, opposed to direct funding but wishes instead to see an element of private sector involvement. The PFI sets out the principles under which there can be greater private sector involvement in the funding of public sector projects. The Treasury will only approve a PFI scheme if it is satisfied that, under the proposals, the private sector partner will take a substantial share of the risks associated with the funded project and in particular the risks associated with the use of an asset.

8.2.2 Satisfaction of PFI Risk Criteria

The PFI criteria would be met by the contracting structure and the associated financing arrangements which are under consideration. In essence, the concession company would be taking the risk that funding obtained to finance the capital investments under the Core Investment Programme can be repaid. Repayment would be dependent both on the investment programme being completed to time, budget and specification and, more importantly, on the achievement of consequent benefits. In this way, the private sector would be taking both the risks associated with the renewal of key assets as well as the risks associated with their subsequent use. Failure to achieve the necessary level of cost savings or any delay in the investment programme would create a mismatch between the level of fixed fee income under the contract and the obligations to meet the maintenance, production and renewal costs of the WCML.

8.2.3 Satisfaction of PFI Value for Money Criteria

Any private sector financing of public assets will inevitably involve a higher cost to the taxpayer than if the same funding was obtained through the Treasury. A value for money test must therefore be met
by any PFI scheme in order for it to meet Government criteria. The contract payment arrangements discussed above and the associated funding structure would meet these requirements by demonstrating a clear risk-sharing relationship between Railtrack and the private sector. The Core Investment Programme would involve a set of technology-based, Cost-Driven expenditures aimed at achieving an overall reduction in the cost structure of the WCML. Risks as well as some of the rewards for achieving the above benefits would rest with the private sector. The PFI value for money test can be illustrated by comparing total costs under the current patch and mend scenario (i.e. Bedrock), which are estimated at £5.8 billion over the 30-year evaluation period, with Railtrack’s fees paid to the private sector consortium for the same period under the proposed contract structure, which are estimated to total £5.2 billion. (The evaluation period should be distinguished from the concession period of some 15-25 years, renewable.)

8.2.4 Risk/Reward

The contract terms would ensure that there is a clear and defined relationship between the manageable risks taken on by the concession company and the rewards earned under the MBDM contract. The private sector has the opportunity to earn profits providing it is successful in implementing the proposed technology-based, Cost-Driven investment programme. Present cost estimates developed under the Core Investment Programme are considered sufficiently robust and conservative. A well managed contract could have the potential for further cost savings, thereby providing a profit potential. On the other hand, failure to manage the new assets effectively will result in higher costs. These will not have to be borne by Railtrack but will be the responsibility of the private sector concession company. Higher costs will reduce profit levels and could, in the extreme case, jeopardise the ability of the private consortium to repay borrowings incurred at the beginning of the Core Investment Programme.

8.2.5 Funding Requirements

As stated above, the contract terms create a substantial funding requirement. This arises from the need to finance the initial phase of capital expenditures as well as to pay the interest during construction and afterwards. Funds generated from cost savings achieved by the new technology and other productivity gains would be used to repay the financing. The concession period would be set with this need in mind. A likely scenario would be for the concession company to...
provide an element of equity towards this funding requirement with the balance as debt in the form of a project financing facility provided by commercial banks, the European Investment Bank and possibly institutional investors.

8.2.6 Funding Rationale

The following, in summary form, is the rationale for the contract payment structure and its associated funding implications:

- Fee payments throughout the contract period would be structured such that they are less than Railtrack's current access revenues from the WCML once all management expenses have been covered. The ORR's review of access charges is of importance here.

- The fixed nature of Railtrack's commitments would enable it to achieve the target return of 8% on net assets by 1998 and to meet its EFC commitments, or such profit targets as may be set after privatisation.

- Although exposed to risk, the successful concession company will have the opportunity to generate attractive returns providing the Core Investment Programme is implemented successfully.

- The committed nature of the fixed fee element would provide the basis for securing the necessary finance from commercial banks on a project finance basis.

- The payment structure would ensure that the concession company takes risks associated with the use of the assets being funded. Repayment would be dependent on a successful cost-reduction programme requiring direct and effective management of operating costs.

- The contract payment structure would satisfy the PFI value for money test by effectively withholding payment for the new train control system and for interim renewals of the existing signalling system (the key element in the CIP) until it has been demonstrated to the satisfaction of Railtrack. While the cost of the associated financing will be higher than if derived from the Treasury, the overall benefits from achieving a lower cost infrastructure are significantly greater.
The payment structure would ensure that the contract would be 'cash negative' for the key period when the concession company is completing the software development of the new train control system. Railtrack would therefore have a strong lever to ensure that contact performance is maintained during this critical period.

8.3 FUNDING SOURCES

The concession company's funding requirements could be provided by limited recourse finance loans from commercial banks. These would not be so large that they would strain the capacity of the bank market for a single project, whereas they would be of a size sufficient to justify the transaction costs involved in arranging such a complex financing deal.

8.3.1 Commercial Bank Sources

The non-recourse debt portion could be provided by a syndicate of international project finance banks and initially underwritten by a small club of perhaps between two and five banks.

8.3.2 Institutional Sources of Funding

It is possible that the non-recourse debt could be provided either initially or by way of subsequent refinancing by institutional investors such as insurance companies.

8.3.3 European Investment Bank

The European Investment Bank (EIB) has a specific mandate to invest in transport projects and has in the past provided funding for a number of privately funded transportation projects in the UK. The list of projects includes loans to Eurotunnel, funding for the Docklands Light Railway extension to Bank Station, the Jubilee Line extension project as well as the Second Severn Crossing and the Skye Bridge. In October of this year, the EIB announced a £100 million loan facility to the South Yorkshire PTA/PTE for the Sheffield Super-tram project.

On 9 and 10 December 1994, the European Community Summit held in Essen confirmed inclusion of WCML on the list of 14 designated TEN projects. While inclusion as a TEN project does not ensure the
provision of funding, it confirms that the WCML is viewed as a priority strategic investment in European transportation infrastructure. The EIBs policy is to support the funding of such transportation projects with extended (special Window) terms providing its own rigorous lending criteria can be satisfied. Loan maturities for European railway projects are normally 16-18 years but may be extended if required for the financing of the project, under the Special Window terms announced at the Summit.

ETB funding is made subject to a number of conditions which include pari passu status with other senior lenders as well as a requirement that at least 50% of the total capital costs are funded from other sources. The ETB will not normally accept the risk of project completion. Either the funding is made available after the investment phase has been completed or these risks are separately indemnified by a commercial bank or other form of credit support acceptable to EIB.

8.3.4 European Investment Fund

The European Investment Fund (EIF) was established under the auspices of the EIB in June 1994. Its ownership is EIB (40%), European Commission (30%) with the balance of shares spread amongst 60 international commercial and development banks. The EIF was created to facilitate the private financing of European infrastructure projects and exists primarily to provide financial guarantees to banks and other financial institutions. The EIF has a capital base of 1.7 billion ECUs (equivalent to £1.3 billion) of which no more than 10% may be committed to any one specific project. In practice commitments will depend on the level of risk and on the need to establish a balanced portfolio of projects. EIF’s total guarantee capacity at present is set at 5.1 billion ECUs.

EIF support may be available for the WCML project as it is a TEN and would assist in attracting private bank finance as well as institutional funding by the concession consortium. In effect, EIF credit support provides an additional layer of funding which can be used to leverage the availability of bank finance and complement the provision of equity by the concessionary consortium.
8.4 RISK CONSIDERATIONS

8.4.1 Revenue Risk

Revenue risks to Railtrack are associated mainly with the regulation of the track access charge regime. The ORR is currently reviewing this. The concession company would receive a fixed fee payment which would, under the current regime, represent a lower amount than the access revenues which Railtrack receives from passenger and freight operating units using the WCML.

8.4.2 Operating Risk

Operating risks defined in terms of running and maintaining the WCML will be the key area of risk sharing. The private sector consortium will need to be in control of annual costs and will be responsible for implementing the programme of cost saving investments which has to be completed over the concession period.

8.4.3 Performance Risk

A further key area of risk sharing will involve the achievement of specified performance standards detailed in the contract. In addition to ensuring that existing performance standards are maintained, the concession company will be committed to achieving a programme of performance improvements which result in a reduction in minutes currently lost as a result of track, signal or power failures. Penalties in the form of contract fee payments withheld will be applied if there is failure to meet these requirements of the contract.

8.4.4 Force Majeure

Force majeure risks will be primarily addressed through insurance cover except for those risks associated with labour unrest and strike action involving the concession company or its sub-contractors.

8.4.5 Ground Conditions

The majority of the new capital works will not involve excavation or working at the level of the track formation. Risks associated with ground conditions will therefore be limited for any new works. Risks associated with subsidence, flooding or landslides will be insured wherever possible. Some measure of ground condition risk will remain where no insurance cover is available. The associated direct

Page 119
and consequential costs will be subject to the detailed negotiated conditions of the MDBM contract.

8.4.6 Asset Conditions

The concession company will be required to maintain and renew existing assets. The condition of these assets at take-over will be a risk to be handled through the compilation of an asset condition survey and register which the concession company will be required to accept, on terms to be subject to detailed negotiation within the MDBM contract.
CHAPTER 9

Involvement of Other Railway Stakeholders

In the newly reorganised railway industry there are many stakeholders in the WCML project who can contribute to or benefit from its success. Section 6.9 discusses the specific impacts of the project on the various stakeholders. This chapter considers the interfaces with the main stakeholders and the wider implications for them.

9.1 TRAIN OPERATORS AND THEIR CUSTOMERS

The train operators will be of key importance in the modernisation of the WCML. The opportunities identified in Chapter 3, and developed to form the Core Investment Programme and Market-Driven investment options, reflect their aspirations in a number of ways. Implementation will depend on the operators' support and interest in achieving improvements: only in active partnership will Railtrack and the operators be able successfully to compete with other modes of transport in the future.

Specifically, the TOUs' and FOCs' aspirations will be met in the following ways:

- ICWC will be able to provide faster, more comfortable, more reliable, and more frequent services.
- ICXC will have greater flexibility in traffic management through the new train command and control system and the possibility of faster journeys.
- There will be opportunities for NLR with greater flexibility to use the fast lines and increase frequency, comfort and reliability of services. The layout will be rationalised and management control improved at Euston Station. In addition the possibility of introducing double-deck trains, with significantly reduced operating costs is an option.
In the Midlands, RRC and Centro will be able, with the new train control system, to path services at increased frequency in the Coventry-Wolverhampton corridor, providing interchanges with InterCity services at Birmingham New Street and International Stations.

For RRNW, new electrification and train control systems will greatly improve flexibility to offer enhanced and more frequent services of a high quality.

In Scotland the WCML project will be supportive of local and long-distance services.

EPS will be able to benefit from increases in speed, comfort and reliability.

New opportunities for freight are included as options: piggyback and longer freight trains. Reliability, flexibility of pathing and new control systems will all provide FOCs with improved competitiveness.

For Res the desire for increased reliability will be met.

Concerns about disruption during the work have been recognised. The Study team has undertaken extensive investigation into working methods and possessions strategies to arrive at an indicative programme which minimises this. The concession contractor will be given incentives to plan and consult with operators to achieve the least possible disruption during the construction period.

For the upgrade options, the TOUs and the OPRAF will have a major opportunity to negotiate with Railtrack to select those options with which they wish to proceed. This approach will give a degree of control to the TOUs/FOCs which will assist in the creation of an effective industry partnership based on a 'win-win' approach to outcomes, leading to successful competition with air and road transport.

