Please Note

Important Disclaimer

This Report is for the sole benefit and use of IPART and was conducted by Booz & Company (Aust) Pty Ltd for the purpose of conducting an independent estimation of efficient costs for RailCorp’s coal network in the Hunter Valley.

In preparing this Report, we have relied on the accuracy and completeness of the information provided to us by IPART and from publicly available sources, and we have not independently verified the accuracy or completeness of that information.
Table of Contents

Executive Summary ........................................................................................................... i

1. Introduction .................................................................................................................. 1
   1.1. Background and Objectives .................................................................................. 1
   1.2. Terms of Reference and Approach ...................................................................... 1
   1.3. Data Sources .......................................................................................................... 2
   1.4. Structure of the Report ......................................................................................... 3

2. Analytical Framework ................................................................................................... 4
   2.1. Introduction ........................................................................................................... 4
   2.2. Rail Network .......................................................................................................... 5
       2.2.1. Route Overview ............................................................................................ 5
       2.2.2. Configuration and Condition ....................................................................... 5
       2.2.3. Usage and Task .......................................................................................... 6
   2.3. Requirement under the Undertaking ................................................................. 6
   2.4. Maintenance Cost Framework ............................................................................ 7
   2.5. Benchmarking Framework .................................................................................... 8
       2.5.1. Economic Regulation Authority (ERA) - WestNet .................................... 9
       2.5.2. Queensland Competition Authority (QCA) – QR Network ..................... 10
       2.5.3. Essential Services Commission (ESC) - Victorian Regional Railway .... 12
       2.5.4. Australian Competition and Consumer Commission (ACCC) - Australian Rail Track Corporation ................................................................. 13
   2.6. Modelling Assumptions and Data Inputs ............................................................ 14

3. Total Efficient Maintenance Costs ............................................................................... 16
   3.1. Introduction ........................................................................................................... 16
   3.2. Overview ............................................................................................................... 16
   3.3. Model Variables and Considerations .................................................................... 17
       3.3.1. Track Configuration ...................................................................................... 17
       3.3.2. Network Control System ............................................................................ 18
       3.3.3. Benchmark Data .......................................................................................... 19
       3.3.4. Secondary Variables and Considerations .................................................... 21
   3.4. Test Permutations ................................................................................................. 22
   3.5. Total Efficient Maintenance Cost Estimation ................................................. 23
       3.5.1. Single Track Configuration .......................................................................... 23
       3.5.2. Double Track Configuration ....................................................................... 24
3.5.3. Regulatory Asset Base Track Configuration ........................................... 24

4. Conclusions ................................................................................................. 26
   4.1. Summary of Benchmarked Costs ............................................................ 26
   4.2. Comparison with RailCorp Cost Estimation and Recent Work ................. 27
   4.3. Impact of Standalone Costs .................................................................. 28

5. Bibliography ................................................................................................. 30

List of Figures

Figure 1-1 - Project Approach ........................................................................ 2
Figure 2-1 - Map of RailCorp’s Network .......................................................... 4
Figure 2-2 - Track Schematic for Newcastle to Newstan .................................. 5
Figure 3-1 - Model Overview .......................................................................... 16
Figure 3-2 - Cost Model Development ............................................................... 17
Figure 4-1 - Total Efficient Maintenance Costs ($FY 2011) ............................. 26

List of Tables

Table 1 - Comparison of RailCorp, Sapere and Booz & Company Results ....... ii
Table 2-1 - Summary of WestNet Network Maintenance Costs ..................... 10
Table 2-2 - Summary of QR Network Maintenance Costs ............................. 11
Table 2-3 - Proportion of Maintenance Activity ............................................... 12
Table 2-4 - Summary of Victorian Regional Network Maintenance Costs ....... 13
Table 2-5 - Summary of ARTC Network Maintenance Costs ........................ 14
Table 3-1 - Track Configuration and Length ................................................. 18
Table 3-2 - Summary of Benchmarks used for Analysis ................................. 20
Table 3-3 - Test Permutations ......................................................................... 22
Table 3-4 - Single Track Total Efficient Maintenance Cost ............................. 23
Table 3-5 - Double Track Total Efficient Maintenance Cost ........................... 24
Table 3-6 - RAB Track Total Efficient Maintenance Cost .............................. 25
Table 4-1 - RailCorp Maintenance Rate Comparison ...................................... 27
Table 4-2 - Comparison of RailCorp, Sapere and Booz & Company Results .... 28
Executive Summary

Introduction

The Rail Corporation of New South Wales (hereafter “RailCorp”) owns and operates five sectors of the rail track from Newstan Junction to Woodville Junction on the New South Wales Central Coast (hereafter “RailCorp network”). These sectors are used by both passenger services and freight services carrying coal and are governed by the New South Wales Access Undertaking (hereafter “the Undertaking”). The NSW Independent Pricing and Regulatory Tribunal (hereafter “IPART”) is responsible for ensuring that RailCorp and other track owners comply with the pricing principles in the Undertaking, specifically that the revenue charged from an access seeker does not exceed the maximum allowable revenue, taken as the full economic cost of owning and operating a standalone network i.e., the minimum infrastructure required to meet the needs of the freight users.

IPART has engaged Booz & Company, in association with GHD, to provide an independent review of the efficient cost estimates for track maintenance and network control for the five sectors of track between Newstan Junction and Woodville Junction owned and operated by RailCorp. Engineering advice and support for this report was provided by GHD. The main purpose of the report is to inform IPART's final decision on the approval of RailCorp’s compliance with the Undertaking, in particular, the operation of the ceiling test. An initial analysis of costs was undertaken by Sapere Research Group in 2011.

The report is a desktop analysis of RailCorp’s standalone efficient maintenance costs based on existing asset configuration and asset condition. In estimating efficient costs for RailCorp’s network the report relied on engineering judgement and benchmarking data from comparable rail systems within Australia. In comparing benchmark data, configuration of rail infrastructure together with the current system usage and operational characteristics was an important consideration. Factors including traffic task, sleeper types, turnout frequency and the presence of bridges and culverts can have an impact on maintenance costs.

Conclusions

RailCorp has provided IPART with the actual costs incurred for track maintenance for the financial year 2004/2005, as well as modelled costs for the financial year 2006/2007.

Table 1 provides a comparison of RailCorp’s actual costs with cost estimates from Sapere analysis and Booz & Company analysis.
Table 1 - Comparison of RailCorp, Sapere and Booz & Company Results

<table>
<thead>
<tr>
<th>Cost</th>
<th>Cost Estimates by RailCorp</th>
<th>Sapere Research Group (Double Track)</th>
<th>Booz &amp; Company (Double RAB track with CTC System)</th>
<th>Booz &amp; Company (Double RAB track with Efficient System)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>$8,675,281</td>
<td>$6,859,088</td>
<td>$2,023,228</td>
<td>$776,000</td>
</tr>
<tr>
<td>Network Control</td>
<td>$1,397,500</td>
<td>$1,482,608</td>
<td>$129,466</td>
<td>$42,000</td>
</tr>
<tr>
<td>Total</td>
<td>$10,072,781</td>
<td>$8,341,696</td>
<td>$2,152,694</td>
<td>$818,000</td>
</tr>
</tbody>
</table>

Sources: RailCorp, Sapere Research Group, Booz & Company

It is evident from the table that RailCorp’s costs are significantly higher than Booz & Company’s efficient cost estimates. However, it is important to note that these estimates are based on a top-down desktop analysis and are only indicative industry figures. There are also differences between Booz & Company’s costing approach in comparison to that taken by the Sapere Research Group.

Due to the lack of data and the nature of a small ‘coal only’ operation, Booz & Company adopted loaded and empty track parameters as opposed to the fixed and variable costs approach used by Sapere, as well as using different benchmark values. Sapere estimated $30,000 per km for fixed track maintenance and $3.52 per ‘000 GTK for variable track maintenance, in comparison to the Booz & Company estimates of $24,000 per km for loaded track maintenance and $9,000 per km for empty track maintenance.

Sapere estimated network control at $4.60 per train km, whilst we assumed the value of $0.55 per train km. The benchmarked costs assumed that the relevant railway can leverage economies of scale from being integrated with a more significant network. It is generally argued that a standalone operator could outsource the relevant functions and the outsourced service provider could then aggregate across networks to deliver the benchmark cost (to the multiple network owners). This may be reasonable in direct cost areas such as major periodic maintenance (albeit some premium may be incurred), but is probably unreasonable in respect of joint or common costs such as network control. As a result, the network control cost estimate of $42,000 per annum is not reasonable given the length of the track. Instead, a ‘bottom up’ approach assuming a Train Order system would result in a total labour cost of $117,600 per annum which would be a more reasonable estimate. It takes into account labour costs for train control, train planning and supervision functions. Since trains may be able to be planned and controlled remotely, it can be concluded that an efficient competitive price for train control functions may lie somewhere in between $42,000 and $117,000.

