Final Report

VALUATION OF CERTAIN ASSETS OF THE RAIL ACCESS CORPORATION

ORTA RECENS QUAM PURA NITES

INDEPENDENT PRICING AND REGULATORY TRIBUNAL
OF NEW SOUTH WALES

Sydney
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G. Mine Life Analysis

EXECUTIVE SUMMARY

Booz·Allen & Hamilton was retained by IPART in December 1999 to undertake an independent valuation of the Hunter Valley Coal Network owned by the NSW Rail Infrastructure Corporation (RIC).

The task is to establish the value, based on depreciated optimised replacement cost as at 1st July 1999, of the infrastructure required to meet the requirements of Category 1 and Category 2 coal mines in the Hunter Valley, measured on a stand-alone basis. Only the 'optimised' network is to be valued, that is, the rail infrastructure required to meet the current and future needs of coal users. Any over-design, over capacity or redundancy in the existing network is excluded from the valuation.

The Terms of Reference (TOR) required a number of discrete steps :

i. Define the existing and expected traffic on the network sectors serving Category 1 and Category 2 Hunter Valley coal mines;
ii. Examine the relevant assets used in the RIC interim valuation, taking account of asset classes that have been determined to have zero value;
iii. Optimise these network assets;
iv. Derive replacement costs for the relevant assets in each of these optimised network sectors, noting that RIC actual costs should be scrutinised for efficiency; and
v. Adjust the optimised replacement costs to reflect depreciation.

Future needs have been assessed based on the likely growth in traffic over the 5 years to 2004. The infrastructure required to meet this future level of demand is used to determine the optimised network. Some adjustment to the value of the regulated asset base may be required over the five year period to account for the efficient actual cost of new infrastructure yet to be constructed.

The TOR called for both a greenfields and a brownfields assessment of the replacement cost of the optimised network. Because the valuation is to exclude land, tunnels, cuttings, embankments and other formation works, it is difficult to conceptualise any real difference between greenfields and brownfields and consequently only a single valuation was developed. Financing costs of 4% were added to the ORC estimate to allow for the cost of cash outlays over the construction period.

The initial discount from optimised replacement cost to arrive at the DORC value was based on asset condition and an assessment of life consumed by asset class by sector. Other methods, including those suggested by stakeholders, were considered but difficulties with their application to this DORC valuation were such that the asset condition approach was preferred in the final assessment.

The final DORC values for Category 1 and Category 2 mines (in aggregate) are presented in Table E.1 below. The 'current cost' replacement values have been discounted by 1.85% to arrive at 1st July 1999 values.

Table E.1 Final DORC Values

	Current costs			1st July 1999 costs		
	ORC ($M)	DORC ($M)	Disc (%)	ORC ($M)	DORC ($M)	Disc (%)
Track	405.6	240.1	40.8	398.1	235.7	40.8
Sigs and Comms	117.0	57.3	51.0	114.8	56.3	50.0
Structures	129.9	65.6	49.5	127.5	64.4	49.5
Total:	652.6	363.5	44.3	640.5	356.8	44.3

Comparisons with RIC's interim DORC[1] and revised DORC[2] are presented in Tables E.2 and E.3 respectively.

Table E.2 Comparisons with RIC Interim Values

	RIC ORC ($M)	BAH ORC ($M)	% Diff	RIC DORC[1] ($M)	BAH DORC ($M)	% Diff
Track	393	398.1	+1	291	235.7	-19
Sigs and Comms	92	114.8	+25	62	56.3	-9
Structures	239	127.5	-47	164	64.4	-61
Total:	724	640.5	-12	517	356.8	-31

1. Discount from ORC based on condition as an interim measure

The RIC revised values reflect more up to date asset information which has become available since the interim DORC assessment was made. The remaining differences between the revised RIC and Booz·Allen ORC estimates are mainly due to Booz·Allen:

i. Applying lower overhead rates to signals, communications and structures costs;
ii. Adopting a lower cost for level crossings; and
iii. Not including an additional allowance for culverts, formation and drainage and weighbridges.