9.2 OPRAF

OPRAF has the responsibility for selecting the companies to operate the franchised passenger TOUs, including ICWC, and to award the franchises. The OPRAF will also award franchises for services
operating partially on the WCML, including ICXC, NLR, RRC, RRNW and Scotrail. The OPRAF will agree with Railtrack and the ORR any terms relating to exclusivity for the franchise operators.

The OPRAF will need to underwrite the level of services over the full modernisation concession period in order that Railtrack and the concession company's commitments for the Core Investment Programme can be met.

It is understood that it intends to award the franchise for ICWC in early 1996. Pre-qualification of potential bidders will begin during the second quarter of 1995. Railtrack intends to award the contract for the WCML modernisation concession in 1995, and will then provide the OPRAF with incremental track charges for the various speed and other upgrade options, based on the concession contract as awarded. The OPRAF will then be in a position to advise franchise bidders of the track charges for the various speed options. Bidders will, in turn, negotiate with rolling stock suppliers, including the leasing companies and manufacturers. They will also take a view of the commercial risks and returns of investing in the higher-speed options. They may submit alternative bids to the OPRAF based on more than one speed upgrade option.

This process should assure the OPRAF that it is paying the minimum possible subsidy for the required level of service. This will support the Government's objective of reducing the dependency of the railway industry on financial support. At the same time it should satisfy the OPRAF that opportunities for service and speed enhancement, where commercially justified, will be made. The OPRAF will need to negotiate with TOUs subsidy levels and terms sufficient to give them confidence in investing in new equipment or accepting new track charges.

In the OPRAF's Passenger Rail Franchising Pre-qualification Document issued on 14 December 1994, the Franchising Director states in relation to the WCML:

"... both the Franchising Director and Railtrack recognise that the modernisation programme could provide an opportunity to enhance this important part of the rail network by further investment to the benefit of passengers and the industry as a whole. Such enhancement could provide, for example, opportunities for reduced journey times."
Consequently, the Franchising Director would be willing to consider proposals from potential franchisees which involved enhancements directed towards improving the standard of service on a commercial basis, perhaps coupled with a longer franchise term. These enhancements would require increased track access charges which would be payable by franchisees."

To this end, the Franchising Director wishes to solicit views from prospective franchisees on the form of modernisation and the length of franchises, by 17 March 1995.

9.3 ORR

The ORR's prime tasks are to:

- protect the interests of rail travellers;
- promote the development of the network;
- provide a regulatory environment which permits open access to the network.

The ORR will be concerned that access agreements and charges are fair and that timetables are flexible enough to permit new franchises access to the network at suitable times. The WCML project will help it to meet all these objectives.

Increased comfort and reliability, together with reduced journey times, will further the interests of passengers.

The network will be developed as a result of the upgrade itself, and increased feeder traffic may trigger investment on interconnecting lines.

The installation of transmission-based train control will be the single most important improvement. This will allow greatly improved flexibility of operations, and an increase in capacity. It will be much less disruptive to install, keeping train delays to a minimum and so helping maintain customer satisfaction. The cost of cab equipment is unlikely to be significant in the overall financial evaluations of any new operation.
Increased capacity will directly support increased competition on the tracks. Competition, within an appropriate regulatory framework, is the best way to ensure the long-term interests of railway users.

### 9.4 RAIL USER CONSULTATIVE COMMITTEES

These committees are officially appointed bodies set up to reflect the users' views of public transport services. One of their major concerns is the level of fares and quality of service offered. The modernisation proposed in the Core Investment Programme is essentially Cost-Driven, and, although better reliability and comfort will be obtained, is also conducive to fares being contained. The upgrade opportunities provided by the Market-Driven investment options will generate additional ridership, and provide significant benefits to existing passengers.

### 9.5 HEALTH AND SAFETY EXECUTIVE

As discussed in Section 6.9.5, continued liaison will be required with the Railway Inspectorate of the HSE.

A project safety case will need to be produced by the concession contractor and, with Railtrack, submitted to the HSE for comment and acceptance. This procedure targets increased safety on the railway both during construction and after implementation. The transmission-based train control system will incorporate ATP as an integral part of its specification. This is a major step forward in train safety and can be achieved at an acceptable cost compared to previous proposals to implement ATP on a stand-alone basis.

Railtrack's policy will be to keep in close contact with the HSE and to obtain its agreement to methods of dealing with project safety issues as they occur.

### 9.6 PASSENGER TRANSPORT EXECUTIVES

There are several PTEs along the route of the WCML, from Strathclyde in Scotland to GMPTE and MerseyTravel in the North West and Centro in Birmingham. They are charged with integrating public transport services within their metropolitan areas and ensuring a high standard for the travelling public. Upgrading the WCML should
provide them with the opportunity to offer more frequent services which will allow easier interchange with other local rail, bus and light rapid transit services. Increased competition on the WCML, made possible by more flexible train control methods, should increase choice to the travelling public.

Some PTEs have indicated that they may be willing to fund specific infrastructure improvements within their cities, when these plans are developed in more detail during the implementation phase of the project.

9.7 ROSCOs AND TRAIN MANUFACTURERS

ROSCOs and train manufacturers will be interested principally in having a known environment in which to design and lease trains for the foreseeable future. They will then be able to concentrate on making trains able to operate in that environment at their most efficient levels.

The options chosen for the WCML will allow the use of tilting trains. As already discussed these trains are currently in use in Germany, Italy, Spain and Sweden and are produced by companies such as ABB and Fiat. If the market for such trains develops in the UK, this will provide an opportunity for rolling stock manufacturers.

9.8 EQUIPMENT MANUFACTURERS

Standards being set for train control on the WCML may be adopted for the rest of the UK’s, as well as mainland Europe’s, railways. Should transmission-based train control become the preferred method, it will allow an element of stability permitting train designs to become more efficient and cheaper.

There will be opportunities for signalling companies to compete to develop the equipment required for the WCML.

9.9 INFRASTRUCTURE SERVICE COMPANIES

Infrastructure service companies, as part of BRIS, will be offered for sale during 1995. Initially they will have a guaranteed workload of maintenance and renewals on the WCML and other lines. On the WCML project, competitive tenders will be invited for the additional modernisation and upgrading work, also including the ongoing
maintenance and renewals to be taken over after a suitable period. These issues are currently in discussion between Railtrack, the DoT and BR Board.
CHAPTER 10

Conclusions and Next Steps

10.1 CONCLUSIONS

This Study has identified a Core Investment Programme of capital investment to modernise the WCML. A full description has been given in Chapter 6. It has been demonstrated that this programme can be funded from within Railtrack's existing track access charges. The Core Investment Programme will reduce costs in the medium term as shown in the comparison with Bedrock in Table 10.1.

Table 10.1: BENEFITS OF CORE INVESTMENT PROGRAMME

<table>
<thead>
<tr>
<th>Option</th>
<th>Railtrack Costs</th>
<th>Net Benefits to TOUs</th>
<th>Benefits to Passengers</th>
<th>Total Benefits</th>
<th>Net Costs and Benefits</th>
<th>Net Benefit over Bedrock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>(2,630)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(2,630)</td>
<td>-</td>
</tr>
<tr>
<td>Core Investment Programme</td>
<td>(2,440)</td>
<td>40</td>
<td>30</td>
<td>70</td>
<td>(2,370)</td>
<td>260</td>
</tr>
</tbody>
</table>

These cost savings, which include £190 million NPV to Railtrack, will improve the financial health of the rail industry, ensuring its growth and prosperity into the next century. It is therefore recommended that this investment programme is implemented immediately.

Various Market-Driven investment options, also described in Chapter 6, have been defined, which would permit the operation of enhanced services. These options could be applied to some or all of the route sections of the WCML network, and are set out in Table 10.2.
## Table 10.2: BENEFITS OF MARKET-DRIVEN OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Brief Description</th>
<th>Cost £m NPV</th>
<th>Revenue Benefit £m NPV</th>
<th>Revenue &amp; Economic Benefit £m NPV</th>
<th>Net Present Value £m</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Upgrade of the track to improve ride quality, reliability and punctuality</td>
<td>(150)</td>
<td>45</td>
<td>143</td>
<td>(7)</td>
</tr>
<tr>
<td>B</td>
<td>Increase line capacity with enhancement of power supply</td>
<td>(11)</td>
<td>.</td>
<td>.</td>
<td>-</td>
</tr>
<tr>
<td>C+</td>
<td>Reduced journey time with 200 km/h conventional trains</td>
<td>(234)</td>
<td>104</td>
<td>293</td>
<td>59</td>
</tr>
<tr>
<td>D+</td>
<td>Reduced journey time with 225 km/h tilting trains</td>
<td>(333)</td>
<td>207</td>
<td>569</td>
<td>236</td>
</tr>
<tr>
<td>E+</td>
<td>Reduced journey time with 250 km/h tilting trains</td>
<td>(413)</td>
<td>231</td>
<td>634</td>
<td>221</td>
</tr>
<tr>
<td>F</td>
<td>Increase the loading gauge for Piggyback and 9''6'' containers from CTRL link to Daventry</td>
<td>(26)</td>
<td>46**</td>
<td>49**</td>
<td>23</td>
</tr>
</tbody>
</table>
| G      | Increase the loading gauge for double-deck rolling stock from Euston to Northampton  
  - incremental on piggyback enhancements  
  - incremental on piggyback and overhead line enhancements | (41)        | .                      | .                             | -                   |
| H      | Lengthening of passing loops to allow operation of freight trains of up to 750 metres in length between London and Scotland | (2)         | .                      | .                             | -                   |

* Revenue and economic benefits are not given as these are dependent on TOU/FOC market demand  

** Based on incremental annual revenues of £10m after 2005  

+ Incremental Option A

Commercial viability of these further investments depends upon the willingness of TOUs to make use of them, and to negotiate track access charges to support the costs, justified by increased traffic and revenues or reduced train operating costs. The passenger options could attract increased subsidies to franchised TOUs to reflect substantial economic benefits.
10.2 PROGRAMME FOR IMPLEMENTATION

10.2.1 Core Investment

If Railtrack is able to award the main concession contract before the end of 1995, the first section of line could be converted to transmission-based train control by the end of the year 2000. Full changeover and control of the line from a single control centre could then be achieved by 2003-04. This programme will depend on agreements being reached in time with OPRAF and the ORR regarding the structure and level of charges for a defined period.

The ORR has indicated that it will approve the structure and level of Railtrack’s charges in early 1995. OPRAF will need to underwrite the existing charges in the same time frame, and both OPRAF and the ORR will need to agree to some minor changes in the track charging and access agreements to allow conversion to cab train control.

10.2.2 Upgrade Options for the Passenger Market

OPRAF has indicated that it intends to award the franchise for ICWC services during 1996. Provided the main concession contract is awarded in 1995, the costs for the relevant speed enhancement options will be available for consideration by potential franchisees in 1996. In conjunction with awarding the ICWC franchise in late 1996, it will have to take a view about the ICXC, NLR and other franchises on the line. Implementation of the upgrade options could then begin in 1997 with high-speed trains in operation at around the end of the century.

In Section 9.2 OPRAF’s recent statement regarding pre-qualification of bidders for the ICWC has been set out. Replies have been requested from potential bidders by 19 March 1995.

Provision for double-deck trains is dependent upon implementation of the piggyback option. If implemented, the double-deck trains might be introduced on the London-Northampton line early in the next century.