Notwithstanding these differences in approach and assumption, the Booz & Company analysis confirms Sapere’s conclusion that RailCorp’s total maintenance costs are higher than industry best estimates.
1. Introduction

1.1. Background and Objectives

The Rail Corporation of NSW (hereafter “RailCorp”) owns and operates five sectors of rail track from Newstan Junction to Woodville Junction on the New South Wales Central Coast (hereafter “the RailCorp network”). These sectors form a part of the Hunter Valley Coal Network (hereafter “HVCN”) and therefore governed by the New South Wales Rail Access Undertaking (hereafter “the Undertaking”). The network is used by both passenger services and freight services carrying coal. The majority of the network is managed by the Australian Rail Track Corporation (hereafter “ARTC”) under a long-term lease from the NSW Government. However, five sectors of track are still owned and managed by RailCorp.

IPART has engaged Booz & Company, in association with GHD, to provide an independent review of the efficient cost estimates for track maintenance and network control over the five sectors of track between Newstan Junction and Woodville Junction owned and operated by RailCorp. Engineering advice and support for this report was provided by GHD. The report is intended to inform IPART’s final decision on the approval of RailCorp’s compliance with the Undertaking, in particular, the operation of the ceiling test.

The report is a desktop analysis based on existing data of asset configuration and asset condition. The report did not involve any site visits and therefore site-specific factors that could influence costs have not been incorporated.

This document constitutes a final draft report on the estimates for efficient cost. It is acknowledged that the desktop review involves subjectivity and engineering judgement. While the estimates are as robust as possible, they are based on limited secondary information and, as such, are subject to error.

1.2. Terms of Reference and Approach

The terms of reference for this project set out the following key tasks:

- Task 1: An initial inception meeting was held with IPART to discuss and confirm the project scope;
- Task 2: Benchmarking study to review track maintenance costs for heavy-haul bulk freight railway infrastructure in Australia;
- Task 3: Estimation of a range of efficient track maintenance costs for the haulage of coal from Newstan Junction to Woodville Junction; and
• Task 4: Estimation of efficient network control costs for a ‘coal-only’ system between Newstan Junction and Woodville Junction.

Accordingly, Figure 1-1 below outlines the approach undertaken for the review.

Figure 1-1 - Project Approach

1. Identify rail network characteristics and configuration
   • Identify railway infrastructure across the network, including track length, curvature and grade, and current signalling system, in order to establish network configuration baseline
   • Confirm constrained and unconstrained factors on the system
   • Develop efficient network control system

2. Identify comparable rail networks to establish benchmark data
   • Conduct desktop benchmarking study of track maintenance costs for heavy-haul bulk freight railway infrastructure in Australia

3. Identify cost drivers and model variables
   • Identify maintenance cost drivers based on benchmarked data
   • Establish model variables based on cost drivers and IPART requirements
   • Outline all model assumptions
   • Develop model framework based on steps 1, 2, and 3

4. Assess effect of variables and benchmarked data on total maintenance cost
   • Estimate a range of likely cost rates that would be applicable across the network
   • Conduct sensitivity analysis of variables and data on the total maintenance cost

5. Estimate efficient total maintenance cost for the rail network
   • Undertake the analysis across the desired track configurations to estimate efficient total maintenance cost for the rail network
   • Estimate efficient network control costs

1.3. Data Sources

Given that the report was a desktop review, data from other jurisdictions and previous studies has been relied upon wherever possible. The following data sources were reviewed:

• Sapere Research Group (2011), A Ceiling Test Protocol for RailCorp – Prepared for IPART;

• Essential Services Commission (prepared by WorleyParsons) (2006), Maintenance Cost Benchmarking for the Victorian Freight Network;

• Queensland Competition Authority (2011), QR Network’s 2011-12 Volume Reset and Annual Variation of Reference Tariffs;

• Economic Regulation Authority (2009), WestNet Rails Floor and Ceiling Costs Review;

• Australian Rail Track Corporation (2009), An Assessment of ARTC Maintenance Costs Relative to Efficient Industry Practice;

• Independent Pricing and Regulation Tribunal (prepared by Booz Allen & Hamilton) (2001), Valuation of Certain Assets of the Rail Access Corporation; and
1.4. Structure of the Report

The remainder of this report is structured as follows:

- Chapter 2 outlines the analytical framework and the approach adopted for the estimation of efficient maintenance costs for the five sectors on the HVCN. This chapter also provides a benchmarking analysis from other comparable jurisdictions within Australia;

- Chapter 3 discusses the methodology, the efficient network control method and estimates a range of efficient maintenance costs across different track configurations for the RailCorp network;

- Chapter 4 presents the conclusions of our analysis;

- Chapter 5 provides the bibliography;

- Appendix A contains a list of key maintenance activities; and

- Appendix B shows the curve and gradient diagrams for the RailCorp network.
2. Analytical Framework

2.1. Introduction

This Chapter outlines the ‘top-down’ analytical framework used to estimate the efficient maintenance cost for the five sectors of RailCorp network, defined with reference to NSW line sections 405, 406, 407, 490 and 497. It also provides a benchmark review of rail systems within Australia that are close comparators to RailCorp’s network.

These sectors comprise a total of 20.816 kilometres as shown in Figure 2-1 below. The Undertaking defines the term ‘sector’ as a continuous length of track with end points, usually delineated by major junctions or traffic origins and includes all rail infrastructure facilities associated with the track on that sector.

Figure 2-1 - Map of RailCorp’s Network

Source: RailCorp’s presentation to IPART, 2011, p. 3

In comparing the benchmarking data, the configuration of the rail infrastructure is an important consideration as different networks tend to have different operational and system characteristics. Various factors can affect track maintenance costs, including sleeper type (concrete, steel or timber), turnout frequency, curvature, grades, tunnels or earth works structures, and under ways (bridges and culverts).

Figure 2-2 illustrates the track configuration, together with the associated structures, controls, and communications infrastructure identified between Newcastle and Newstan. The existing Regulated Asset Base (hereafter “RAB”) is shown in red in Figure 2-2 and consists of approximately 51.56 km of track and a Centralised Traffic Control (hereafter “CTC”) system. The RAB also includes some quadruple track, sidings and storage loops.

2. NSW Rail Access Regime as published in Gazette No. 22, 19 February 1999, p. 929.
2.2. Rail Network

2.2.1. Route Overview

The RailCorp network is typical of the NSW mainline coastal route with sharp curves, a minimum radius to 320m and steep grades to maximum of 1 in 40. These characteristics are likely to translate into higher maintenance costs when compared to other Australian routes with similar tonnages. The curve and gradient diagram for RailCorp’s network is provided in Appendix B.

2.2.2. Configuration and Condition

The RailCorp network was built at the end of 19th Century. It has since been upgraded, although the foundation condition of the cuttings and embankments are likely to be poorly constructed given the earthworks machinery available when initially constructed.

The tracks and control infrastructure are relatively modern. The controls are modern infrastructure based electric controls, and the track has been upgraded to the ‘Heavy Freight Option’ class. This implies the sleepers are long-lasting, with the rail suitable for the axle load of the trains it is carrying and the ballast deep enough to spread the load, at least to maintain reasonable stability. A site inspection of the assets has not been conducted but as the track carries passenger trains travelling at modern speeds, the infrastructure is assumed

---

* Figure 2-2 - Track Schematic for Newcastle to Newstan

to be in good condition. However, like any other railway track built with natural materials, maintenance is required to correct geometric movements, worn rails, displaced sleepers and expended electrical equipment.

The mainline track is composed of concrete sleepers and some of the turnouts have concrete bearers\(^7\). However, the network has timber turnouts as well. The track upgrading has continued over a lengthy period with the most recent major works being in September 2010\(^8\).

The existing controls are the CTC type, where ground based controls are connected to a control centre by telemetry and controlled through a combination of automatic electrical track circuits and train controller instructions.

2.2.3. Usage and Task

According to the project brief, the coal traffic originates from Newstan and Teralba collieries and can travel both north and south of these locations. Most of the coal traffic however travels from Newstan Junction to Woodville Junction in order to be exported through Newcastle Port. The project brief states an annual haulage of 4 million tonnes, which is approximately 7 to 7.5 million gross tonnes when an industry standard gross to net ratio of 1.8 is assumed\(^9\). Freight trains travelling south from Newstan are not within the scope of the review. Trains are loaded in the southbound direction when they are delivering coal to Eraring and Vales Point power station.