[1] *The interim DORC was established by RIC following the IPART review of the NSW Rail Access Regime in 1999. The interim DORC underpins current access charges although RIC is committed to retrospectively adjusting charges following this independent review*

[2] *RIC, "Submission to IPART on the Booz·Allen & Hamilton Revised Draft Report : Valuation of Certain Assets of the Rail Access Corporation", 30th March 2001, Reference Point 1*

Table E.3 Comparisons with RIC Revised Values

	RIC ORC ($M)	BAH ORC ($M)	% Diff	RIC DORC[1] ($M)	BAH DORC ($M)	% Diff
Track[2]	413.2	398.1	-4	305.7	235.7	-23
Sigs and Comms	125.7	114.8	-9	93.0	56.3	-39
Structures	138.6	127.5	-8	102.6	64.4	-37
Total:	677.5	640.5	-5	501.3	356.8	-29

1. Discount from ORC of 26% based on mine life
2. Includes assets RIC identified as additional assets-i.e.culverts, formation and drainage, weighbridges

Booz·Allen has generated a single point estimate of the DORC as required by the TOR. It is acknowledged that the process has involved considerable subjectivity and engineering judgment. The analysis of current condition used to establish the starting depreciation, while as objective and robust as possible, was based on limited information and is subject to error. In our view, actual condition (measured as percentage of asset life expired) could reasonably lie anywhere in the range of 40 to 50%, giving a DORC range of $320m to $384m. Our assessment of 44.3%, giving a DORC value of $357 million, reflects our best judgment based on the information available.

There has been considerable debate as to whether this DORC valuation, and in particular, the methodology used to determine the starting value of depreciation, must be consistent with previous decisions in relation to other factors affecting access prices in the Regime, such as on-going depreciation and WACC. We do not hold to this view as far as this initial DORC is concerned but acknowledge the need for internal consistency within the Regime going forward. For example, the need for consistency between the on-going depreciation method and DORC valuation methodology is accepted for future investment. Similarly, there will need to be consistency between the risk assessment embodied within the regulated WACC and the actual risk environment for the infrastructure owner, having regard to the potential for asset stranding, technical obsolescence and related issues.

RIC have argued that as a result of this DORC valuation, they will be constrained in effectively operating, upgrading and enhancing the network[3]. Further, its investment capacity will be reduced to an amount below optimal expenditure[4]. It is not clear why this is so given that this DORC valuation deals with historic (sunk) investment and it is the Regime more generally which influences the climate for future investment. Indeed, the Minerals Council has commented that access seekers are already encountering the disincentive for RIC to invest given the uncertainty surrounding the regulatory treatment of new investment[5].

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3 *RIC, "Submission to IPART on the Booz·Allen & Hamilton Revised Draft Final Report: Valuation of Certain Assets of the Rail Access Corporation", 30 March 2001, p4*

4 *The impact of a lower DORC value on RIC's free cash flow is acknowledged but this of itself is not sufficient to necessitate capital rationing. The entire issue of RIC's ability to internally fund new investment and its ability to tap alternative sources of capital is beyond the scope of this Report.*

5 *Minerals Council, "Submission to Booz·Allen on Revised Draft Final Report on Valuation of Certain Assets of the Rail Access Corporation",February 2001*

The DORC process identified a range of regime issues, which are not directly within the scope of this valuation exercise, but which require attention to ensure stakeholders have certainty in regard to future pricing arrangements. Issues raised include :

- Roll forward process and the treatment of new capital expenditure prior to the next regulatory review;
- Treatment of capacity increases to accommodate new mines;
- Scope of the revaluation in 2004, particularly in relation to optimisation; and
- Process for the update of WACC.

These are matters to be addressed by the Government as custodian of the access regime.

1.0 INTRODUCTION

The Independent Pricing and Regulatory Tribunal was requested by the Premier of NSW in October 1998 to examine specific aspects of the pricing principles in the NSW rail access regime, including the interpretation of the ceiling price to apply in the regime.

The Tribunal's Final Report[1] recommended depreciated optimised replacement cost (DORC) as the appropriate asset valuation methodology to be used in establishing the appropriate ceiling price to apply in the regime.

Booz·Allen & Hamilton was retained by IPART in December 1999 to undertake an independent valuation, using the DORC methodology, of the Hunter Valley Coal Network owned by the NSW Rail Infrastructure Corporation (RIC).