10.2.3 Upgrade Options for the Freight Market

Railtrack has already begun negotiations with FOCs and other potential investors who could finance the necessary gauge enhancement for the carriage of piggyback trailers and 9'6" containers. The recommended investment strategy is, however, dependent upon clearance of a route from London to the Channel Tunnel.
The incremental investment required for longer freight trains is very small, and dependent only on the provision of longer passing loops in conjunction with the introduction of the new train control system. Early negotiations with FOCs on this investment would enable it to be added to the Core Investment Programme.

10.2.4 Railtrack's Draft Timetable (Fast-track)

1995 First Quarter

Agreement by the Government to proceed;

- Invitation for pre-qualification of potential concession companies through the European Journal;
- Definition of MDBM contract heads of terms and payment arrangements;
- Approval by the ORR of current track charging structure and level;
- Agreement by OPRAF to underwrite future payments for a defined period, and to necessary changes in charging and access agreements for transmission-based train control;

1995 Second Quarter

Modernisation programme begins through targeted renewals funded by 1995-96 EFL;

- Articulation of performance specification and detailed terms and conditions of MDBM contract;
- Completion of WCML Asset Register;
- Issue of tender documents for concession contract;

1995 Fourth Quarter

Return of bids;

- Award of concession contract for Core Investment Programme;
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Implementation of Core Investment Programme begins;</td>
</tr>
<tr>
<td>1998</td>
<td>Fitting of cab-signalling equipment commences;</td>
</tr>
<tr>
<td>2000</td>
<td>Earliest date for introduction of transmission-based train control on a section of line;</td>
</tr>
<tr>
<td>2003-04</td>
<td>Full changeover to transmission-based train control and single control centre for WCML.</td>
</tr>
</tbody>
</table>
ANNEX A STATEMENT OF THE SECRETARY OF STATE FOR TRANSPORT, 1 DECEMBER 1993

House of Commons

Mr Stephen Day (Con - Cheadle):

288 To ask the Secretary of State for Transport, if he will make a statement about the modernisation of the West Coast Main Line's infrastructure.

Mr John MacGregor

My Rt Hon Friend, the Chancellor of the Exchequer, announced in his Budget Statement that the Government has decided that the modernisation of the West Coast Main Line will be taken forward as a privately managed and financed investment as part of the private finance initiative. The investment made by the private sector will be additional to the investment which Railtrack will be able to fund under the public expenditure plans announced in the Budget.

Principles for using private sector management and finance have been agreed between the Department of Transport and Railtrack following a Study carried out by Hambros Bank Limited. Under these:

- Railtrack will be responsible for project definition and will draw up performance standards for the line in association with the private sector. Railtrack will be inviting expressions of interest in the next few days.

- Once the new performance standards have been set, a competition will be held in late 1994 to select a private sector consortium to modernise the line and to maintain it for a defined period. The responsibility for project management and design will also rest with the successful consortium.

- The successful consortium will be remunerated by service payments from Railtrack during the contract period. These payments will be subject to penalties and bonuses linked to the performance of the consortium in meeting the new performance standards and the consequential impact this will have on revenue losses and gains on the line.
The new standards will stipulate minimum performance criteria. Where commercially justified, the InterCity West Coast franchisee (and, possibly, other train operators) will be able to contract for linespeed and other improvements in exchange for increased access payments.

To facilitate this the InterCity West Coast franchise will be let at the earliest practicable date.

The principles has been devised to transfer risks out of the public sector to those who can control them best. The risk that the infrastructure fails to perform to specification will be transferred to the private sector consortium. That consortium will also bear revenue risk insofar as it is affected by the performance of the infrastructure. The bulk of the remainder of the revenue risk will be transferred to the train operating companies and the providers of private sector funds.

This approach will bring together private and public sector expertise to modernise the line in a way which will ensure that its full potential is realised without the capital cost coming out of public funds.

Wednesday 1 December 1993
Department of Transport
ANNEX B  COMMUNICATIONS AND CONSULTATION ACTIVITIES

B.1  Introduction

Railtrack and WCML Development Company Ltd undertook a wide, open and extensive consultation programme as part of the feasibility Study process.

The consultation programme, and the communications activities that underpinned it, addressed a wide number of audiences over and above those who could be considered to be customers of the WCML. Furthermore, it sought to address not only their aspirations with regard to any modernisation or upgrade, but deliberately aimed to ascertain views, comments, and opinion beyond the scope of the feasibility Study and the modernisation/upgrade that would follow.

B.2  Consultees

The diverse audience range included:

- over 239 national politicians with constituencies on or near the line (MPs and MEPs and Peers);
- 25 county or metropolitan authorities, with a further 90 local (district or regional) councils;
- business groups incorporating branches of the Confederation of British Industry, Institute of Directors, Chambers of Commerce and Trade, and other small business groups;
- railway or transport groups, such as Transport 2000 and various Rail Users Consultative Committees;
- organised consortia, often made up from a collection of the above to form 'super lobbies', such as:
  - North of England Regional Consortium (NOERC),
  - West Coast Rail 250 Group,
  - North West Regional Association,
  - West Midlands Regional Rail Forum;
- customers, potential customers and other stakeholders in the new railway industry;
media and press interests from the South and London through all major conurbations along the route to North Wales, Northern Ireland, and all areas in Scotland.

The total numbers within the Study's constituency of interest started from a 'low' of 650 and grew through the nine months of the Study to a peak of just below 1,000. A good third of these were either headquarters operations or the lead body for many other groups or organisations; for example, the NOERC body represents some 100 individuals, authorities, or business groups.

B.3 Process

The communications exercise involved an integrated mix of messages to these groups delivered in direct and indirect ways:

- via a direct mailing campaign updating all audiences of progress of the Study on a regular basis;
- face-to-face meetings and presentations with the principal organised consortia on the line;
- four meetings with the West Coast All Party Group of MPs and Peers;
- ministerial and officials meetings with the Treasury and the DoT, with OPRAF, with ORR, and also with the European Commission's DG7 and representatives of European institutions in Brussels and Strasbourg;
- customer meetings to ascertain aspirations more directly;
- four major events for 'opinion formers' in Birmingham, Glasgow, London and Manchester;
- press conferences at each of those events plus regular briefings for the national media and trade (railway, construction and engineering) press on an ongoing basis.

Numerous requests were met for specific briefings by Study team members and over 1000 information packs were distributed over the period of the Study.

The opinions and views ranged from the broad (benefits to UK Limited) to the local and specific. All were listened to and logged for use by the Study team.
B.4 List of Responders Who Made Specific Comments

Regions, Counties and Districts

Aberconwy Borough Council
Birmingham City Council
Blackburn Borough Council
Blackpool Borough Council
Bromsgrove District Council
Cannock Chase Council
Central Manchester Development Corporation
Cheshire Country Council
Chorley Borough Council
Colwyn Borough Council
Copeland Borough Council
Crewe and Nantwich Borough Council
Cumbria County Council
Daventry District Council
Dumfries and Galloway Regional Council
Ellesmere Port and Neston Borough Council
Gwynedd County Council
Hertfordshire County Council
Hyndburn Borough Council
Inverclyde District Council
Lancashire County Council
Lancaster City Council
Manchester City Council
Mid Bedfordshire District Council
Milton Keynes Borough Council
Motherwell District Council
North of England Assembly of Local Authorities
North Warwickshire Borough Council
Northampton Borough Council
Northamptonshire County Council
Pendle Borough Council
Ribble Valley Borough Council
Rugby Borough Council
South Lakeland District Council
South Northamptonshire Council
South Ribble Borough Council
Staffordshire County Council
Tamworth Borough Council
Three Rivers District Council
Warwickshire County Council
West Lancashire District Council
Wrekin Council
MPs and MEPs

Tony Cunningham MEP
George Foulkes MP
Phil Gallie MP
Doug Hoyle MP
Michael Jack MP
Michael Jopling MP
Rt Hon. Gerald Kaufman MP
Mark Lennox-Boyd MP
Joan Lester MP
Eric Martlew MP
Andrew Miller MP
Tom Sackville MP
Brian Simpson MEP
Alex Smith MEP
Sir David Steel MEP
George Stevenson MP
John Taylor MP
Malcolm Thornton MP
Phillip Whitehead MEP
Terrence Wynn MEP

Passenger Transport Authorities/Executives

Centro
Greater Manchester PTE
Merseyside PTA
MerseyTravel
West Midlands PTA

Rail Groups and Pressure Groups

Clydesdale Rail Action Group
Derwent Railway Society
Greater Manchester Transport Users' Consultative Committee
London Regional Passengers Committee
North West Channel Tunnel Group
North West Institute of Highways and Transportation
North West Regional Association
Rail Users' Consultative Committee
Shrewsbury-Wolverhampton Rail Users Association
Stratford-upon-Avon Rail Transport Group
The Oxon and Bucks Rail Action Committee (OBRAC)
Tunnel Link Group
West Midlands Regional Rail Forum
West Coast Rail 250 Group
Freight Transport Industry

CAIB UK Limited
Daventry International Freight Terminal
Freight Transport Association
P & O European Transport Service
RfD Managing Director
The Mersey Docks and Harbour Company

Business and Union Groups

Birmingham Chamber of Commerce & Industry
Business Link Crewe and Nantwich
Cumbria Training and Enterprise Council
East Mercia Chamber of Commerce and Industry
Lancaster District Chamber of Commerce, Trade and Industry
Liverpool, Chamber of Commerce and Industry
RMT Scotland
Redditch & District Chamber of Commerce and Industry
Stafford Training and Enterprise Council
Walsall Training and Enterprise Council

Civic and Leisure

Cockermouth and District Civic Trust
Cumbria Tourist Board

Others

Government Departments (DoT, Treasury)
OPRAF
ORR
ANNEX C  TECHNICAL OPTIONS EVALUATED

A number of potential improvements to the operation of the railway were evaluated. These were intended either to reduce costs, or satisfy market demand. These improvements and the result of their evaluation are tabulated below. Where options were reflect, the reasons were recorded.