The coal train working status sheet indicates that the total travel time from one end of the network to the other is approximately 35 minutes\(^10\). According to the project brief, this review is based on the premise that a maximum of 10 trains operate in each direction per day. On average, there is likely to be 4 to 5 trains travelling per day carrying, on average, 3,000 trailing tonnes or 2,200 net tonnes. Therefore, train paths take on average 3 hours per day in each direction and 12 hours per day at the maximum frequency. This is in contrast to RailCorp’s payload estimates of around 4,000-8,000 net tonnes based on the length of the trains. Since this appears to be inconsistent with the maximum number of the trains operating per day provided in the brief, this report assumes an average pay load of 2,200 net tonnes. Further, in a stand-alone system, the length of a train is a function of the haul length.

2.3. Requirement under the Undertaking

IPART is responsible for ensuring that RailCorp and other track owners comply with the revenue limits specified by the Undertaking. In this particular instance, this means that:

- Track maintenance costs should represent efficient costs of providing access to coal traffic;

---

\(^7\) Booz Allen & Hamilton (2001), op.cit, p.42.  
\(^10\) ibid.
Network control costs should represent efficient costs of providing safe passage to coal train services (including some planning costs); and

Efficient costs include maintenance costs, network control costs and corporate overheads (the latter is not included in this review).

Under the requirements of the Undertaking, the following criteria should be satisfied when negotiating prices with access seekers:11

- Access revenue from access seeker must at least meet the direct costs imposed by that access seeker. In addition, for any sector or group of sectors, revenue from access seekers should meet the full incremental costs of those sectors (i.e., the floor test).
- Access revenue must not exceed the full economic cost of the sectors that would be required on a standalone basis by an access seeker (i.e., ceiling test).
- The rail infrastructure owner’s total access revenue must not exceed the standalone full economic costs of that part of the NSW rail network.

The floor/ceiling approach reflects the boundaries of pricing that would exist if there was competition in the market. In this context, the standalone cost refers to the minimum cost of providing access and maintaining a “coal only” network. Baumol and Sidak (1994) describe standalone costs as:

*The cost that would be incurred by an efficient entrant to the industry if it were to produce only some specified set of commodities ... That is, it is the cost to produce just those items, “standing alone”*.12

For the purposes of our analysis, we have assumed that the standalone analysis refers to a network operating diesel coal trains only and that no passenger or other traffic co-exists on the network.

2.4. Maintenance Cost Framework

Total maintenance costs are broken down across track maintenance costs, operations (train control) costs and corporate overhead costs. According to the project brief, corporate overheads costs are to be excluded from this review.

Track maintenance costs are normally further segmented into track infrastructure, structures (bridges, tunnels etc.), control infrastructure and communications assets.

Track maintenance activity can be broadly classified as follows:

- Routine Maintenance (RM); and
- Major Programmed Maintenance (MPM)

---

RM refers to activities that are undertaken more than once a year to ensure that tracks remain operational. Usually, these activities are planned and therefore time dependent but could also include unplanned events and reaction to specific incidents. Examples of routine maintenance include track inspections, electronic monitoring, fence maintenance, control testing, vegetation control and corridor maintenance. Routine maintenance is mostly fixed in nature with little or no variability to tonnages and is mostly time dependent. Unplanned events such as collisions and derailments caused by below rail failures are accounted for in corporate overhead insurance.

MPM activities are major capital-intensive planned activities such as rail grinding, mechanised resurfacing, ballast cleaning and sleeper replacement. These activities occur at regular intervals and are capital intensive in nature. MPM can be further classified as fixed MPM and variable MPM (driven by volume). For the purpose of this review, we have not been able to split maintenance activities between fixed or variable activities, given the top-down nature of the study and the limited accompanying benchmarked data. Rather, track maintenance costs were estimated across loaded and empty track parameters using the metric of dollars per kilometre of track. Furthermore, it makes sense to classify costs on the basis of loaded and empty tracks given the nature of a stand-alone ‘coal only’ analysis where a single track would be used in both directions, while a double track would have loaded traffic on one track and empty cars on the other. This approach is further discussed in Section 3.3.1. RailCorp’s network is a combination of concrete and timber sleepers. For concrete sleeper tracks, the MPM activities primarily relate to the repair of track geometry and the maintenance of the actual rail section itself. However, for timber sleeper track MPM activity involves the replacement of actual timber sleepers.

For the purposes of calculating efficient costs, a theoretical ‘levelled’ approach to maintenance has been adopted. IPART supports the use of a levelled (smoothed) amount for expensing MPM based on the long-term average MPM expenditure. This approach requires the present value of the total cost of network maintenance over its economic life to be converted to equal annual payments.

2.5. Benchmarking Framework

In accordance with the requirements of the brief, we have undertaken the analysis using a benchmarking approach. Benchmarking provides a useful baseline check but accurate estimates are difficult to arrive at because of differences in operational and system characteristics.

In estimating for industry best practice maintenance costs, we conducted a benchmarking study of track maintenance costs for heavy-haul bulk freight railway infrastructure in Australia. In doing so, we looked at past determinations by other regulators in Australia, including the Western Australian Economic Regulation Authority (ERA), Queensland Competition Authority (QCA), Victorian Essential Services Commission (ESC) and Australian Competition and Consumer Commission (ACCC). In compiling the benchmarks, the following major assumptions were made:

Unit costs have been normalised for June 2011, using the ABS non-residential building construction index for CPI\textsuperscript{14};

Engineering judgment has been used to assess the applicability or relevance of maintenance activities for Newstan to Woodville Junction Network (see Appendix A);

The operation and maintenance activities for maintaining the network have been contracted out; and

Unit costs have been rounded up to allow for cost factors that could not be benchmarked but are specific to the RAB i.e., over bridge maintenance and operation in populated urban areas.

2.5.1. Economic Regulation Authority (ERA) - WestNet

The 2009 determination of ERA reviewed the maintenance costs, operating costs and overhead costs for the South West Main, South West Collie branch and East West Main line sections\textsuperscript{15}. Two line sections were also analysed - the individual section from Brunswick East to Worley had similar characteristics to the RailCorp’s ‘loaded track’ network and the track section from Kulin to Yilliminning displayed similar characteristics to RailCorp’s ‘empty track’ network. These sections display commonality with the RailCorp’s network in terms of basic parameters such as concrete sleepers, controls, length and tonnage.

The Western Australian regime views maintenance costs as those that are incurred within the first few years of the life of an asset. This is mainly because capital costs are calculated using the gross replacement value approach rather than the Depreciation of the Optimised Replacement Cost (DORC). Therefore, the ERA approved numbers are likely to be at the lower end of the spectrum when compared to other jurisdictions.

Further, the regime assumes that the track is close to new for the purpose of estimating maintenance costs, therefore the values are insensitive to sleeper types and that there is no material differences in maintenance costs between different gauge types (standards vs. narrow). Table 2-1 below provides a summary of maintenance costs estimates along with the parameters for WestNet.

\textsuperscript{14} ABS (2011), Consumer Price Index, Catalogue 6401, Canberra.
\textsuperscript{15} Economic Regulation Authority (2009), WestNet's Rail Floor and Ceiling Cost Review – Final Determination on the Proposed 2009-10 Floor and Ceiling Costs.
Table 2-1 - Summary of WestNet Network Maintenance Costs

<table>
<thead>
<tr>
<th>Section</th>
<th>Track Km</th>
<th>Task (Million Gross Tonnes)</th>
<th>Cost per Track km (2011)</th>
<th>Curvature/Grade</th>
<th>Controls</th>
<th>Number of Mainline Turnouts</th>
<th>Sleepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>South West Main NG</td>
<td>181.69</td>
<td>&gt;10</td>
<td>$21,163</td>
<td>Straight/Flat</td>
<td>Yes</td>
<td>12</td>
<td>Concrete</td>
</tr>
<tr>
<td>SW Collie Branch NG</td>
<td>68.41</td>
<td>~10</td>
<td>$21,164</td>
<td>Very Curvy/1/40</td>
<td>Yes</td>
<td>10</td>
<td>Concrete/Timber</td>
</tr>
<tr>
<td>East-West Main SG</td>
<td>856.78</td>
<td>&gt;10 to 20</td>
<td>$22,574</td>
<td>Mostly Straight/Flat</td>
<td>Yes</td>
<td>40</td>
<td>Concrete/Timber</td>
</tr>
<tr>
<td>Brunswick East - Worsley</td>
<td>22.00</td>
<td>~10</td>
<td>$21,164</td>
<td>Very Curvy/1/40</td>
<td>Yes</td>
<td>4</td>
<td>Concrete</td>
</tr>
<tr>
<td>Kulin - Yilliminning</td>
<td>99.81</td>
<td>&lt;1</td>
<td>$11,286</td>
<td>Flat</td>
<td>No</td>
<td>12</td>
<td>Timber/Steel</td>
</tr>
</tbody>
</table>

Source: ERA (2009) and Booz & Company (NG refers to narrow gauge and SG refers to standard gauge)

The benchmark costs for WestNet can be summarised as follows:

- The unit maintenance cost for Brunswick East to Worley section that represents the ‘loaded’ track is approximately $21,164 per track km when normalised for June 2011.
- The unit maintenance cost for Kulin - Yilliminning section that represents the ‘empty’ track is approximately $11,286 per track km when normalised for June 2011.
- The unit operating costs for Brunswick East to Worley section is approximately $538 per '000 train km when normalised for June 2011.