An initial Draft Final Report was released in November 2000 and a revised Draft Final Report in February 2001. The substantive comments on the Draft Reports by stakeholders have been addressed in this Final Report.

1.1 Terms of Reference

The Terms of Reference (TOR) for the DORC valuation required a number of discrete steps :

vi. Define the existing and expected traffic on the network sectors serving Category 1 and Category 2 Hunter Valley coal mines;

vii. Examine the relevant assets used in the RIC interim valuation, taking account of asset classes that have been determined to have zero value;

viii. Optimise these network assets;

ix. Derive replacement costs for the relevant assets in each of these optimised network sectors, noting that RIC actual costs should be scrutinised for efficiency; and

x. Adjust the optimised replacement costs to reflect accumulated depreciation.

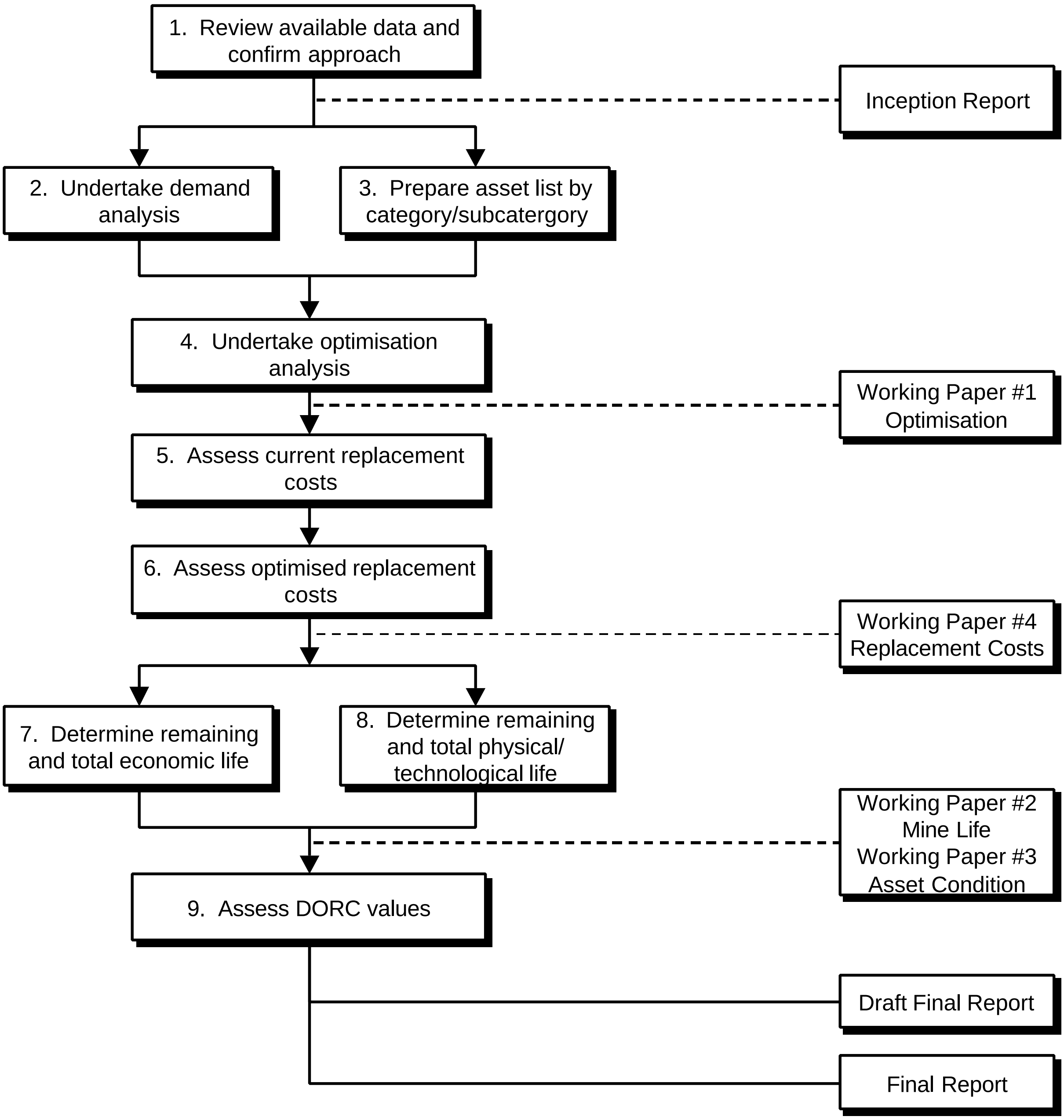
The output from the study is to be a DORC value by asset class by line sector as at 1st July 1999, which can be input to the RIC pricing models and used to evaluate access prices against the ceiling test in the regime.