### COST-DRIVEN OPTIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Result of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRACKWORK</strong></td>
<td></td>
</tr>
<tr>
<td>Improved track components</td>
<td>Matters for contractor’s decision, but</td>
</tr>
<tr>
<td>New civil renewals plant</td>
<td>good opportunities identified</td>
</tr>
<tr>
<td>Amended maintenance schedules</td>
<td></td>
</tr>
<tr>
<td><strong>STRUCTURES</strong></td>
<td></td>
</tr>
<tr>
<td>Removal of redundant structures</td>
<td>To be incorporated where beneficial</td>
</tr>
<tr>
<td><strong>ROLLING STOCK</strong></td>
<td></td>
</tr>
<tr>
<td>Improved bogie design</td>
<td>Matters for ROSCOs/TOUs decision</td>
</tr>
<tr>
<td>Pantograph improvements</td>
<td></td>
</tr>
<tr>
<td><strong>TRACTION POWER</strong></td>
<td></td>
</tr>
<tr>
<td>Improved feed reliability</td>
<td>Not found to be cost-beneficial</td>
</tr>
<tr>
<td>Rationalise Mk 1 OHLE</td>
<td></td>
</tr>
<tr>
<td>Additional remote section facilities</td>
<td>Matter for contractor's decision</td>
</tr>
<tr>
<td>Increased supply security</td>
<td>Extra security not found to be cost</td>
</tr>
<tr>
<td></td>
<td>beneficial</td>
</tr>
<tr>
<td>Double rail traction return</td>
<td>Feature of chosen train control scheme</td>
</tr>
<tr>
<td>Points heating supply and monitoring</td>
<td></td>
</tr>
<tr>
<td>New OHLE renewals plant</td>
<td>Matters for contractor’s decision</td>
</tr>
<tr>
<td>Increased OHLE monitoring</td>
<td></td>
</tr>
<tr>
<td>Regenerative braking - supply / mods</td>
<td>Matter for ROSCOs/TOUs decision</td>
</tr>
<tr>
<td><strong>SIGNALLING</strong></td>
<td></td>
</tr>
<tr>
<td>Review maintenance schedules</td>
<td>Matter for contractor’s decision</td>
</tr>
<tr>
<td>Remote diagnostic monitoring</td>
<td>Feature of chosen scheme</td>
</tr>
<tr>
<td>Rationalise signalling layout</td>
<td>To suit track rationalisation</td>
</tr>
<tr>
<td>Renew data transmission system</td>
<td>Feature of chosen scheme</td>
</tr>
<tr>
<td>Fully automatic trains</td>
<td>Not in chosen scheme but possibility for</td>
</tr>
<tr>
<td></td>
<td>future</td>
</tr>
<tr>
<td>Reliable point machines</td>
<td>Recommended for chosen scheme</td>
</tr>
<tr>
<td>Reliability centred maintenance of</td>
<td>Recommended, but matter for contractor</td>
</tr>
<tr>
<td>points</td>
<td></td>
</tr>
<tr>
<td>Long DC track circuits</td>
<td>Not required with chosen signalling</td>
</tr>
<tr>
<td></td>
<td>technology</td>
</tr>
<tr>
<td>Signalling power diagnostics</td>
<td>Feature of chosen scheme</td>
</tr>
</tbody>
</table>
### COST-DRIVEN OPTIONS (CONTINUED)

<table>
<thead>
<tr>
<th>Description</th>
<th>Result of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPERATIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Rationalise routes to Manchester</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Track rationalisation and remodelling</td>
<td>Selective changes recommended</td>
</tr>
<tr>
<td>Catering for longer trains</td>
<td></td>
</tr>
<tr>
<td>- freight</td>
<td>Ongoing implementation option</td>
</tr>
<tr>
<td>- passenger</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Heavier axle loads</td>
<td>Matter for Railtrack/FOCs' review</td>
</tr>
<tr>
<td>Improved possession/crossover strategies</td>
<td>Matter for contractor, but feasibility of</td>
</tr>
<tr>
<td></td>
<td>long possessions demonstrated on certain</td>
</tr>
<tr>
<td></td>
<td>sections</td>
</tr>
<tr>
<td>Shorten / reduce number of platforms</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Segregated light rail</td>
<td>Not recommended</td>
</tr>
<tr>
<td>One person operation</td>
<td>Possible with chosen signalling technology</td>
</tr>
<tr>
<td>Close depots / sidings</td>
<td>Limited benefit found</td>
</tr>
<tr>
<td>Build diversion lines</td>
<td>Not recommended</td>
</tr>
<tr>
<td><strong>COMBINED</strong></td>
<td></td>
</tr>
<tr>
<td>Integrated control centre</td>
<td>Single centre and back-up recommended</td>
</tr>
</tbody>
</table>

### MARKET-DRIVEN OPTIONS

<table>
<thead>
<tr>
<th>TRACKWORK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Modify track standards</td>
<td>Not found to be beneficial</td>
</tr>
<tr>
<td>Lift PSRs</td>
<td>Selected on cost/benefit basis</td>
</tr>
<tr>
<td>200 km/h (125 mph)</td>
<td>Ongoing implementation options with</td>
</tr>
<tr>
<td></td>
<td>conventional or tilting rolling stock</td>
</tr>
<tr>
<td>225 km/h (140 mph)</td>
<td>Ongoing implementation options with</td>
</tr>
<tr>
<td></td>
<td>tilting rolling stock</td>
</tr>
<tr>
<td>250 km/h (155 mph)</td>
<td>Ongoing implementation option</td>
</tr>
<tr>
<td>300 km/h (186 mph)</td>
<td>Not found to be cost-beneficial</td>
</tr>
<tr>
<td><strong>STRUCTURES</strong></td>
<td></td>
</tr>
<tr>
<td>Piggyback gauge</td>
<td>Ongoing implementation option</td>
</tr>
<tr>
<td>B+ gauge</td>
<td>Only through progressive upgrade</td>
</tr>
<tr>
<td>Rolling motorway gauge</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Double-deck passenger trains</td>
<td>Ongoing implementation option</td>
</tr>
<tr>
<td>Heavier / faster freight trains</td>
<td>Matter for Railtrack/FOCs' review</td>
</tr>
<tr>
<td>Eliminate level crossings</td>
<td>Recommended where needed for</td>
</tr>
<tr>
<td></td>
<td>higher-speed options</td>
</tr>
</tbody>
</table>
MARKET-DRIVEN OPTIONS (CONTINUED)

<table>
<thead>
<tr>
<th>Description</th>
<th>Result of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROLLING STOCK</td>
<td></td>
</tr>
<tr>
<td>Introduction of high-speed (&gt; 225 km/h) passenger diesel trains</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Improve train acceleration and braking</td>
<td>Matter for ROSCOs/TOUs</td>
</tr>
<tr>
<td>Tilting trains</td>
<td>Ongoing implementation option</td>
</tr>
<tr>
<td>TRACTION POWER</td>
<td></td>
</tr>
<tr>
<td>Reinforce existing 25kV supply</td>
<td>Progressive reinforcement up to 225 km/h operation</td>
</tr>
<tr>
<td>Auto-transformer system with existing supply points</td>
<td>Found not to be feasible</td>
</tr>
<tr>
<td>Auto-transformer system with existing new supply points</td>
<td>Needed for 250 km/h operation</td>
</tr>
<tr>
<td>Catenary enhancements</td>
<td>Progressive enhancement needed for higher linespeeds</td>
</tr>
<tr>
<td>SIGNALLING</td>
<td></td>
</tr>
<tr>
<td>Conventional technology</td>
<td>Not found to be cost-beneficial</td>
</tr>
<tr>
<td>Track-based cab-signalling</td>
<td>Recommended scheme</td>
</tr>
<tr>
<td>Transmission-based train control</td>
<td>Feature of chosen scheme</td>
</tr>
<tr>
<td>Automated control systems</td>
<td></td>
</tr>
<tr>
<td>OPERATIONS</td>
<td></td>
</tr>
<tr>
<td>Reduce dwell times</td>
<td>Commercial issue (Railtrack/TOUs)</td>
</tr>
<tr>
<td>Increase route capacity</td>
<td>Ample capacity demonstrated with chosen signalling system (including Coventry-Wolverhampton if timeabling constraints accepted)</td>
</tr>
<tr>
<td>Change route configuration (up/up down/down)</td>
<td>Not found to be cost-beneficial</td>
</tr>
</tbody>
</table>
ANNEX D MARKET DEMAND MODELS

D.1 Passenger Demand Forecasting Methodology

For the purposes of the Study, a passenger demand model was required to forecast the patronage of changing rail service parameters, in particular changes in journey times. Outputs from the model were used to identify increased patronage, revenue and user benefits. In addition, an analytical technique was employed to estimate benefits to non-users arising from highway decongestion as a consequence of the diversion of trips from road to rail following service improvements. This section summarises the key features of the techniques used in the Study.

D.2 Network Demand Forecasting Model

A zone-based rail and road network was built, using the TRIPS suite of programs, as the framework for the demand forecasting process. Focused on the 15 sections of the WCML corridor and the competing road corridor (M1, M40, M6), the model characterised links and flows between 186 zones covering the whole of mainland Britain.

The rail passenger origin-destination matrix was derived from passenger surveys on services operated by the three TOUs with the largest share of WCML market: ICWC, ICXC and NLR, augmented by BR’s CAPRI ticket sales data for these three TOUs. Data were segmented for each TOU by ticket type and journey purpose based on the passenger surveys.

Rail network data were based on the summer 1994 timetable, with allowances made for the provincial EPS services due for commencement in 1995.

It was not possible to develop highway demand matrices in the timescale of the Study. Instead flows within the highway model were pre-loaded, based on flow data already available to the Study team. Base year highway link flows were then growthed up to forecast years using the National Road Traffic Forecasts. Future year highway schemes such as the Birmingham Northern Relief Road were incorporated into the future year networks based on the National Roads Programme.

Three separate time periods were modelled: morning peak (0700-1000), inter peak (1000-1600) and evening peak (1600-1900).
Sensitivity analysis of key parameters was undertaken, both 'on' and 'off' the model. This allowed the testing of a range of elasticity values without being constrained by the structure of the model (which was itself determined by the information contained within BR's PDFH).

D.3 Development of Options

Bedrock times were estimated from the run times of CL90 locomotives plus 9 MkIII coaches and 1 DVT, assuming the existing linespeed profile, as provided by BR's Train Performance Unit at Derby. These were 'calibrated' to the summer 1994 timetable, by the addition of:

- performance allowances at 5% of run times;
- engineering allowances at two minutes per section;
- operational allowances on a train-specific basis, as shown in the working timetable;
- a further allowance, to the extent that arrival times in the working timetable and published schedules differed.

Option A (Improved Track Quality) was assessed on identical timetables to that of Bedrock but with 50% reduction in engineering allowances. This was due to reduced need for temporary speed restrictions as a result of infrastructure investment. There was also a 30% reduction in charter time to reflect the improved reliability of rail infrastructure.

All higher-speed options were based on the run times of an IC250 set, as supplied by Derby. No further adjustments were made to engineering or other allowances for higher-speed options.

D.4 Growth Forecasting

For the three principal TOUs, BR's PDFH elasticities were used to forecast the general growth in rail patronage over time. These include gross domestic product (GDP) assumptions consistent with the latest DoT models. Growth assumptions have been used to generate low and high growth scenarios. A further 'central growth' scenario was obtained by taking a 60/40 ratio in favour of low growth. This was performed for both the scheme opening year and the design year (15 years after opening). The only exception to this method is for commuting traffic using Network SouthEast services where GDP elasticities do not apply; the growth factoring of NLR's peak matrices is discussed below.

A network demand model needs to be more sophisticated, however, as it is required to predict changes in the spatial distribution of trips over time. National Trip End Model planning data were therefore supplemented with London Transport Study (LTS) planning data for...
London zones to control the distribution when growing up the base year matrices to 2005 and 2020. The resultant matrices were then factored to the controlled totals derived from the GDP elasticities except for the NLR peak matrices which were left unaltered. LTS do not have growth scenarios and therefore our peak NLR matrices were assumed to be the same for both low, central and high growth scenarios.

The GDP elasticities used are outlined below with associated time trend.

<table>
<thead>
<tr>
<th>Service Type</th>
<th>GDP Elasticity</th>
<th>Time Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercity West Coast</td>
<td>1.5</td>
<td>-2.5% pa</td>
</tr>
<tr>
<td>Intercity Cross Country</td>
<td>1.5</td>
<td>-2.5% pa</td>
</tr>
<tr>
<td>North London Railways (Inter peak)</td>
<td>1.2</td>
<td>-2.0% pa</td>
</tr>
<tr>
<td>North London Railways (AM &amp; PM)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

D.5 Journey Time Elasticities

In addition to the 'natural' growth of patronage over time there will also be patronage growth resulting from service improvements from the implementation of schemes. The responsiveness of demand to journey time improvements was modelled in the network demand model through the use of journey time elasticities.

The principal journey time elasticities of 0.8 was used in the analysis.