2.5.2. Queensland Competition Authority (QCA) – QR Network

The Central Queensland Coal region in Queensland is made up of the following systems:

- Goonyella;
- Blackwater;
- Newlands; and
- Moura.

However, for the purposes of the maintenance cost benchmarking review, we believe that the Moura system and the Newlands system can be viewed as reasonably close comparators for RailCorp’s network. The Moura system consists of 228 km of concrete

---

sleeper single track sections. The Newland system consists of 190 km of single track, with a mix of concrete and timber sleepers. Both systems have passing loops with electronic control systems and are configured for diesel trains\(^\text{17}\). We are using estimates from the Newlands system as our benchmark as it has a mix of concrete and timber sleeper tracks.

For coal trains on these systems, the gross to net tonne ratio is approximately 1.65 and therefore the Moura system would task approximately 30 MGT and Newlands approximately 32 MGT\(^\text{18}\). These are considerably higher than the RailCorp section and reinforce the expectation that these costs will be higher than those for RailCorp, even though the network characteristics are very similar. This is further confirmed by the higher concentration of traffic, ballast contamination and associated maintenance inefficiency practices that this line is subject to.

The maintenance costs and the factors affecting them are summarised in Table 2-2.

![Table 2-2 - Summary of QR Network Maintenance Costs](image)

The benchmark costs for QR Network can be summarised as follows:

- The unit maintenance cost for Newlands system is approximately $41,040 per track km when normalised for June 2011. This is quoted for the ‘loaded’ track parameter (there is no equivalent ‘empty’ track parameter in this benchmark).

- The unit operating costs for Newlands system is $750 per '000 train km. This has been calculated by using a benchmark of 1.25 persons per 20,000 train km and a per person cost of $100,000. Including costs for labour and an additional cost premium of 25% for building space and electronic systems, the equivalent comparison is 1.5 persons.

- For the QR Network’s Western system, the proportion of network control costs to total maintenance costs, excluding overheads, is approximately 7%.

These benchmark numbers represent an upper bound when compared to other jurisdictions because of the aforementioned higher tonnages and coal contamination.


2.5.3. **Essential Services Commission (ESC) - Victorian Regional Railway**

In 2006, the ESC undertook a maintenance cost benchmarking review of the Victorian network\(^20\). The review was a 'bottom-up' estimate of the costs of the Victorian Regional railway (VRR) tracks. This review also compared the Victorian tracks with other similar networks in Australia. Since this is a 'bottom-up' review, it provides a good indication of the changes to the ratio of RM to MPM for various types of infrastructure on the network. The benchmarking review looked at the Regional Fast Rail Network (RFRN), Residual Passenger Network (RPN), Class 2 and 3 Freight (2&3 Freight) only lines and Class 4 and 5 Freight (4&5 Freight) only line.

Table 2-3 shows the relative proportion of activity costs in each of track, bridges and controls & communications for each of the line types.

### Table 2-3 - Proportion of Maintenance Activity

<table>
<thead>
<tr>
<th></th>
<th>RFRN</th>
<th>RPN</th>
<th>2&amp;3 Freight</th>
<th>4&amp;5 Freight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track</td>
<td>66.3%</td>
<td>87.6%</td>
<td>89.9%</td>
<td>94.1%</td>
</tr>
<tr>
<td>Bridges</td>
<td>1.3%</td>
<td>2.3%</td>
<td>2.7%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Controls/</td>
<td>32%</td>
<td>10%</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Communications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: ESC (2006) (prepared by WorleyParsons)*

For higher speed passenger trains, traffic density and high risks are mitigated by complex control systems, which have a significantly higher percentage of total maintenance cost (32% as opposed to 10% for a normal passenger network). The RFRN lines are fitted with train based Automated Train Protection (ATP) as well as line side controls, so the communications and control costs extend beyond the relatively simple maintenance of standard CTC systems.

The RPN is lower in density and requires fewer inspections with no vehicle-based maintenance, and have a commensurately lower level of maintenance cost. This type of control system is closer to the RailCorp network control in the RAB. The 2&3 Freight and 4&5 Freight do not have CTC control systems, but do have level crossings and isolate ‘point protection’ at passing loops. Their overall costs are much lower. This type of control is closer to the RailCorp’s network control.

Table 2-4 below provides the summary benchmark estimates for different networks in Victoria.

---


---

Booz & Company Review of Efficient Maintenance Costs of RailCorp’s Hunter Valley Coal Network Final report

Date: 17 November 2011 Filename: IPART_Review of Efficient Costs_Final Report_SUBMITTED.doc Prepared for IPART 12
Table 2-4 - Summary of Victorian Regional Network Maintenance Costs

<table>
<thead>
<tr>
<th>Section</th>
<th>Single Track Km</th>
<th>Track (MGT)</th>
<th>Cost per Track km (2011)</th>
<th>Curvature/Grade</th>
<th>Controls</th>
<th>Mainline Turnouts</th>
<th>Sleepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFRN</td>
<td>800</td>
<td>~5</td>
<td>$24,781</td>
<td>Mod Curves</td>
<td>Yes</td>
<td>2 every 20 km (average)</td>
<td>Concrete</td>
</tr>
<tr>
<td>RPN</td>
<td>200</td>
<td>&lt;2</td>
<td>$21,321</td>
<td>Flat</td>
<td>Yes</td>
<td>2 every 20 km (average)</td>
<td>Timber</td>
</tr>
<tr>
<td>2 &amp; 3 Freight</td>
<td>800</td>
<td>1 to 2</td>
<td>$18,314</td>
<td>Mostly Straight/Flat</td>
<td>No</td>
<td>2 every 20 km (average)</td>
<td>Timber</td>
</tr>
<tr>
<td>4 &amp; 5 Freight</td>
<td>800</td>
<td>&lt;1</td>
<td>$11,457</td>
<td>Mostly Straight/Flat</td>
<td>No</td>
<td>2 every 20 km (average)</td>
<td>Timber</td>
</tr>
</tbody>
</table>

Sources: ESC (2006) and Booz & Company

The lines most similar to the 'loaded' RailCorp network is the RPN because it has an electric control system with unit maintenance costs of approximately $21,321 normalised for June 2011.

2.5.4. Australian Competition and Consumer Commission (ACCC) - Australian Rail Track Corporation

In 2009, ARTC conducted an independent review of the efficiency of its maintenance costs for its East-West interstate network and North-South interstate network\(^{21}\). However, in its submission to ACCC, ARTC adjusted the WorleyParsons efficient costs benchmarks to reflect future replacement of timber sleepers to concrete sleeper track.

In 2007, ARTC reported that its unit costs for operations was $411 per '000 train km. It is important to note that ARTC does not refer to these costs as 'best practice' but, nevertheless they are considered to be a realistic benchmark for the purposes of this review, as these costs were submitted by ARTC as complying with its obligations under its Undertaking.

With respect to overheads, a flat 20% mark-up to maintenance costs has been applied. The mark-up is similar to those associated with other competitively tendered maintenance contracts including ARTC’s alliance contract with engineering firms.

A summary of the results from the ARTC benchmark is shown in Table 2-5 below.