1 Aspects of the NSW Rail Access Regime, Final Report, Independent Pricing and Regulatory Tribunal, 28 April 1999

1.2 Approach to the DORC valuation

The approach to the study is illustrated in Figure 1.1 below. Various working papers were produced and circulated to stakeholders in advance of the Final Report.

Figure 1.1 Study Approach



As far as possible, comments from stakeholders and their advisers on the working papers and the Draft Final Report have been addressed in this Report. Comments have been received from the following stakeholders:

- Rail Infrastructure Corporation (RIC);
- Hunter Rail Access Task Force (HRATF);
- FreightCorp; and

- Ulan Coal Mines.

1.3 Structure of the Report

Chapter 2 summarises the approach and results of the DORC valuation. The remainder of the Report is structured to reflect the key work steps in the assignment. There are six further chapters:

– Chapter 2 Establishing the DORC value
– Chapter 3 Existing and expected rail network requirements
– Chapter 4 Optimised stand alone rail network
– Chapter 5 Replacement costs
– Chapter 6 Condition Assessment
– Chapter 7 Final DORC values

Details from the working papers are included in the appendices as follows:

A. Coal Demand And Supply
B. Annual Tonnage By Coalfield
C. Tonnage And Train Flow Diagrams
D. Optimised Network Asset Listing, Excluding Bridges
E. Optimised Network Bridge Listing
F. Costs By Asset Type
G. Mine Life Analysis

2.0 ESTABLISHING THE DORC VALUE

2.1 Introduction

The task is to establish the DORC value as at 1st July 1999 of the infrastructure required to meet the requirements of Category 1 and Category 2 coal mines in the Hunter Valley, measured on a stand-alone basis. Only the 'optimised' network is to be valued, that is, the rail infrastructure required to meet the current and future needs of coal users. Any over-design, over capacity or redundancy in the existing network is excluded from the valuation.

A key issue is the initial discount to be applied to the optimised replacement cost (ORC) to arrive at the DORC. While acknowledging that some judgment will be required, the TOR identified a number of alternative methods which were to be taken into account in establishing a reasonable starting value for depreciation. The methods identified were:

- An estimate of actual depreciation by reconstructing estimates of capital expenditure, maintenance expenditure and depreciation charges to date using RIC records;
- An estimate of the average coal mine life exhausted to date as a proportion of the total average coal mine life; and
- An estimate of a proxy for depreciation using an asset condition approach as used by RIC for the interim DORC.

This Section addresses a range of alternative approaches to establishing the initial discount on ORC to arrive at DORC, including those raised by stakeholders in commenting on the Draft Report.

2.2 Asset condition approach

Using the existing asset condition to determine the initial discount from ORC has some intuitive appeal, i.e. using the estimated cost of restoring the track to new condition as a proxy for accumulated depreciation.

Given the cyclic nature of rail renewals, it could be expected that on average the infrastructure would be approximately 50% life expired across a reasonably sized rail network, notwithstanding that the condition of individual sectors and assets will fall anywhere within the range of new to life expired. With a reasonable MPM program, the condition is likely to remain relatively constant over time. In the case of railway infrastructure assets in the Hunter Valley, the physical lives of many of the component parts are likely to be much less than the overall economic life of the Hunter Valley coal business (hence the need for substantial ongoing MPM).

The hypothesis which underpins the asset condition approach is outlined below. Conceptually, the **average** asset condition profile across the Hunter Valley rail network is likely to follow the form illustrated in Figure 2.1. After the initial investment there is a maintenance and renewal 'holiday' as the asset condition declines to a steady-state, consistent with the desired level of service performance and an efficient renewal programme (which minimises peaks in renewal activity). Towards the end of the economic life of the network, the asset condition is allowed to decline towards the end of its economic life.