D.6 Estimation of Revenue, User and Non-user Benefits

The methodology for deriving revenue benefits to TOUs, user benefits (i.e. changes in consumer surplus of existing passengers) and non-user benefits is summarised in this section.

Revenue benefits, user benefits and non-user benefits were assessed for two forecast years 2005 and 2020 and for three growth scenarios, low, central and high.

Revenue benefits to TOUs were assessed by applying the journey time elasticity to proportional changes in in-vehicle journey time at the zonal level between Bedrock and each of the alternative upgrade options in order to generate new demand.

Benefits to existing passengers through journey time improvements were calculated by:
the product of value of time (weighted by journey purpose for each TOU);

- the time saving;

- the annualised demand.

Non-user benefits were calculated using the cost benefit analysis (COBA) model, which was pre-loaded with forecast link flow volumes to represent the 'Do-Minimum' situation. To create a 'Do-Something' situation for each of the alternative upgrade options, it was assumed that 50% of the new rail trips would be diverted from car. Thus, for each option, 50% of the increased rail demand was assigned to the TRIPS highway model to identify the routes that would have previously been used by those diverting from car. Forecast links values from the highway model were then used to create the Do-Something link flows for the COBA model. Current COBA default values of vehicle composition, occupancy, operating costs, values of time and accidents costs were used. Benefits were calculated based on the difference in operating costs, journey times and accidents between an option and the Bedrock case. COBA benefits were scaled down to ensure that existing road users transferring to rail would not also accrue non-user benefits. In addition, non-user benefits on urban roads were excluded from the COBA analysis.
ANNEX E  EFFICIENCY SAVINGS

E.1  Basis of Cost Estimates

The costs of capital works have been developed from BRIS rates, and recent experience of major capital projects, such as the Channel Tunnel route clearance works, the Heathrow Express project and international experience.

E.2  Cost Savings from a Single MDBM Contract

In the Core Investment Programme, it is envisaged that a single MDBM contract will be awarded to a concession company. There are good reasons to expect further cost savings will arise due to the type of contract to be awarded. For example:

- The size of the modernisation contract will support the deployment of the highest level of competent management and systems which will reduce the cost of maintaining the infrastructure.

- It will be possible to plan out the capital and maintenance investment programme over the period of the concession. As such, the different types of capital investment and maintenance can be optimised, and the most effective method of maintaining the performance of the infrastructure chosen.

- Possessions can be tailored to the work schedule, subject to the constraints embodied in the Rules of the Route, and therefore save considerable management time and cost.

- There will be a solid schedule of work stretching out over 15-25 years. Therefore early investment in plant will be possible in order to drive productivity increases.

- The introduction of a concession company will create vitality in the market and introduce competitive tendering pressures earlier than would otherwise be the case.

E.3  Cost Savings from the Transmission-based Signalling System

Track maintenance costs will be lower in CIP than in Bedrock due to the introduction of transmission-based signalling. Cost saving benefits will arise after the introduction of the new signalling system between 2001 and 2005. The main benefits will be:

- increased capacity and full bi-directionality reducing the disruption of trains caused by possessions;
- Reduced labour costs due to the use of geographical monitoring tags worn by track crews. This will reduce the need for look-outs and result in labour savings.

- Elimination of most track circuits over time. This will reduce the cost and effort that goes into installing the maintaining insulated joints.

It is estimated that the benefits of transmission-based signalling will reduce track maintenance costs by a further 5%.
ANNEX F RELIABILITY

F.1 Background

Investment in the WCML will impact on TOU operational performance in terms of improved train punctuality and a reduced need for allowances in the timetable for unplanned maintenance activities.

Operational performance 'benchmarks' are contained in the access agreements with TOUs, and vary by operator and by service type. Costs and benefits relating to performance comprise three categories:

- incentive payments to Railtrack, to encourage reductions in average train lateness below base levels (normal regime);
- payments to TOUs to compensate for persistent failure due to infrastructure;
- payments to TOUs to compensate for severe disruption;

A further category of performance-related payment relates to the Passengers Charter. Improvements in Railtrack's performance may therefore lead to an increase in income from TOUs (or a decrease in payments).

F.2 Methodology Adopted for Analysis

In the absence of data with which to perform an analysis of potential benefits to Railtrack from operational performance improvements, a methodology based on the estimation of the total benefits to the railway industry has been adopted. Revenue, user and non-user benefits have been estimated from the change in passenger demand resulting from operational performance improvements.

A database of causes of infrastructure-related delay and associated minutes lost on WCML was prepared. This list was analysed to identify which components would reduce following the implementation of the Recovery strategy, and by how much. Some causes of delay would be avoided, others considerably reduced, while others (e.g. road vehicles hitting bridges) would be unaffected. This analysis therefore produced an estimate of the total time by which delays to trains would be reduced.
Reliability improvements have two components:

- an improvement in journey time as a result of the requirement for fewer allowances in the timetable;
- an improvement in punctuality or operational performance.

The former improvement has been taken into journey time savings, and the appropriate PDFH elasticity applied to derive changes in market demand and hence revenue, user and non-user benefits.

Benefits from reduced delays were also estimated in an elasticity model, using PDFH values to determine changes in market demand. In this model, passenger demand is a function of total delays to trains. It was therefore necessary to relate delays attributable to infrastructure to total delays to trains from all causes, and thence to determine the extent to which the Core Investment Programme would reduce total delays. It was assumed that infrastructure delays as identified by the database represented 33% of all delays on the WCML, following the 1989 WCML Strategy Review study.

Elasticities were applied to the percentage change in delay time to derive reliability benefits by type of service and by operator. Average lateness for InterCity services was weighted at 1.7 times in-vehicle time in accordance with advice from ITS at Leeds University, which is a more conservative assumption than that of PDFH which recommends 2.5; average lateness on commuter services was weighted at 1.25 times in-vehicle time in accordance with PDFH.
ANNEX G  RISK ANALYSIS

G.1  Methodology

A risk assessment has been conducted on the engineering costs of the Core Investment Programme and Bedrock options. Through discussion with specialist engineers, a range of likely costs have been determined for each of the elements that make up these investment programmes and an overall assessment of cost risk has been made for the Core Investment Programme and Bedrock options.

The overall process is represented diagrammatically below. A cost risk analysis has been conducted for each of the four disciplines (track, train control, power and structures) which has then been combined into an overall assessment of engineering cost risk for the two investment options.

Figure 1: RISK ASSESSMENT PROCESS

The analysis has been conducted on the whole of the WCML using total capital and maintenance expenditure over a 15-year period from 1996-67 to 2011-12. It uses un-escalated, non-discounted cost estimates (i.e. disciplines' base data).
The analysis has been carried out on the cost estimates which have been provided by each of the Study's technical discipline leaders.

Standard risk assessment worksheets have been completed by the risk analysts and signed off following interviews with discipline leaders. In general, risk ranges have been developed for the cost centres given below. Exceptions have been made where a discipline's costs do not adequately fit into these categories:

- **For Capital Expenditure**

  - design
  - equipment/materials
  - construction
  - installation
  - commissioning

- **For Maintenance**

  - materials
  - labour
  - plant
  - overheads (where not included in materials, labour and plant)
  - lease costs for telecommunications.

A composite risk accuracy range for each of the above cost centres has been determined using the judgement of the discipline leaders in order to take into account the risk factors identified during the interviews.

The risk ranges developed for each of the elements of capital expenditure and elements of maintenance expenditure reflect confidence levels in: the sources of information, anticipated changes in unit rates and quantities. These risk ranges were used to develop the appropriate spread of costs for each centre.

A Monte Carlo simulation has been conducted independently on each of the estimates produced for each discipline and each investment option. Likely correlation of variables between track sections has been taken into account.

The risk assessment is based on engineering cost estimates and does not include:

- cost variations due to programme uncertainty and other time-dependent costs;
- interest rates, inflation and taxation;
• costs associated with legislation, regulations and guidelines;
• contract strategies, incentives and liquidated damages;
• contractor default costs;
• insurance and other risk reduction costs;
• project management costs, IT and other in-house services;
• interest charges and financial arrangement fees;
• compensation payments;
• contingencies and claims.
ANNEX H  ECONOMIC EVALUATION OF THE REMOVAL OF PSRs

H.1  Introduction

As part of the Market-Driven options to reduce journey times, consideration has been given to removing PSRs from sections of the line. The approach used to select PSRs for removal is outlined in this annex.

H.2  Time Savings

Technical assessments were made of the effect of each PSR on journey times at different linespeeds, using the BR Train Performance model. The results of these model runs showed the extent of time savings which could be achieved through the removal or easing of individual PSRs.

H.3  Assessment of Costs

In most cases, the main cost of removing or easing each PSR was investment in additional air shafts in tunnels which would permit higher-speed operations without an unacceptable deterioration in passenger comfort levels. Costs were combined with the results of the train performance model to produce 'costs per minute saved' for each PSR.

H.4  Revenue Benefits

In order to evaluate the effectiveness of PSR removal, and to prioritise options, costs needed to be set against a measure of benefit. For the analysis to be commercially robust, for both Railtrack and the TOUs, the benefit measure selected was the additional revenue earned by TOUs from the reductions in journey times attributable to the removal of the PSR. This approach therefore specifically excluded non-financial benefits, such as benefits to existing passengers and to non-users.

Revenue benefits were derived from the passenger demand model. The differences between 'Bedrock' and high speed option timetables were reduced to a 'revenue per minute saved' statistic for 59 sub-sections of line. Revenue per minute saved' is strongly correlated with the volume of traffic being carried over any sub-section. Therefore, those sub-sections on Section 1 between London and Rugby were found to have the highest value, as the following table shows.
<table>
<thead>
<tr>
<th>Section No.</th>
<th>Line Section Description</th>
<th>Present Value of Revenue per Minute saved on Average over the Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>London-Trent Valley Junction</td>
<td>£15.3 million</td>
</tr>
<tr>
<td>2</td>
<td>Trent Valley Junction-Weaver Junction</td>
<td>£7.7 million</td>
</tr>
<tr>
<td>3</td>
<td>Weaver Junction-Gretna junction</td>
<td>£1.6 million</td>
</tr>
<tr>
<td>4</td>
<td>Gretna Junction-Glasgow</td>
<td>£1.0 million</td>
</tr>
<tr>
<td>6</td>
<td>Trent Valley Junction-Stafford via Birmingham</td>
<td>£2.9 million</td>
</tr>
<tr>
<td>7</td>
<td>Crewe-Manchester</td>
<td>£1.0 million</td>
</tr>
<tr>
<td>9</td>
<td>Weaver Junction-Liverpool</td>
<td>£1.3 million</td>
</tr>
<tr>
<td>12</td>
<td>Colwich-Manchester</td>
<td>£2.8 million</td>
</tr>
</tbody>
</table>

The ranking of PSRs in terms of costs per minute showed that, while there were some at low cost and others at very high cost, there were few in the intermediate cost range. The selected PSRs included all the low cost options at the higher line speeds which gave a positive net benefit.
ANNEX I COMMAND AND CONTROL

1.1 Introduction

The existing signalling on the WCML is a mix of technologies, but the basic system is four aspect colour light signalling with track circuit vehicle detection. Every generation of interlocking technology is represented, from mechanical interlocking through free wired and geographical relay systems to solid state interlocking (SSI), although pre 1974 equipment predominates. The area is controlled by a number of signal boxes of different types, from large panel boxes (e.g. Rugby and Preston) to traditional distributed small signal boxes of varying styles.