\(^{21}\) ARTC (2008), *An Assessment of ARTC Maintenance Cost Relative to Efficient Industry Practice.*
Table 2-5 - Summary of ARTC Network Maintenance Costs

<table>
<thead>
<tr>
<th>Section</th>
<th>Track (Km)</th>
<th>Task (MGT)</th>
<th>Cost per Track km (2011)</th>
<th>Curvature/Grade</th>
<th>Controls</th>
<th>Mainline Turnouts</th>
<th>Sleepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-West</td>
<td>4,500</td>
<td>~10</td>
<td>$16,929</td>
<td>Straight/Flat</td>
<td>Yes/No</td>
<td>2 every 20 km</td>
<td>Concrete</td>
</tr>
<tr>
<td>North-South</td>
<td>2,800</td>
<td>~4</td>
<td>$28,215</td>
<td>Mod Curves/1/60</td>
<td>Yes</td>
<td>2 every 20 km</td>
<td>Concrete/</td>
</tr>
<tr>
<td>Total ARTC (excl HV)</td>
<td>&gt;4 to&lt;10</td>
<td></td>
<td>$20,725</td>
<td>Straight/Mostly Flat</td>
<td>Yes/No</td>
<td>2 every 20 km</td>
<td>Concrete/</td>
</tr>
</tbody>
</table>

Sources: ARTC (2008) and Booz & Company

The benchmark costs for ARTC can be summarised as follows:

- The unit maintenance cost for the East-West line is approximately $16,929 per track km when normalised for June 2011. The unit maintenance costs for the North-South line is $28,215 when normalised for June 2011.

- The unit operating costs for ARTC is approximately $442 per ’000 train kilometres when normalised for June 2011. The ARTC network has a mix of highly centralised network control and train orders and therefore the costs are expected to be at a lower end of the cost range.

An overview of the benchmark data from different jurisdictions indicates that it is difficult to draw comparisons largely due to the differences in network characteristics and cost assumptions. Further, there are no comprehensive benchmark reviews done in Australia that have similar characteristics with the RailCorp’s network and traffic tonnages. However, benchmark estimates for ERA and ESC have been used for estimating a range of efficient total maintenance costs. These benchmark estimates have been discussed in greater detail in Chapter 3.

2.6. Modelling Assumptions and Data Inputs

The following assumptions have been made in order to estimate efficient costs for track maintenance:

- Current market prices for all inputs (materials and labour) have been used;
- Maintenance overhead costs have been assessed using a standalone FTE workforce;
- Overhead costs for maintenance to the job manager level are encompassed within the quoted track maintenance cost;

---

22 ARTC (2009), Annual Report.
- Train operations costs are assessed taking into account the type of authority system in use, such as controls or train orders and the associated staffing requirement for such systems;

- The maintenance activities for routine and major programs are assessed using industry benchmarks from comparable networks and jurisdictions;

- Maintenance activity for replacement assets like rail, ballast, sleepers and control equipment are in proportion to asset lives;

- The condition of the infrastructure is considered at half-life in perpetuity and will remain in a fit for purpose state for coal traffic;

- Given that it is a top-down study, it has been assumed that axle load or wagon design has no significant impact on the maintenance costs;

- Maintenance costs have not been separated into fixed and variable as this analysis relies on benchmark data; and

- It is assumed that public overbridges are included in the RAB and therefore carried forward.
3. Total Efficient Maintenance Costs

3.1. Introduction

This Chapter outlines the modelling framework adopted to estimate the total efficient maintenance costs of the RailCorp network. This is presented together with the quantitative results under the various scenarios. The model was developed to incorporate a range of desktop benchmark data and variables, as well as to facilitate numerous test permutations. This approach allowed a range of efficient maintenance cost values to be established given the various track configurations, control systems and comparable datasets.

The efficient network control costs are presented together with the efficient track maintenance costs due to their dependent relationship. As explained further in Section 3.3.2, the network costs were estimated using a top-down approach and calculated as a percentage of direct maintenance costs. This method was adopted as it was deemed the most robust given the scope and requirements of the work.

3.2. Overview

The first step of the model was to identify three different track configurations for the estimation of efficient maintenance costs. The second process was to identify the most efficient network control system given the size of the network and the freight task. This is then used to estimate total efficient costs for different track configurations using both the efficient and current control system.

An overview of the model process is shown in Figure 3-1.

![Figure 3-1 - Model Overview](source_image)

Source: Booz & Company

In developing the model, comparable benchmark data and industry analysis were used to first identify maintenance cost drivers. Variables for the model were then developed based
on this analysis and IPART requirements. The relationship between cost drivers and model variables was mapped, with assumptions based on industry standards, IPART input and GHD advice. The total efficient maintenance cost drivers were identified as track maintenance costs on loaded and empty track, and operations (train control) costs. Corporate overhead costs were also identified as a cost driver; however, they were excluded from the analysis as per the IPART brief. The key model variables reflect the cost drivers and the track configuration, network control system and payload per trip.

The development of the model is shown in Figure 3-2.

![Figure 3-2 - Cost Model Development](image)

Source: Booz & Company

3.3. Model Variables and Considerations

3.3.1. Track Configuration

Three track configurations were defined based on the physical configuration of the tracks, their respective length, and use. Within each configuration, we made further distinction between whether the track is subjected to payload tonnage – trains originating from Newstan Junction are considered to be ‘loaded’, whilst those returning from Woodville Junction are considered ‘empty’. ‘Loaded’ pertains to an average payload of 2,200 tonnes per train per trip whilst ‘empty’ is defined as ‘very lightly loaded’ or considered the weight of an empty train. This approach ensures that the double track configuration does not have double the maintenance costs of single track, and that the difference in tonnage and wear is reflected in the respective loaded and empty track maintenance costs ($/km). Furthermore, the maintenance cost efficiencies leveraged through economies of scale are also reflected in the cost difference.

The three track configurations are:

1. Single track: consists of one 20.816km section of rail together with two 1.6km passing loops. As it is used for both directions of traffic, the entire 20.816km section of train is considered to be ‘loaded.’ The 3.2 km of loops is considered empty as it is used by trains returning from Woodville Junction to allow loaded trains from Newstan Junction to pass.

2. Double track: consists of two 20.816km sections of track such that each direction of traffic runs on its own line. Trains originating from Newstan Junction are considered ‘loaded’, whilst those returning from Woodville Junction are considered ‘empty’.
3. Double RAB track: consists of two 20.816km sections of track of which one is 'loaded' and the other 'empty'. As defined by RailCorp, the RAB is set at 51.56km in length and thus an extra 9.928km of quadruple track is considered ancillary or 'other' track.

Within the single and double track configuration are concrete turnouts - five and four respectively. The industry standard for estimating their intensive maintenance requirements is to apply an equivalent maintenance track length beyond that of their actual length. Our estimation approach, however, considers the presence of similar turnouts on a comparable frequency in the benchmark data maintenance cost. We believe this cost value is thus inclusive and reflective of the turnout's increased maintenance task. In light of this, the equivalent track maintenance length approach has been disregarded to avoid double counting the turnout maintenance cost.

A summary of the track configurations is shown in Table 3-1.

<table>
<thead>
<tr>
<th>Table 3-1 - Track Configuration and Length</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Track configuration</strong></td>
</tr>
<tr>
<td>'Loaded' track km</td>
</tr>
<tr>
<td>'Empty' track km</td>
</tr>
<tr>
<td>'Other' track km</td>
</tr>
<tr>
<td>Total track km</td>
</tr>
</tbody>
</table>

**Source:** Booz & Company

3.3.2. **Network Control System**

The existing network control system used by RailCorp is a conventional CTC system. It includes trackside controls at intermediate places between crossing loops and turnout locations, together with remotely powered turnouts. In short, the entire track is electrically circuited and monitored.

In determining the most relevant network control system for comparison, we considered a range of other network control systems. These include:

- The simplest control system used on secondary lines carrying less than a train per day is the one where all of the turnouts are manually operated and there are no field electric systems. The driver receives his authorisation to use a track through a message over the radio system. This method involves considerable occupational health and safety issues for the staff operating the system. That said, it is still in use on very low volume lines.

- The next level of automated network control systems uses a physical token, usually a ‘staff’ - a metal bar designed to fit into a machine which ensures that no other train is on the same section of the track. This is used on secondary and heritage tracks and requires manual effort on part of the driver. This system relies on control box operation which is not recommended for a modern railway.

- A variation of the token system involves a ‘staff’ and the ‘ticket’ replaces one of the ‘staff’ functions operating in the other direction.
Another simple mechanised system involves the use of 'self-restoring' system on the turnout. This ensures that the turnout is always set for the appropriate direction of travel on the next train. It is suited for trains travelling in the same direction when approaching a turnout. It is not suitable for RailCorp’s network as trains need to enter and depart from mainline turnouts in different direction.

The recommended comparable network control system for the hypothetical ‘coal only’ RailCorp network is a remotely controlled turnout in a train order system. The track between turnouts is not electrically circuited and the train driver receives authorisation to run through a verbal or electronic data transmission from the train controller. The turnouts are track circuited and interlocked on a standalone basis. This type of network control system is the simplest, contemporary system for a mainline network involving ten trains each way per day.