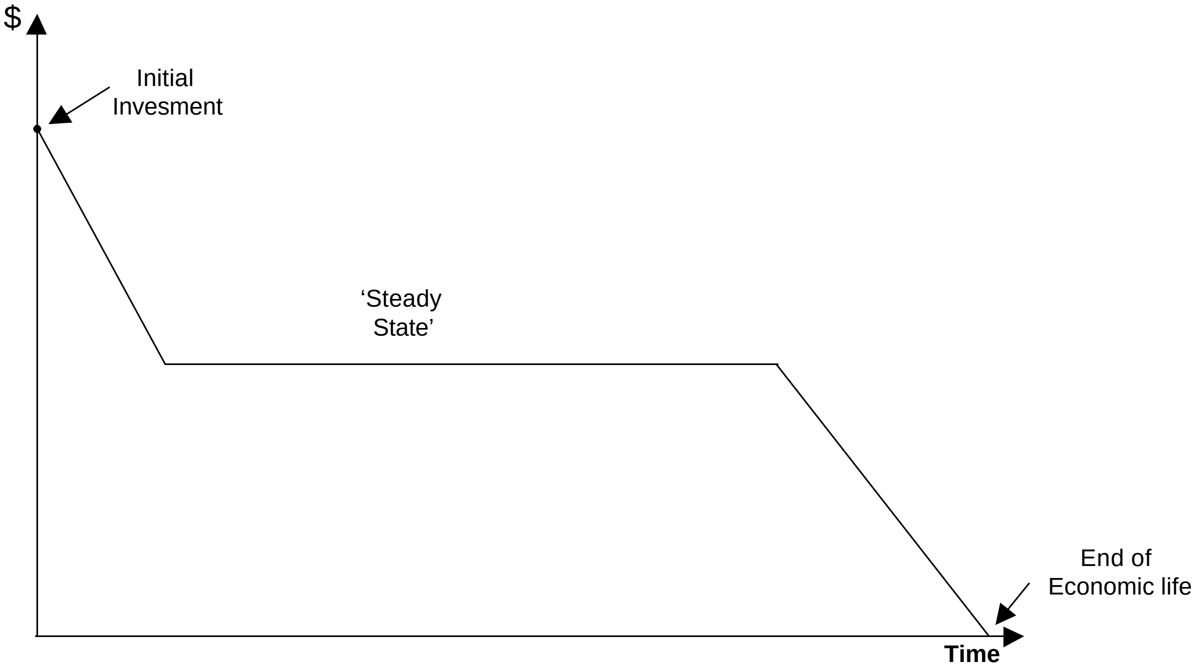


Figure 2.1 'Average' asset condition profile

To maintain the steady state condition, maintenance and renewal (MPM) expenditure is undertaken as illustrated in Figure 2.2. Routine maintenance and MPM expenditure is expensed in line with an earlier IPART determination.