A world-wide survey of existing and developing systems determined transmission-based train control to be the best in technical and cost terms for the WCML. This is similar to the European Train Control System (ETCS) level 3 standards as currently proposed. It is therefore intended that the signalling system will, where appropriate, comply with ETCS level 3 standards.

The ETCS project is the collective name for a number of sub-projects financed by the EU, under the TEN programme. The aim is to allow motive power from the various national railway systems to operate freely across the European rail network. European railways need interoperability and are providing the staff for the specification work of the project. European industry is developing train-carried equipment (known as EUROCAB) using an open computer architecture; intermittent data transmission devices (EUROBALISE and EUROLOOP) and interfaces for dependable, continuous data links by radio (EURORADIO). Technical principles and feasibility studies have been formulated during a programme in 1990-93 under the EURET programme. Functional and system requirements specifications for ETCS are being developed and are expected to come into force in 1997. This programme will allow equipment development to be completed within the WCML timescale. It is intended that the ETCS equipment will use an 'open' architecture, i.e. any manufacturer will be able to supply equipment that meets a common interchangeable equipment standard.

The timescale for the WCML modernisation is compatible with the aims of the ETCS Project, and it is likely that the WCML project will be one of the first major applications for the equipment. The WCML is therefore set to receive the attention of industry and the EU to ensure its success.
I. 2 WCML Application

Transmission-based train control will be installed over the majority of the WCML Study area. It uses train-based location and inherently provides ATP. Track circuits will be replaced by on-board equipment determining train position from the use of track-mounted position references. All position reporting and vehicle control is transmitted over the radio system. Lineside signals are eliminated except in areas indicated below.

The concept of 'islands' of dual signalling has been developed, so that vehicles which only traverse a small part of the WCML need not be equipped. In these areas, when a cab-equipped vehicle approaches a multi-aspect signal, a new and unique aspect is displayed indicating that cab-signalling is to be observed by the equipped vehicle. Movements of non-equipped vehicles will be controlled using the normal aspect sequence of the signals.

The technology will be applied in the following way.

I. 2.1 Trainborne Equipment and Functionality

The primary information on the driver's display shows the actual speed, the permitted speed, the target speed (the next change in permitted linespeed), the distance to the target and the current movement authority. Secondary information such as train health and timetable data will also be displayed to assist the driver.

The train protection and control equipment is required to calculate vehicle position based on absolute position references derived from transponder information. Coupled with a fine position reference, the current vehicle position will be calculated in a high integrity manner. The equipment will report the vehicle position to the control centre via the radio system and will periodically receive movement authorities and linespeed profile data. The vehicle control equipment will calculate the permitted speed for the current authority and target speeds. The diverse, on-board processor will supervise the driver's adherence to permitted and target speeds and movement authority. If the permitted speed is significantly exceeded by the vehicle, the ATP element of the system will enforce a brake application.

In addition, the passive transponders may also be used to pass 'spot' information to the vehicle such as emergency restrictions or other information that is of a fixed nature. Emergency restrictions or stop instructions, could, for example, be provided by a hand-placed transponder, in a way similar to that in which a detonator is used currently.
A broken rail detection regime will be introduced to ensure that the probability of detecting a broken rail is no worse than that achieved currently including the contribution from track circuits.

I. 2.2 Trackside Equipment and Functionality

Outside the dual and lineside signalling areas there will be minimal train control infrastructure; only radio base stations and points will be dead locked using axle counters. The point machines and the axle counters will be connected with the interlocking via a trackside interface and the fibre optic network. The only other equipment will be passive, cableless transponders fixed to the top of the sleepers. Their numbers and placing will ensure through redundancy and diversity that a high-integrity, failure proof system results.

Placement of radio equipment will be the responsibility of the successful tenderer following a radio survey. It is expected that appropriate infill techniques, such as leaky feeder communication, will be used in radio ‘dead’ spots, such as some cuttings and tunnels. Lineside communications will be stipulated to be of very high availability, but not of high-integrity, as the integrity is specified to be contained within the protocol. The radio base stations will be linked to the control centre using dual, counter rotating fibre optic cables.

Anomalous propagation, leading to situations as currently occur with BR Cab Secure Radio, where messages are received by a control centre other than that intended, will be defended against by both protocol and by frequency choice.

In the dual signalling islands, conventional multi-aspect signals will be controlled in a similar manner to current SSI technology i.e. through a trackside functional module and fibre optic connection to the interlocking core and the control centre.

I.2.3 Interlocking Functionality

The interlocking function for the system will be a derivative of moving block signalling developed for heavy metro systems. Unlike moving block signalling, which relies on a certain type of rolling stock and a known performance characteristic for the stock, this interlocking will be designed to handle mixed stock types with differing performance characteristics.

From the details of the trains in the control area and their performance characteristics, the interlocking allocates an appropriate movement authority. In addition, the interlocking is required to perform Boolean operations, in order to control point machine operation and conventional multi-aspect signals where required. The interlocking
has a fibre optic interface to lineside radio communication sites. The interlocking may be distributed or centralised as driven by relative economics, availability and maintainability.

1.2.4 **Control Centre Functionality**

The control centre functionality is not specified by ETCS, and so the WCML project has complete flexibility to meet Railtrack's requirements. The control centre is expected to be a specific development for the WCML suitable for wider application. Prospective tenderers may reuse and develop existing control centre technology.

As well as being the control centre for real time control of trains, the change of business emphasis for Railtrack means that the control centre will require additional functions. It must be an asset management centre and it must provide regulatory control for the TOUs which run trains on the WCML. The control centre therefore not only presents the user with the information to be able to run trains within the WCML corridor, but also provides the necessary facilities to manage the business.

Railtrack has a requirement to manage possessions and isolations as efficiently as possible. Present procedures are time consuming and procedurally intensive. Each controller will be responsible for route setting, possession management and electrical isolation in his area. The workstations will therefore have traditional IECC style facilities for both manual and automatic route setting as well as high-integrity possession management and traction isolation facilities.

Although the application of train-borne detection of hot axle boxes is likely to increase, there will be a continuing need for the current network of trackside hot axle box detectors for many years. The network will need to be developed in line with current requirements. The detectors will be connected to the control centre through the new communication network. A fully traceable procedure for handling alarms will be developed reflecting present requirements.

1.2.5 **Staff Protection**

The resignalled railway will be fully bi-directional giving much greater flexibility during possessions or emergency working. There is already considerable focus on improved safety procedures for on-track staff, and bi-directional working adds considerably to their problems.

Staff requiring access to the tracks will log-on with the control centre whether they intend to work or not. This will give them access to a staff warning system similar in concept to the existing train operated warning system. They will then require an electronic 'permit to work'
if physical work is intended. If a blockage is needed, it will also be given electronically over the radio system. Staff will be protected when accessing vulnerable sites by providing similar facilities to the existing patrolman’s and staff lockout devices.

The system will offer further enhancements to safety because it will be possible to enforce speed restrictions past work sites where clearances are restricted or a temporary speed restriction is necessitated by the nature of the work. All these transactions will be via portable electronic terminals. They will require the cooperation of both parties and each transaction will be logged and auditable.

1.2.6 Local Control Functions

Control will be possible from remote sites. Portable control centres will allow direct local control in a given area, for use in emergency or following incidents. Any controls assumed by the local operator will remain monitored by the main control centre, but central control will be disabled.

1.2.7 Back-up Facilities

A back-up control centre will be provided near the main control centre but sufficiently distant from it to eliminate common-mode failures and threats. The back-up may have reduced functionality compared with the main control centre, but will be capable of moving trains safely and allowing restoration of 50% of the service within two hours. It will also be a training facility for normal operational scenarios and for incident management. There will also be a separate facility for software development and maintenance over the lifetime of the main centre.

1.3 Conclusion

The following is envisaged for the WCML:

- implementation of a transmission-based train control system compatible with ETCS level 3, for the majority of the line and fitting cab-signalling equipment to all trains which require access;
implementation of 'islands' of dual signalling having both transmission-based train control and conventional lineside signalling to allow flows of non cab-equipped trains to cross the WCML;

- implementation of conventional lineside signalling in areas which would otherwise require large numbers of additional trains to be fitted with cab equipment;

- implementation of a single control centre having enhanced control facilities for train operation, possession management and traction isolation.
ANNEX J TRACK

J.1 Data Sources

The study collected data on capital and maintenance budgets, programmes and track conditions for all 15 sections of route; these naturally vary widely over such an extensive study area and route mileage. General trends were identified from track quality measurements, Geographical Information System (GEOGIS) age-of-track data and in liaison with Railtrack zonal engineers. Several features are worthy of note.

J.2 Existing Conditions

Track performance and reliability vary considerably; some lines consistently achieve better than target figures, while others fall consistently below desirable standards. Most importantly, it is at the vital southern end of the route where ride quality is poorest; particular problems occur with formation and ballast conditions, and there has been extensive deferral of junction and crossover renewal.

Track condition is not entirely age-related, but data have been analysed to show widespread and very significant levels of track renewal backlog on all routes. Renewals have been carried out at a lower-than-desirable annual rate and maintenance costs tend to be high, reflecting the patch and mend approach of many years. Even where ride quality is at present acceptable, major renewal programmes will be required to address specific component deterioration. The peak nature of resleepering on routes extensively relaid in the 1960s is one such example.

J.3 Modernisation Programme

Extensive study work has been undertaken to assess the optimum modernisation strategy. This included consideration of approaches to capital investment in track renewals based both on current budgets and on a significant acceleration of current rates of spending on track relaying.

Current budgets are such that, if these were continued unchanged, the average age of track components would rise gradually but inexorably, leading to loss of condition and the need, increasingly, for TSRs. This would be commercially unacceptable. It was thus concluded that Bedrock should be based on a level of spending on track renewals determined by the average age of track components being held at the current level. The actual allocation of funds to particular sections of track at any one time would be based on track condition, allowing
specific problem areas to be given priority and a satisfactory overall ride quality to be sustained.

Significant acceleration of the rate of spending would provide some benefits in the longer term (with maintenance costs eventually reducing and ride quality and reliability improving), but would leave a major deficit in NPV when discounted over the 30-year evaluation period. This would not be viable as an investment. Hence Recovery has been based on a more modest acceleration in renewals spending. This will be targeted specifically on improving reliability.

The Core Investment Programme makes the same assumptions as Recovery.

To obtain the best possible value from capital renewals, and deliver the best quality and reliability to the train operators, a sophisticated asset management system, based on a detailed database including condition survey and deterioration information, will be required.

J.4 Upgrade Options

While significant acceleration of track relaying is not a viable modernisation option, it would give market benefits. These relate to ride quality improvements and higher linespeeds, for which track condition has to be at a higher level. Option A in the Market-Driven investment options thus provides for this acceleration of work. The option may therefore be the subject of negotiations with TOUs and OPRAF, either as a stand-alone option to provide better ride quality, or combined with higher linespeed Options C, D or E, for each of which it is a prerequisite.

J.5 Possession Requirements And Working Methods

Engineering access to the railway is governed by a complex set of Rules of the Route which specify times and locations at which tracks can be blocked by engineering works. Although some longer track possessions are currently available, much work is undertaken in relatively inefficient short periods at weekends.