This type of network control system has the following benefits:

- It reduces the occupational health and safety issues related to manual switching of the points of the turnout;
- It reduces the time required for manually operating the turnouts; and
- It reduces the potential for human error.

3.3.3. Benchmark Data

As discussed in Chapter 2, in estimating the industry best practice maintenance costs, we conducted a benchmarking study of total maintenance costs for heavy-haul bulk freight railway infrastructure in Australia. Benchmark data from only two jurisdictions, the ERA decisions for WestNet and ESC’s review of the Victoria Regional network have been used for the purposes of estimating efficient costs for RailCorp. As discussed in Chapter 2, the ARTC and QCA networks were not comparable to the RailCorp network. Furthermore, they were also found to not offer a suitable value for the ‘empty’ track scenario that could be applicable to the RailCorp network.

The ESC determination included a detailed breakdown of costs that provide useful insight into the different components of maintenance costs and the relevant importance of the different maintenance activity. Although this provides a robust set of figures, there is a mismatch in the task and configuration dimensions for the ‘loaded’ track scenario when compared to the RailCorp network.

The lines most similar to the 'loaded' RailCorp network in the Victorian Regional network was the Residual Passenger network, as it has electric network control and the unit maintenance cost is approximately $21,321 per track km when normalised for June 2011. These have been adopted to be representative of the timber tracks on the sidings included in the RAB. Due to the seasonal nature of freight task, these regional lines have low tonnages which increases the average cost of timber sleeper replacements.

For WestNet, we looked at an individual section from Brunswick East to Worley which had similar characteristics to the RailCorp’s ‘loaded’ track network, and the track section from Kulin to Yilliminning displayed similar characteristics to RailCorp’s ‘empty’ track network.
These sections display commonality with the RailCorp’s network with regards to basic parameters such as concrete sleepers, controls, length and tonnage.

The unit maintenance cost for the Brunswick East to Worley section that represents the ‘loaded’ track is approximately $21,164 per track km when normalised for June 2011. The unit maintenance cost for Kulin - Yilliminning section that represents the ‘empty’ track is approximately $11,286 per track km when normalised for June 2011.

The unit operating costs for the Brunswick East to Worley section is approximately $538 per ’000 train kilometres when normalised for June 2011. Table 3-2 below summarises the benchmark data used in our analysis.

<table>
<thead>
<tr>
<th>Network</th>
<th>Context</th>
<th>‘Loaded’ $/track km</th>
<th>‘Empty’ $/track km</th>
<th>‘Other’ RAB track $/track km</th>
<th>Control Operations cost $’000 train km</th>
</tr>
</thead>
<tbody>
<tr>
<td>WestNet</td>
<td>High similarity with RailCorp</td>
<td>$21,164</td>
<td></td>
<td></td>
<td>$538</td>
</tr>
<tr>
<td></td>
<td>Low tonnage No control</td>
<td></td>
<td>$11,286</td>
<td>$11,286</td>
<td></td>
</tr>
<tr>
<td>Victorian Regional Network</td>
<td>Low tonnage and controls</td>
<td>$21,321</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very low tonnage and no controls</td>
<td></td>
<td>$11,457</td>
<td>$11,457</td>
<td></td>
</tr>
<tr>
<td>Recommended for RAB</td>
<td></td>
<td>$24,000</td>
<td>$9,000</td>
<td>$9,000</td>
<td>$550</td>
</tr>
</tbody>
</table>

Source: Booz & Company

For estimating the benchmark for network control, we have taken into account the Victorian Regional data and the WestNet data.

The WestNet System has a mixture of CTC and train order (referred to as DTC in Queensland) network control. It also has many level crossings requiring control maintenance. The proportion of network control (trackside systems) costs to total maintenance costs not including overheads is approximately 7%. It is important to note that this benchmark provides a lower end of industry estimates for full CTC electronic control systems but is nevertheless an important reference point for the purposes of our analysis.

For the Victorian network, we looked at the regional fast rail network (RFR) and the residual passenger line for an appropriate estimate for network control cost. Since the RFR lines had high speed passenger trains and high traffic density network control, control operations costs were a significantly higher proportion of total costs. In contrast, the residual passenger lines were low density and thus have a control system that is closer to RailCorp’s existing control system.

The total control operations cost as previously discussed has been calculated based on the number of train kilometres per annum. The associated benchmark value has been estimated.
on the premise that the relevant network forms part of a more significant rail network from which economies of scale can be leveraged. If the control operations costs were estimated solely on the basis of a standalone system, the control operations cost would be substantially higher. The benchmark approach is similar to that of ARTC and QCA which calculated control operations cost under the assumption that the rail section belonged to a larger network. This is discussed further in Section 4.3.

On the basis of this data, we estimate that an efficient network control system would result in a reduction of 7.5% of the benchmarked maintenance costs.

The following caveats and benchmark data limitations should be noted:

- In the case of Victorian Regional network, there are only concrete sleeper tracks;
- Train operation costs were not available for the Victorian Regional rail network;
- Operations activity has been assumed to be mainly associated with train control function;
- Most of the benchmarks used, with the exception of Victoria have tonnages greater than RailCorp’s network ‘loaded’ track in the double track scenario;
- In the case of WestNet, given the use of the gross replacement value approach, the ERA’s benchmark figures can be considered to be at the lower end of the industry best practices estimates;
- In the absence of any data for ‘empty trains’ on concrete sleeper track, the recommended value has been derived by interpolating Victorian data for low task tracks without the need for replacing timber sleepers;
- For the scenario, ‘other’ track that comprises of timber sidings and turnouts, the lowest task scenario from the WestNet and Victorian networks have been used as a proxy; and
- Where there is a lack of comparable benchmark data, we have relied on engineering judgment.

3.3.4. Secondary Variables and Considerations

Control operations cost is estimated on the number of train kilometres per annum on the network, which in turn is affected by the annual tonnage task, average payload size per train per trip, and length of the track. Given a net annual tonnage task of four million tonnes, and a finite section of track, the average payload size per train per trip is an important parameter. As a result, it is a variable within the model, populated with the recommended value of 2,200 tonnes.

The estimated total efficient maintenance cost can be further assessed against an upper or lower cost boundary. The industry standard upper error margin of 20% is recommended in order to display an appropriate range of costs.
A further consideration for the model is that of rolling stock and axle loads. The RailCorp network is constructed of concrete sleepers, 250mm of ballast and 60 kg/m rail, making it well suited for the traffic using the track. Moreover, there is no reason to adjust any of the benchmarks in consideration of the 25 tonne axle load rolling stock.

### 3.4. Test Permutations

The model was designed to test multiple variable combinations in order to determine the change in cost for different track configurations and control systems. This is consistent with RailCorp’s request to estimate the potential difference in total maintenance cost should the track configuration change from double to single, which may be suitable given that the track is subjected to relatively low tonnages and traffic.

Six tests were chosen to highlight the difference in cost, with the central case being the RailCorp ‘as-is’ network, which is a configuration of the RAB featuring a double track configuration and CTC control system. This network consists of 51.56 km of track, however, as noted in Section 3.3.1, there is 41.632 km of track of which half is considered loaded and the other empty. There is a further 9.928 km of ancillary track which is regarded as empty.

The standalone case is to inform IPART of the maintenance cost associated with a ‘simple’ system that is capable of fulfilling the required coal haulage task of four million tonnes per annum. This is in alignment with the Sapere Research Group (2011) report that proffers a single track configuration would suffice to carry the given haulage task. The efficient network control system is used in consideration of the network operating with a maximum of twenty trains per day on the network. This test thus consists of a single track configuration (inclusive of two 1.6 km loops for trains to pass), the actual track kilometric of 20.816 km and the efficient control system.

Tests 3 to 6 highlight the change in cost associated with the adoption of an efficient network control system, across both single and double track configurations.

The six tests are further considered with respect to the three datasets discussed in Section 3.3.3 – the WestNet, VRR and Booz analysis. It is noted that the VRR data is only used to estimate track maintenance costs as the dataset is not inclusive of an estimate for train control operations cost.

The test permutations are summarised in Table 3-3.