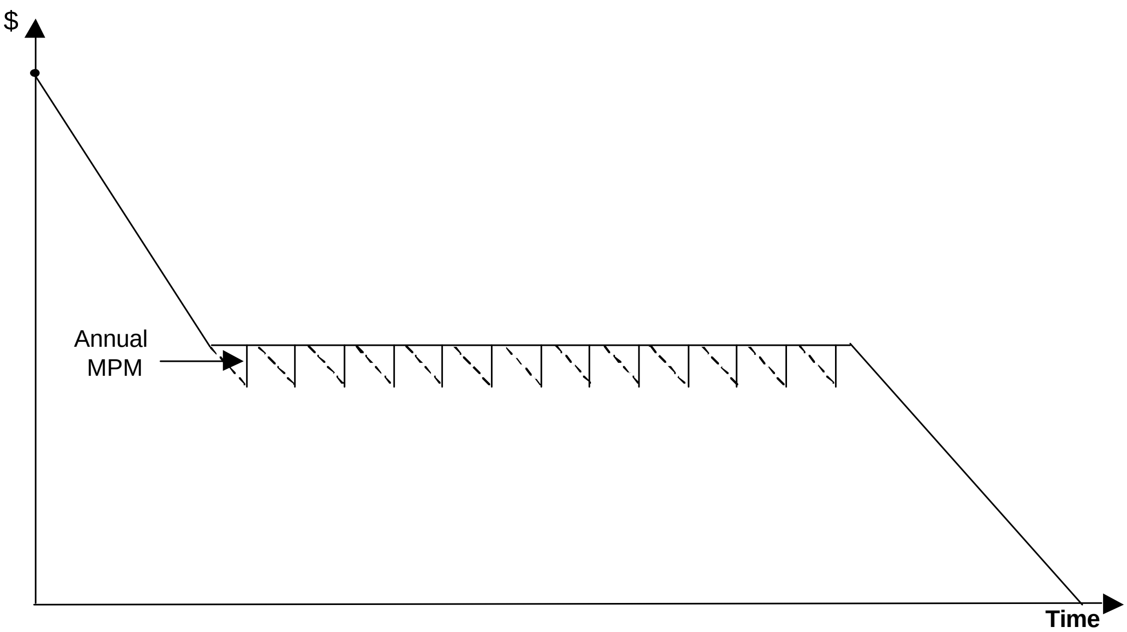


Figure 2.2 'Average' asset condition profile with MPM

It is accepted that revenues from customers should include a return of capital to the investor and a return on capital based on the market value of the assets (or as a proxy, the value of investment still outstanding). In the Hunter Valley we are likely to be at some point on the steady state line as depicted by point C in Figure 2.3, i.e. we have been investing MPM continuously for some time and looking forward expect to do so for some time yet.

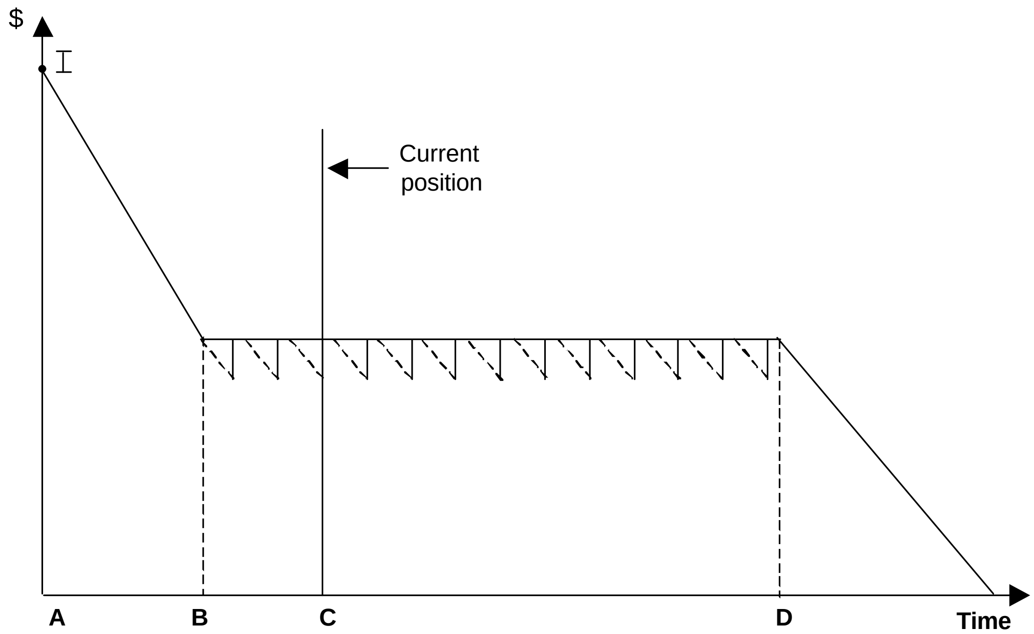


Figure 2.3 Current position within the steady state period

In a normalised environment (i.e. assuming we priced appropriately in the past), the decline in the value of the asset over the period A to B would have been returned to the investor through depreciation charges (absent any MPM charges as the asset condition declines). From point B onwards, no further depreciation is charged but MPM is expensed to ensure the asset condition remains at the steady-state level. At point C, the amount of capital outstanding is the initial investment (I) less the capital returned to the customer over the period A-B. This amount is adopted as the starting value for depreciation.

Criticisms of this approach

RIC have argued that asset condition and depreciation are different concepts and relying solely on asset condition to proxy asset life consumed does not give adequate consideration to the finite economic life of Hunter Valley coal mines. In particular, the asset condition approach implies a constant DORC value over the 'steady state' period which is inconsistent with the finite economic lives of Hunter Valley coal mines.