The scale of the workload would require some extension of these rules in order to achieve recovery largely within a reasonable period. Longer weekend possessions would considerably improve productivity, yielding significant reductions in unit rates.
It is also anticipated that the workload would give added impetus to improvements in working methods and the introduction of new types of plant. Several such opportunities were examined and the consequential benefits were evaluated.
ANNEX K  STRUCTURES

K.1  Existing Conditions

There is a general perception that the structures on the WCML are in a poor condition and that the current level of maintenance corresponds to 'firefighting'. The key characteristic of structures is that the normal running costs are relatively low but the costs of major repairs are very high. It is therefore essential that tactical repairs are undertaken quickly and effectively to avoid severe deterioration to the point where renewal/reconstruction is necessary. In recent years this has not happened as large volumes of work have been deferred year on year. The situation is generally redeemable by an increased level of spending over the next five to six years. However, the condition of the structural assets is finely balanced at the moment with the potential for rapid deterioration if the matter is not addressed in a timely fashion.

K.2  Maintenance Backlog

Several disturbing trends are emerging whereby some masonry structures are exhibiting serious distress due to lack of waterproofing and tactical stitching repairs in the past. Similarly, very little painting or protective repairs have been undertaken on metallic bridges. This has resulted in heavy corrosion on many steel bridges, with trough deck structures being particularly susceptible.

K.3  Modernisation Programme

Wherever possible bridges should be maintained rather than renewed. This is the business rationale that has been applied in recent years and is the right economic decision, providing that sufficient funds are made available to maintain the bridge stock in a condition which minimises structural deterioration, i.e. steel bridges are regularly painted to maintain a protective coating, brickwork and concrete repairs are carried out expeditiously, and priority is given to bridge waterproofing.

The investment programme will therefore be the same for Bedrock, Recovery and the Core Investment Programme, and is based around an initial increase in maintenance expenditure to overcome the maintenance backlog identified above. Spending in the early years will include two specific projects:

- the structural work required for the route clearance of the EPS Class 373 rolling stock;
work necessary to clear bridges over the railway for 40-tonne lorries (DoT Standard BD 21/93) by 1999 at DoT expense. Should a bridge fail its BD 21/93 assessment, it is re-assessed to establish if it satisfies Railtrack’s liability. If it fails this assessment as well, Railtrack has a statutory responsibility for enhancing the assessed strength to the level of its liability (but not to 40 tonnes), unless a weight restriction can be agreed with the local authority.

There is a substantial backlog of bridge assessment works which will be addressed to ensure that the load-carrying capacity of underbridges is ascertained. This may in itself generate additional bridge strengthening or reconstruction work.

The effects of alkali silicate reaction (ASR) and the deterioration in the older iron bridges will be allowed for as follows:

- ASR is just starting to be assessed and will probably not become a significant problem for 10-15 years. However, there will be an increasing workload in repairing and waterproofing affected structures and a likelihood that some will need to be reconstructed.

- There are difficulties in determining the material properties of the older irons and steels used in bridge construction and this, coupled with the structures’ past loading history being largely unknown, has resulted in difficulties in assessing the fatigue life of older metallic bridges. Wherever possible, bridges will be strengthened but where this proves uneconomical or impracticable reconstruction will take place.

Finally, there are a number of redundant structures on the route which will be removed, provided a net cost saving can be shown or they are structurally unsafe.

K.4 Upgrade Options

Higher linespeeds have three distinct impacts on the structural assets:

- The faster linespeeds necessitate re-assessment of the level crossing facilities provided on the route with consequent upgrades or closures resulting.

- Faster trains have aerodynamic impacts especially through tunnels, where additional pressure relief shafts may be required, and past platforms, where for speeds in excess of 200 km/h passengers must be excluded from platforms as trains pass.
Re-alignments to ease tight curvature involve major remodelling or reconstruction of bridges.

Gauge upgrades are covered in Annex O.
ANNEX L  TRACTION POWER

L.1  Modernisation Works

Examination of the age, condition and performance limitations of the existing electrification system and equipment has revealed a significant amount of capital works which will be required to maintain the 1994 timetable with present reliability levels to 2025, particularly on the Euston-Birmingham-Manchester-Liverpool sections.

Works required to commence immediately are:

- supply point renewal and refurbishment to address equipment overloading, condition and poor system performance under supply and track outage conditions;
- replacement of supervisory remote control system to address deteriorating reliability and equipment obsolescence;
- provision of interference suppression in localised areas where repeated complaints have been received;
- replacement of distance protection relays where operation constrained and minor works to ensure maintained reliability of bulk oil switch gear.

Works able to be phased over the period to 2025 are:-

- renewal of overhead line contact wire due to wear including removal of auxiliary catenary wire and any necessary replacement of associated components;
- replacement of bulk oil switch gear and associated distribution equipment to address age and forecast deterioration in reliability of equipment.

These works, together with some overhead line works and sectioning for specific crossovers, will also enable extended weekend possessions to be adopted.

L.2  Upgrade Works

Increases in maximum linespeed will result in an increased power demand and affect the dynamic performance of the overhead contact wire-traction pantograph interface. The effect of an increase in maximum linespeed for current levels of InterCity 175 km/h services to 200, 225 and 250 km/h, and the effect of tilting or conventional
traction, have been evaluated for both the power supply system (by simulation, referred to below) and the overhead line system.

At linespeeds up to and including 225 km/h, incremental reinforcement of the existing conventional 25kV power supply system, by the addition of a combination of new supply points, balancers, distribution equipment and interference suppression equipment, is sufficient to cater for the increase in power demands. Significant overhead line works are required to meet the dynamic performance requirements of the contact wire-traction pantograph interface and ensure good current collection performance. For 200 km/h, new MkIIIB type wiring is required retaining as many of the existing structures as possible; at 225 km/h a new overhead line system with all new structures is required.

To achieve linespeeds of 250 km/h between Euston and Crewe reinforcement of the existing conventional 25kV power supply system to meet the significantly increased power demands is not cost-effective. This is because of insufficiently frequent power supplies. A 25-0-25kV auto-transformer system will be necessary. This achieves 50kV distribution while providing 25kV traction by employing an additional 25kV feeder forming part of the overhead line system together with auto-transformers. This requires a completely new overhead line system, new supergrid-derived supplies, auto-transformers and distribution equipment. It is therefore a major investment.

L.3 New Electrification Works

Route sections 13 and 14, from Manchester to Euxton Junction and Liverpool to Wigan, respectively, are not currently electrified. Although not included in the works of either the Core Investment Programme or the Market-Driven investment options listed in this report, consideration has been given to the costs of electrifying these routes. Preliminary estimates suggest the following:

- Section 13 - £15 million
- Section 14 - £10 million

These are capital costs at 1994 prices, including new and upgraded power supply feeder stations, new MkIIIB type OHLE and the necessary civil/structures reconstruction to achieve clearance for the catenary. They exclude the costs of any modifications to trackwork or to the S&T systems.

L.4 Tilting Rolling Stock

The effect on the power supply system of using tilting rolling stock in place of conventional traction at a given linespeed has been assumed to
be marginal. This is because the extra power draw required for additional periods of sustained higher-speed running is offset by the reduced acceleration requirements of tilting trains. The power draw characteristics of any future, possibly more advanced, rolling stock acquired for the WCML would need to be considered in finalising the extent of power supply enhancement which is implemented.

There are no implications for the overhead line system of tilting versus conventional trains as there is no tilting of the traction pantograph.

L.5 Capacity Increases

Additional passenger services operating at maximum linespeeds would require further power supply reinforcement, particularly on the main line between Rugby and Crewe. Relatively minor additional power supply reinforcement is required to provide for the extra capacity.

During long possessions the power draw on operational tracks may exceed the power supply capacity for individual tracks. This is able to be managed by the proposed train control system.

L.6 Traction Power Simulation

L.6.1 Introduction

Dynamic traction power computer simulations were performed to evaluate the suitability of power supply system designs developed by the study for higher linespeed scenarios.

L.6.2 Methodology

The section of the WCML between London and Crewe was selected for simulation as this is the core section of the line and it affects the majority of city-to-city centre journey times. The effect of an increase in maximum linespeed for all present InterCity 175 km/h traction services was evaluated on the basis of the Summer 1994 timetable employing the BR Class 93 traction characteristics and higher linespeed profiles developed by the Study. The peak period between 1600-1900 hours was selected for simulation as this was considered to be the most onerous in terms of power demand for this section of the line.

The effect of additional trains at existing or higher linespeeds was not considered as this was not defined at this point of the Study.

The higher linespeed scenarios and power supply designs simulated were:
London to Nuneaton 200 km/h conventional 25kV system;

- London to Crewe 225 km/h conventional 25kV system;

- London to Crewe 225 km/h 25-0-25kV auto-transformer system.

L.6.3 Modelling

The OSLO traction power simulation package was selected as the most suitable for this application with simulations undertaken by Powertrack Railway Electrification Services assisted by BR Research. This package is readily available, is sufficiently detailed to cater for the complex multi-track WCML infrastructure, has been fully validated against measured data and requires, as a major input, 'VISION' operational data which were able to be prepared by the Study team (see Annex M).

Inputs were provided to the simulation in the form of 'VISION' timetable, linespeed profile and traction and rolling stock data, together with power supply system designs and emergency feeding scenarios.

Outputs from the simulations consisted of supply point maximum one-minute peak and average half-hour demands, nodal and train voltage regulation and individual track feeder currents, under normal and first emergency feeding scenarios.

L.6.4 Conclusions

The results from the simulations demonstrated that the 200 km/h and 225 km/h linespeed scenarios evaluated were able to be supported by a conventional 25kV system without the need to adopt a 25-0-25kV auto-transformer system. The results also confirmed the electrical suitability of, and have enabled the refinement of, the power supply designs developed by the Study team for these and other sections of line and/or linespeed scenarios.
ANNEX M OPERATIONS SIMULATION

M.1. Introduction

Operational simulations were undertaken to test various scenarios relating to increased frequency of trains combined with cab-signalling and some track remodelling proposals. No single simulation model had the capacity to model all key sections of the WCML in the time available for the Study, despite some having modelled parts of the WCML in the past. Three key parts of WCML were therefore simulated by three different teams developing complementary models and making maximum use of previous work.

M.2 Euston-Wembley

ComrecoRail's RAILPLAN was employed to model from Euston to Wembley. It demonstrated that roughly twice the number of fast passenger train services could be run into and out of Euston Station given the recommended train control system and the remodelling of the approaches.

M.3 Wembley-Crewe

BR Research's VISION model was selected for Wembley to Crewe. This encompasses the most heavily trafficked sections of the WCML. VISION demonstrated that if roughly twice the number of fast passenger services were to run, delays which would occur using the present signalling in the Watford, Milton Keynes and Rugby areas would be avoided with the recommended train control system.

M.4 Rugby-Birmingham-Stafford

Booz-Allen & Hamilton's VISTA model was used to study the line from Trent Valley Junction at Rugby to Stafford via Birmingham. VISTA examined the robustness of proposed enhanced service patterns. VISTA demonstrated that both the fast and slow passenger services on the Coventry to Wolverhampton line could be increased to four trains per hour given remodelling of Proof House Junction, new train control and timetabling of fast trains to run past slow trains at either Birmingham International or New Street Stations.

M.5 Model Verification

A thorough verification was used to ensure that all three models produced valid results. The first run on each model (the base case) was used for verification. A representation of the present day track and signalling infrastructure then used this to model all passenger and freight trains in the summer 1994 timetable, plus a number of
representative untimetabled trains. The result of each base case was then compared critically with the real life performance of the same section of the WCML.