<table>
<thead>
<tr>
<th>Test</th>
<th>Track</th>
<th>Kilometric</th>
<th>Control System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Case</td>
<td>Double</td>
<td>RAB</td>
<td>CTC</td>
</tr>
<tr>
<td>Standalone Case</td>
<td>Single</td>
<td>Actual</td>
<td>CTC</td>
</tr>
<tr>
<td>Test 3</td>
<td>Single</td>
<td>Actual</td>
<td>Efficient</td>
</tr>
<tr>
<td>Test 4</td>
<td>Double</td>
<td>Actual</td>
<td>CTC</td>
</tr>
<tr>
<td>Test 5</td>
<td>Double</td>
<td>Actual</td>
<td>Efficient</td>
</tr>
<tr>
<td>Test 6</td>
<td>Double</td>
<td>RAB</td>
<td>Efficient</td>
</tr>
</tbody>
</table>

Source: Booz & Company
3.5. Total Efficient Maintenance Cost Estimation

The results of each test are presented in Table 3-4 to Table 3-6 with the costs shown on a per annum basis. Whilst the benchmarked maintenance cost ($/km) has been normalised and quoted ‘as-is’ without rounding, the resulting estimated maintenance and operations cost, and their sum (estimated total cost of maintenance) has been quoted rounded to the nearest thousand dollars. An average payload of 2,200 tonnes per train per trip is also used based on GHD’s recommendation. The respective track length values were given in Table 3-1.

3.5.1. Single Track Configuration

The total efficient maintenance costs for a single track configuration from the WestNet, VRR and the Booz analysis are shown in Table 3-4.

<table>
<thead>
<tr>
<th>Single Track Configuration</th>
<th>Current (CTC) Control System</th>
<th>Efficient Control System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WestNet</td>
<td>VRR</td>
</tr>
<tr>
<td>Benchmark Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loaded track</td>
<td>$21,164</td>
<td>$21,321</td>
</tr>
<tr>
<td>Empty track</td>
<td>$11,286</td>
<td>$11,457</td>
</tr>
<tr>
<td>Total Track Maintenance</td>
<td>$477,000</td>
<td>$480,000</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Operations Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(’000 train kilometres pa)</td>
<td>$538</td>
<td>NA</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>$41,000</td>
<td>NA</td>
</tr>
<tr>
<td>Total Costs</td>
<td>$518,000</td>
<td>NA</td>
</tr>
</tbody>
</table>

Source: Booz & Company

An efficient control system cost for a standalone case is estimated to have a total maintenance cost of $533,000 per annum. Benchmarking data has shown that the adoption of an efficient control system reduces the total track maintenance cost from the CTC system by approximately 7%. In this instance, this translates into a cost saving of approximately $37,000 of the total maintenance costs when compared to the current control system for the Booz analysis.

This reduction is a percentage of total track maintenance cost rather than operations, as the difference is primarily a reduction in hardware maintenance costs. The operations cost is expressed in terms of train kilometres per annum on the network, and thus does not change between current and efficient control systems.
3.5.2. *Double Track Configuration*

The total efficient maintenance costs for a double track configuration from the WestNet, VRR and the Booz analysis are shown in Table 3-5.

**Table 3-5 - Double Track Total Efficient Maintenance Cost**

<table>
<thead>
<tr>
<th>Benchmark Data</th>
<th>Current (CTC) Control System</th>
<th>Efficient Control System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WestNet</td>
<td>VRR</td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loaded track</td>
<td>$21,164</td>
<td>$21,321</td>
</tr>
<tr>
<td>Empty track</td>
<td>$11,286</td>
<td>$11,457</td>
</tr>
<tr>
<td>Total Track Maintenance Costs</td>
<td>$675,000</td>
<td>$682,000</td>
</tr>
<tr>
<td>Control Operations Costs ('000 train kilometres pa)</td>
<td>$538</td>
<td>NA</td>
</tr>
<tr>
<td>Total Control Operations Costs</td>
<td>$41,000</td>
<td>NA</td>
</tr>
<tr>
<td>Total Costs</td>
<td>$716,000</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Source: Booz & Company*

The cost estimate for double track is approximately 28% greater than for single track under the current control system. This is reflective of the economies of scale that can be leveraged across the greater length of track, as well as the larger spread of fixed costs. The implementation of an efficient control system would result in a decrease of total maintenance costs of approximately 5% compared with CTC system.

3.5.3. *Regulatory Asset Base Track Configuration*

The total efficient maintenance costs for a Double RAB track configuration from the WestNet, VRR and the Booz analysis are shown in Table 3-6.
Table 3-6 - RAB Track Total Efficient Maintenance Cost

<table>
<thead>
<tr>
<th>RAB Track Configuration</th>
<th>Current (CTC) Control System</th>
<th>Efficient Control System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WestNet</td>
<td>Booz</td>
</tr>
<tr>
<td>Benchmark Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loaded track</td>
<td>$21,164</td>
<td>$24,000</td>
</tr>
<tr>
<td>Empty track</td>
<td>$11,286</td>
<td>$9,000</td>
</tr>
<tr>
<td>Other track</td>
<td>$11,286</td>
<td>$9,000</td>
</tr>
<tr>
<td><strong>Total Track Maintenance Costs</strong></td>
<td><strong>$788,000</strong></td>
<td><strong>$776,000</strong></td>
</tr>
<tr>
<td>Control Operations Costs (000 train kilometres pa)</td>
<td>$538</td>
<td>$550</td>
</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td><strong>$41,000</strong></td>
<td><strong>$42,000</strong></td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td><strong>$829,000</strong></td>
<td><strong>$818,000</strong></td>
</tr>
</tbody>
</table>

Source: Booz & Company
4. Conclusions

4.1. Summary of Benchmarked Costs

The total efficient maintenance costs for the three track configurations and the two network control systems as calculated on Booz analysis data are shown in Figure 4-1 below. An average payload size of 2,200 tonnes per train per trip is assumed.

![Figure 4-1 - Total Efficient Maintenance Costs (FY 2011)](image)

GHD quotes the industry standard error margin for total maintenance costs as between zero to twenty percent upside of the estimated cost. For the ‘central case’ of the double RAB configuration with the current control system estimated as $818,000 pa, the cost range is estimated between $818,000 pa and $982,000 pa. For the standalone network of a single track configuration with efficient network control, the estimated cost range is between $533,000 and $639,000 pa. Across all three track configurations, the efficient control system has an associated maintenance cost saving of $37,000 pa in 2011 monetary terms. This figure represents a saving of between five to seven percent of total track maintenance costs dependent on the track configuration.

As discussed in Section 3.3.4, the average payload size per train per trip is an important parameter on operations costs if the net annual haulage task and track section length are held constant. GHD estimated an appropriate average payload of 2,200 tonnes, whilst Sapere Research Group uses a value of 6,300 tonnes (discussed further in Section 4.2). Although this is an increase of approximately 285%, given that operations cost is a relatively small percentage of total efficient maintenance cost (as can be seen in Figure 4-1), a change in average payload of this size results in a change of total maintenance costs of approximately 3.5%. This was estimated for the central case of double RAB configuration and current network control system. Furthermore, this is on the assumption that the approximate track maintenance cost quoted in $ per km remains constant, which is
reasonable given that the track is rated to a considerably higher rolling stock limit. Given the optimal train size is directly proportional to haul distance\textsuperscript{24}, an average payload size of 2,200 tonnes provides an appropriate balance between train frequency and size given the relatively short haul.

4.2. Comparison with RailCorp Cost Estimation and Recent Work

A recent study conducted by Sapere research group for IPART concluded that RailCorp’s unit costs are excessively high compared to freight railways elsewhere in Australia\textsuperscript{25}. Unit costs for network control and corporate overheads were high as a result of inappropriate allocation to coal traffic of RailCorp’s non-track specific costs. Again, these costs were high for RailCorp because of the dominant influence of passenger considerations within the organisation. Table 4-1 below presents a comparison of RailCorp’s implied unit cost rates and the upper best practice range.

<table>
<thead>
<tr>
<th>Table 4-1 - RailCorp Maintenance Rate Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>RailCorp Implied Unit Rates</td>
</tr>
<tr>
<td>2006-07</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Fixed maintenance ($/track km)</td>
</tr>
<tr>
<td>115,110</td>
</tr>
<tr>
<td>Variable maintenance ($’000 GTK)</td>
</tr>
<tr>
<td>5.18</td>
</tr>
<tr>
<td>Network control ($/train km)</td>
</tr>
<tr>
<td>46.59</td>
</tr>
<tr>
<td>Corporate overheads ($/train km)</td>
</tr>
<tr>
<td>25.28</td>
</tr>
</tbody>
</table>


RailCorp has provided IPART with the actual costs incurred for track maintenance for the financial year 2004/2005, as well as modelled costs for the financial year 2006/2007. For the purposes of comparison, these results are presented in Table 4-2 together with the cost estimates from the Booz and Sapere analysis. (Note: Both RailCorp and Sapere quoted costs for corporate overheads, however given these were not in the scope of our report they have been disregarded).