The Minerals Council argues that the asset condition approach understates the discount to be applied in estimating a DORC from ORC given the contribution made to present condition by MPM which was funded by the customer rather than the track owner. The Council argues that asset condition would provide an extreme upper limit to depreciation that has been charged[2].

RIC also argues that the asset condition approach is extremely subjective involving engineering interpretation of raw data and the use of multiple assumptions for each asset category. Because of the subjectivity, RIC has suggested that asset condition should be only one of a number of reference factors used to determine asset value[3].

2.3 Mine life approach

Using mine life consumed as a proportion of total mine life to determine the initial discount has some appeal in that it attempts to mirror the economic life cycle of the Hunter Valley coal network. The mine life approach is generally consistent with the asset condition approach in that it assesses accumulated depreciation based on the value of the initial investment outstanding (i.e. not yet returned in depreciation charges[4]) but with a different hypothesis regarding the depreciation curve.

The argument in support of this approach is that the **initial** investment should be returned over the period in which 'the asset' generates economic benefits. This period is related to mine life. In further support of this approach, RIC suggests that this approach was accepted by stakeholders in the earlier IPART process which addressed various aspects of the access regime.

A key issue with the mine life approach is the appropriate commencement date to apply. IPART has suggested average age of coal mines whereas RIC have argued that 1984/85 is a more reasonable commencement date assumption as it reflects the year closest to the formation of the optimised Hunter Valley coal network. Yet it is clear that the Hunter Valley coal network was hauling significant tonnages prior to that date. Adopting the average mine age would give a start date of around 1974[5].

The apropriate end date is also subject to uncertainty. In its previous determination, IPART adopted 40 years (from 1999) as representing the remaining economic life of coal mining in the Hunter Valley. The analysis of mine life for this assignment[6] gave a remaining economic life of 33 years (also from 1999).

It has been suggested that the 'older' IPART estimate of mine life (i.e. 40 years) would be the best proxy for use in assessing accumulated depreciation rather than the updated Booz·Allen estimate. This is on the basis that "revising mine life, given better information, is likely to be inconsistent with what would have been done in

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2 *NSW Minerals Council, "Submission to Booz·Allen & Hamilton on Stakeholder Submissions on Draft Report on Valuation of Certain Assets of Rail Access Corporation" p11.*

3 RIC, "Submission to IPART on the Booz·Allen & Hamilton Draft Report: Valuation of Certain Assets of the Rail Access Corporation", 17 January 2001 p12.

4 *Hypothetical rather than actual depreciation charges.*

5 *See Working Paper 2; based on the average age of mines operating in 1999 which has been assessed at 25 years.*

6 *See Appendix G.*

the past, and is likely to result in RIC under-recovering its (return of) capital"[7]. The suggestion is that past depreciation policies were set according to the old estimate of mine life, but this is clearly not the case. It is therefore difficult to accept the proposition that using a different mine life is likely to lead to under-recovery of capital.

On the same point, it is further argued that the instruction (to Booz·Allen) to estimate accumulated depreciation based on mine life "should have stipulated the need to be consistent with the end date for ongoing (mine life) depreciation specified in the Regime…[and]… the potential use of inconsistent mine life end points is unreasonable"[8]. It is not clear why there needs to be consistency between the mine lives. Not to use the best information available to estimate starting depreciation would seem more unreasonable. If mine life used to establish on-going depreciation in the Regime is then inconsistent with the most recent estimate of mine life, this is a matter to be taken into account at the next regulatory review (when on-going depreciation may be adjusted).

Figure 2.4 illustrates the depreciation curves which are derived using starting dates of 1974 and 1984 and remaining lives of 33 years and 40 years.