M.6 Conclusions

The results of the simulations showed that, with the proposed transmission-based train control system, with dynamic blocks, the aspirations of TOUs and the increased market demand resulting from higher-speed trains could be met without the delays which would otherwise occur.
ANNEX N ROLLING STOCK

N.1 Introduction

Railtrack is responsible for the maintenance of the WCML infrastructure and operation of the control and signalling systems on a daily basis, but is not involved in the provision of train services. Passenger services are provided over the WCML by TOUs, which will be franchised in the coming years. The rolling stock they use is currently leased from ROSCOs. FOCs use rolling stock which they own and maintain to provide freight services.

The type of trains used in the future will have financial implications for Railtrack in terms of infrastructure maintenance. For this reason the Study team has undertaken an investigation into possible rolling stock developments.

N.2 Implementation of Cab-Signalling

The introduction of transmission-based train control requires the installation of cab equipment to all vehicles that run on the WCML where lineside signals will be removed (see Annex I.2). Once changeover to the new train control system is complete, vehicles without cab equipment will not be able to run on sections of the WCML that have been re-signalled solely with transmission-based equipment. It is estimated that some 974 vehicles will need modifying, representing almost 1,780 cabs.

The fitting of cab-signalling equipment to vehicles will not be straightforward. Every vehicle type has a different cab layout and the wiring of two vehicles of the same type may differ. Many types of vehicle operate on the WCML and much design work will need to be done in close cooperation with the vehicle owners. It is estimated, on the basis of the time taken to fit ATP equipment, that vehicles may be out of service for up to two weeks during the modification works. These works could conceivably be conducted during scheduled maintenance examinations, e.g. E exams. The concession company will have to ensure that before sections of the system are commissioned, all relevant vehicles are equipped, while at the same time ensuring that sufficient vehicles are available to TOUs and FOCs to maintain service levels.

It is envisaged that cab-signalling equipment will have the minimum possible number of interfaces to the existing train wiring in order to make fitting as simple as possible. The use of independent inertial platforms or Doppler sensors to provide speed inputs (rather than a tachometer) is an example. As the development programme is anticipated to take between three and four years, there will be ample
time to conduct detailed surveys of each cab and design the equipment accordingly. This equipment will conceivably fit into a 48 cm (19") rack of 30 printed circuit boards with the driver's display unit some 15 cm x 23 cm (6" x 9"). Radio equipment must also be fitted. It should be possible to fit mounting bracketry over the three year period, ready to accept cab equipment once its development is complete.

Fitting cab equipment to enable transmission-based train control brings with it other benefits. ATP is inherent and the transmission capability can be used to effect remote diagnostics of vehicle systems. The system can be used to deliver improved customer information systems and more efficient vehicle maintenance.

N.3 Improved Train Acceleration and Braking

Given the speed profile of the WCML, reductions in the journey time to a specific destination can be achieved by the use of 'state-of-the art' rolling stock. Modern micro-processor controlled traction systems provide fine control of tractive effort such that the wheel-rail adhesion is used to the full, realising the maximum possible acceleration. A potential benefit to Railtrack of vehicles which accelerate and decelerate more rapidly is that signalled track sections will be cleared more quickly releasing extra headway which could result in extra train paths. Although adoption of these improvements is not in Railtrack's control, these benefits can be expected to be obtained from the natural replacement of rolling stock, as micro-processor traction control currently represents the least-cost system. Motoring and braking characteristics are fundamental to the design of lineside signalling systems, so the implications of improved train performance were taken into account in the signalling, operations and journey time assessments undertaken by the Study.

N.4 Tilting Trains

The operation of passenger trains on the WCML at speeds above 200 km/h not only necessitates modifications to the power supply but also substantial work to the track. Replacement of sleepers, ballast and rail, along with realignment and recanting, is needed and this is expensive. Curves need to be redesigned such that passengers in trains travelling at high speed do not experience uncomfortable levels of lateral acceleration. The use of trains that tilt when travelling round curves reduces the amount of civil engineering work that needs to be done to allow higher-speed operation. Actively tilting trains are operating successfully in Germany, Italy and Sweden at speeds up to 180 km/h. Recent test runs in the USA suggest that a tilting train could run at 250 km/h on infrastructure designed for the operation of conventional trains at 225 km/h.
Two manufacturers, Fiat and ABB, have produced trains with active tilting mechanisms. ABB has indicated that the tilting mechanism only accounts for 5-6% of the capital cost of a trainset. An assessment of the financial implications for the West Coast TOU and the ROSCO indicates that the extra capital cost of replacing the Intercity fleet with tilting trainsets is some £36 million in net present cost terms. Provision of a 200 km/h service with tilting trains is estimated to be £28 million cheaper than using conventional MkIII coaches and locomotives, because of reduced maintenance and power costs. These figures are based on manufacturers' estimates of capital and operating costs (which may be suspect) and makes no assumption about a reduction in fleet numbers which may result from operation at higher speeds.

N.5 Double-Deck Passenger Trains

It was believed that an increase in loading gauge to allow the operation of piggyback freight vehicles could also permit the operation of double-deck trains between London and Northampton. Enquiries with manufacturers indicated that an increase of 170 mm over the envisaged piggyback gauge would be needed to give a 2 m headroom on both decks.
ANNEX O  PIGGYBACK

O.1  The Concept

Piggyback operation allows the carriage of a lorry trailer on an adapted rail wagon without the additional dead weight of the lorry cab. Special trailers, at slightly increased cost over standard ones, and container-type lifting facilities at termini, are required.

The Piggyback Consortium, a pressure group, published a report in April 1994 which recommended the adoption of an initial preferred route to a number of locations, such as Birmingham, Manchester, Scotland and a selection of ports.

O.2  Benefits and Disbenefits

The main advantage to Railtrack of upgrading of the WCML for piggyback gauge would be the capture of long-distance freight traffic, particularly from mainland Europe via the Channel Tunnel.

Piggyback would extend the choice of transport modes for exporters and importers and encourage the transfer of more freight from road onto rail, which would give environmental and social benefits.

Disbenefits would be the special 'spine' wagons required on the railway, and the modest additional costs that would have to be incurred by the haulage contractor to modify trailers for a modern type of suspension system and lifting eyes for piggyback operation. However this investment by the haulier is considerably less than that required for swap body.

Implementation of piggyback has synergy with the introduction of double-deck trains for passenger use.

O.3  Loading Gauges

BR upgraded a number of main freight routes between the Channel Tunnel and key freight termini to a new larger gauge. However, this new gauge, the SB1, is smaller than piggyback and European gauges.

The Study team has taken the concept promoted by the Piggyback Consortium and considered upgrading a number of sections of the WCML to the larger piggyback gauge. The work has been carried out in conjunction with a concurrent validation exercise run by Railtrack's Major Projects Division, to confirm infrastructure costs quoted in the Piggyback Consortium's report.
Prerequisites

A link between the WCML and the Channel Tunnel would need to be in place, or increased to piggyback gauge, as the long distances of European hauls are needed for the concept to be really attractive. There are two links that have currently been proposed: the existing swap body route via Redhill put forward by the Piggyback Consortium, and the proposed CTRL, connecting via an improved North London Line.

The Freight Market

The international market for unitised traffic through the Channel Tunnel is expected to be buoyant, particularly if new modes such as piggyback are made available. The WCML could gain a portion of this market, linking as it does a substantial number of the UK's trading centres which are well served with existing or proposed railfreight terminals.

The Opportunity on the WCML

Justification of the costs of undertaking clearance works for piggyback gauge is for the Piggyback Consortium and, ultimately, potential operators to make. The consortium has put forward a least-cost route network which avoids large parts of the WCML, including a key section just north of London where it proposes a lengthy loop to the west of the main line rejoining at Bletchley.

The Study has examined the possibility of using a more direct route on the WCML itself to avoid this loop. A scenario was chosen for testing including clearance works on a section of the WCML from the junction with the North London Line, via the junction with the West London Line to the proposed freight terminal at Daventry. If that part of the WCML can be cleared for piggyback, it is more likely that the clearance of other parts of the network further to the north become viable.

Modifying the Infrastructure

The DoT standard structure gauge is encouraged for new works and this allows the passage of piggyback freight. Most existing bridges do not meet the standard.

The existing BR loading gauge would need to be raised by 140 mm to accommodate the piggyback gauge. This would require the reconstruction of some road overbridges, footbridges, tunnels, platform canopies and lineside equipment. The cost of the works between Camden Junction and Daventry would be reduced if modifications to the mainline have been carried out for high-speed passenger rolling stock. As part of the alleviation of PSRs proposed for this, Linslade...
Tunnel could be opened out for 250 km/h operation provided the investment can be shared with piggyback gauge clearance works.
ANNEXE P SAFETY

P.1 Objectives

The safety objectives specified in the Railway Group Safety Plan 1994-95, as related to risk of fatality to passengers, and trackside workforce, are:

- Individual frequent passenger risk (500 single journeys) 1 in 100,000 average
- Individual trackside workforce risk (Railtrack staff and contractors) 1 in 5000 average

P.2 Benefits of the Core Investment Programme

The benefits obtained from the Core Investment Programme, and in particular the introduction of transmission-based train control and a single combined operations control room, provide reasonable assurance that on the WCML the risk of:

- Passenger fatalities resulting from collisions will be substantially reduced, by the inherent ATP.
- Fatalities and major accidents to personnel working trackside will be reduced because the new train control:
  - can be installed and maintained mostly from positions of safety;
  - will, together with the integrated control centre provide enhanced control of possessions, power isolations and emergency situations;
  - can supervise train speed past trackside staff.
- Vandalism of signalling equipment will be reduced because there is minimal equipment located on/alongside the track, and the remaining equipment can be located inside secure compounds.

These safety benefits will provide a measurable improvement of the safety of the WCML, will at least meet the minimum Railtrack safety objectives set out above, and provide a sound basis for improving safety on the railway network-wide.

P.3 Cost/Benefit Estimate

While no detailed analysis of safety cost/benefit was considered feasible, a preliminary estimate has been made based on data contained
within an ATP booklet issued at the July 1994 conference 'Value for Money in Transport Safety Measures'.

It is suggested in the booklet, that the installation of ATP network-wide would prevent 52 equivalent fatalities over a 20-year period allowing 10 years building up and 10 years of steady state operation. This equates to 3.5 equivalent fatalities per year of steady state operation. The cost of damage and disruption avoided was suggested to be approximately £66 million. The WCML accounts for roughly 15% of the total network passenger-km and, over a 30-year period, approximately 13 equivalent fatalities could be prevented. Using the accepted figure for a passenger fatality of £2 million provides a 'willingness to pay' benefit of £26 million (£7.4 million NPV). Similarly, the damage and disruption avoided equates to £16 million (£4.6 million NPV).

Considering that the installation and operating costs of ATP are accounted for elsewhere in the Study costings, this total of £12 million NPV can be considered as net benefit.

P.4 Risks

With regard to other risks to the public at large, the proposed works will not significantly improve the situation.

The introduction of new technology requires the careful consideration of the hazards that it introduces. Their eventual elimination/mitigation is an essential feature of the design process. Critical hazards have been identified during the Study, and sufficient examination by the Study team has been carried out to confirm that all are capable of elimination/mitigation to an acceptable level. These critical hazards have been compiled into a Safety Hazard Register.

P.5 Approvals and Implications

The Railway Inspectorate has been kept fully informed of Study progress. It has indicated that it has no objections in principle to the proposed scope of works.

Recent safety legislation, combined with Railtrack mandatory requirements, presents a formidable challenge to both Railtrack and the chosen concession company throughout the project execution. It is essential, therefore, that a clear understanding of the responsibilities, workscopes and methods to be employed by Railtrack and the chosen contractor regarding safety related activities is established. An outline safety strategy has been prepared for this purpose.