\textsuperscript{24} Generally as average haul length increases, the optimal train size increases given the need to balance the time capital is tied up in loading/unloading versus line haul.

Table 4-2 - Comparison of RailCorp, Sapere and Booz & Company Results

<table>
<thead>
<tr>
<th>Cost</th>
<th>RailCorp (FY04/05 – Actual)</th>
<th>RailCorp (FY06/07 - Modelled)</th>
<th>Sapere Research Group (Double Track)</th>
<th>Booz &amp; Company (RAB track with CTC System)</th>
<th>Booz &amp; Company (RAB track with Efficient Network Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>$8,675,281.77</td>
<td>$6,859,088</td>
<td>$2,023,228</td>
<td>$776,000</td>
<td>$739,000</td>
</tr>
<tr>
<td>Network Control</td>
<td>$1,397,500.08</td>
<td>$1,482,608</td>
<td>$129,466</td>
<td>$42,000</td>
<td>$42,000</td>
</tr>
<tr>
<td>Total</td>
<td>$10,072,781.85</td>
<td>$8,341,696</td>
<td>$2,152,694</td>
<td>$818,000</td>
<td>$781,000</td>
</tr>
</tbody>
</table>

Sources: RailCorp, Sapere Research Group, Booz & Company

Booz & Company undertook a different approach to the Sapere Research Group to estimate maintenance costs, adopting the loaded and empty track parameters as opposed to a fixed and variable costs approach.

Network control costs are estimated consistently across the two reports, using a dollar per train kilometre approach. The difference between the Sapere estimate and ours is primarily a result of two factors – the calculation method (fixed/variable vs. loaded/empty) and the benchmark values.

Sapere estimates $30,000 per km for fixed track maintenance and $3.52 per '000 GTK for variable track maintenance, in comparison to our estimates of $24,000 per km for loaded track maintenance and $9,000 per km for empty track maintenance. Sapere also estimates network control at $4.60 per train km, whilst we assumed the value of $0.55 per train km.

The derivation of our benchmark estimates has been discussed in Section 3.3.3. The Sapere model also uses an average payload value per train per trip of 6,300 tonnes, whilst the Booz model uses 2,200 tonnes. As discussed previously, this difference has been shown to have a marginal effect on estimated total efficient maintenance cost. Notwithstanding these differences in approach, the Booz & Company research confirms Sapere’s judgement that RailCorp’s unit costs are high.

Contained within the ancillary 9.928km track in the RAB configuration are 78 timber turnouts. Although each is equal to approximately 50m in track length, due to their intensive maintenance requirements the timber turnouts are equivalent to 250m of track maintenance effort. These timber turnouts have been disregarded from analysis given the requirement to analyse the system as a standalone coal network. If RailCorp has included these turnouts in their calculations it is possible that such a discrepancy in total track cost estimation is due in part to this.

4.3. Impact of Standalone Costs

As outlined previously, the benchmarked costs assume that the relevant railway can leverage economies of scale from being integrated with a more significant network. In the context of setting a price ceiling and establishing the standalone costs of serving a single customer, or group of customers, this approach is unlikely to provide a reasonable estimate.
It is generally argued that a standalone operator could outsource the relevant functions and the outsourced service provider could then aggregate across networks to deliver the benchmark cost (to the multiple network owners). This may be reasonable in direct cost areas such as major periodic maintenance (albeit some premium may be incurred), but is probably unreasonable in respect of joint or common costs such as network control.

Network control costs are shared across the relevant controlled network and as such are joint between various network segments. The avoidable cost of removing any small part of the network is probably small. In establishing a standalone cost for network control, apportioning costs on a train kilometre basis is unlikely to deliver a robust estimate. In the case of the RailCorp network, $42,000 per year to plan and control the movement of 10 trains a day, 365 days a year is not reasonable.

Instead, a ‘bottom up’ approach assuming a Train Order system would result in a total labour cost of $117,600 per annum which would be a more reasonable estimate. It takes into account labour costs for train control, train planning and supervision functions. Since trains may be able to be planned and controlled remotely, it can be concluded that an efficient competitive price for train control functions may lie somewhere in between $42,000 and $117,000.
5. **Bibliography**

Australian Rail Track Corporation (2009), *An Assessment of ARTC Maintenance Costs Relative to Efficient Industry Practice*.


National Competition Council (1997), (prepared by KPMG), *The Pricing Principles contained in the NSW Rail Access Regime*, Melbourne.


Queensland Competition Authority (2011), *QR Network’s 2011-12 Volume Reset and Annual Variation of Reference Tariffs*.


RailCorp (2009), Roll Forward of Regulatory Asset Base, Ceiling Test, Unders and Overs Account, Sydney.


## Appendix A. Track Maintenance Activities

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Activity</th>
<th>Relevance for this Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MPM</td>
<td>Tie renewal - installation</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>2</td>
<td>MPM</td>
<td>Tie renewal – ballast &amp; tamp</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>3</td>
<td>MPM</td>
<td>Ballast delivery – tie cycle</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>4</td>
<td>MPM</td>
<td>Sleeper Delivery – tie cycle</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>5</td>
<td>MPM</td>
<td>Turnouts</td>
<td>Surfacing</td>
</tr>
<tr>
<td>6</td>
<td>MPM</td>
<td>Surfacing (concrete)</td>
<td>Track surfacing</td>
</tr>
<tr>
<td>7</td>
<td>MPM</td>
<td>Surfacing (timber)-alternate with tie cycle</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>8</td>
<td>MPM</td>
<td>Ballast delivery</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>9</td>
<td>MPM</td>
<td>Surfacing (steel or mixed timber/steel)</td>
<td>All sleepers concrete for optimised scenario, but mixed for RAB</td>
</tr>
<tr>
<td>10</td>
<td>MPM</td>
<td>Grinding</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>MPM</td>
<td>Undercutting</td>
<td>Interpreted as ballast cleaning and/or replacement</td>
</tr>
<tr>
<td>12</td>
<td>MPM</td>
<td>Rail replacement (MPM)</td>
<td>Full curves and tangents, not plugs</td>
</tr>
<tr>
<td>13</td>
<td>MPM</td>
<td>Formation maintenance &amp; vegetation control</td>
<td>Relevant</td>
</tr>
<tr>
<td>14</td>
<td>MPM</td>
<td>Level crossings – panel renewal (sealed road)</td>
<td>Relevant</td>
</tr>
<tr>
<td>15</td>
<td>MPM</td>
<td>Level crossings – panel renewal (gravel road)</td>
<td>No gravel road</td>
</tr>
<tr>
<td>16</td>
<td>MPM</td>
<td>Controls Fixed - maintenance</td>
<td>Relevant</td>
</tr>
<tr>
<td>17</td>
<td>MPM</td>
<td>Communications-maintenance</td>
<td>Relevant</td>
</tr>
<tr>
<td>18</td>
<td>MPM</td>
<td>Bridges - Timber</td>
<td>Not relevant, all bridges steel or concrete</td>
</tr>
<tr>
<td>19</td>
<td>MPM</td>
<td>Bridges- concrete / steel</td>
<td>Relevant</td>
</tr>
<tr>
<td>20</td>
<td>MPM</td>
<td>Bridges – major</td>
<td>Relevant</td>
</tr>
<tr>
<td>21</td>
<td>MPM</td>
<td>Tunnels</td>
<td>One 150 tunnel on ‘down’ track</td>
</tr>
<tr>
<td>22</td>
<td>RM</td>
<td>Track inspection (incl. fault detection)</td>
<td>Relevant</td>
</tr>
<tr>
<td>23</td>
<td>RM</td>
<td>Reactive maintenance (civil)</td>
<td>Relevant including insulated rail joint maintenance and plug insertion</td>
</tr>
<tr>
<td>24</td>
<td>RM</td>
<td>Controls inspection &amp; reactive maintenance</td>
<td>Relevant</td>
</tr>
<tr>
<td>25</td>
<td>RM</td>
<td>Communications inspection &amp; reactive maintenance</td>
<td>Relevant</td>
</tr>
</tbody>
</table>

Source: ARTC (2009), p.5.
Appendix B - RailCorp’s Network: Hunter Valley Coal

Figure B-1: Curve and Gradient Diagram for RailCorp’s Network – Part 1

Source: www.railcorp.info/data/assets/file/0020/686/Curve_and_gradient_Daigrams_V2-0_b.zip
Figure B-2: Curve and Gradient Diagram for RailCorp’s Network – Part 2

Source: www.railcorp.info/data/assets/file/0020/686/Curve_and_gradient_Daigrams_V2-0_b.zip