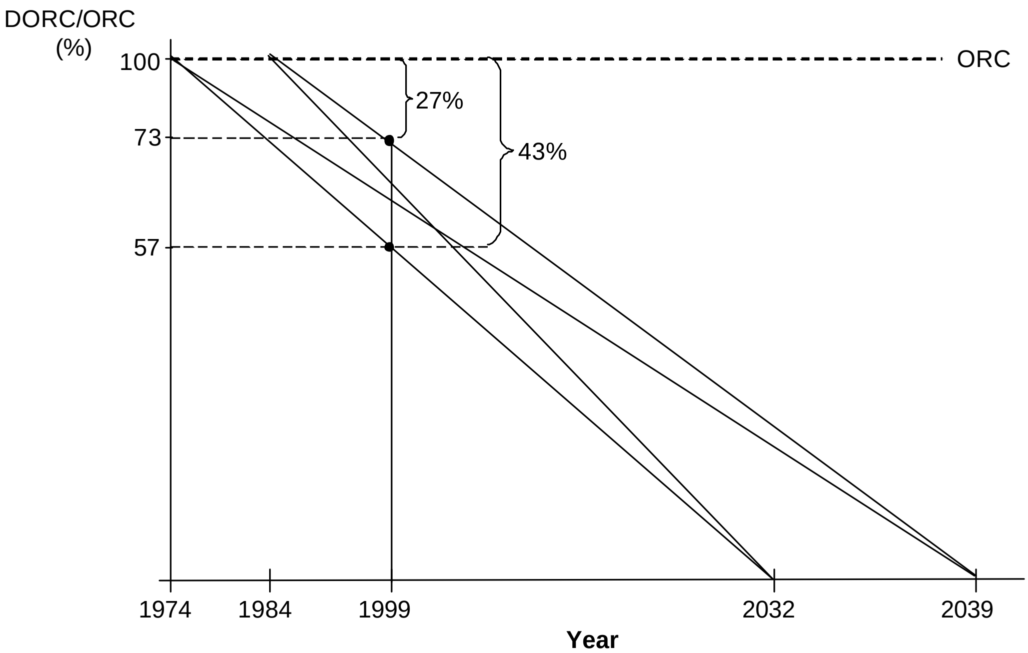

Figure 2.4 Straight line depreciation on mine life

The principal advantage of the mine life approach is that it is independent of the current asset condition and reflects a reasonable hypothesis that the value of the initial investment in rail infrastructure for coal is being recovered over the economic life of the investment as determined by the lives of the relevant coal mines.

7 *NERA, "Derivation of Accumulated Depreciation", Memo to Ross Farmer, 14 February 2001.*

8 *PriceWaterhouseCoopers, "Approaches to Estimating Accumulated Depreciation in Rail", Letter to Ross Farmer, 13 February 2001.*

Criticisms of this approach

The Minerals Council are strongly opposed to the use of mine life to derive the initial discount on ORC. They argue that the approach is inappropriate because:

- "It totally ignores past depreciation that has actually been charged.
- It totally ignores the condition of the track, and any future expenditure that may be required to maintain existing capacity.
- It would treat equally a railway (or line sector) which is totally unfit for purpose and requires to be completely rebuilt and another railway (or line sector) which has just been rebuilt, renovated or upgraded. In the first case, the real DORC would be zero while in the second case the DORC would equal the ORC, yet this method does not distinguish between the two. In this way it could penalise some users and advantage others under combinatorial pricing by artificially assuming all sectors are in equal condition.
- It totally ignores the role of renewals expenditure and MPM that has been fully funded by users through being expensed, and which therefore should not be expensed"[9].

Further, the Council points to the inaccuracies which could arise from considering only currently operating mines in a life of mine analysis and, in response to RIC's criticism of the subjectivity involved in adopting an asset condition approach, argues that the subjectivity of adopting mine life is greater. FreightCorp is in broad agreement with the views of the Minerals Council and does not support the use of mine life to determine the initial discount.

There is nothing intrinsically wrong with the mine life approach. The primary issue in its application to this DORC valuation surrounds its applicability to servicing a 'network' of mines, some of which are no longer in production, and some of which are yet to commence production. The uncertainty surrounding appropriate start and end dates creates a wide range of possible outcomes depending on the assumptions adopted.

2.4 Net Present Value approach

RIC has raised the merits of the so-called 'Agility approach' which hypothecates an alternative depreciation path with relatively little depreciation early on in the life of the asset and relatively high depreciation charges towards the end of the asset life[10]. The approach is premised on an asset earning a constant income stream over its remaining life. Probably the best analogy for this approach is a home mortgage. A lender repays principal and interest over the life of the mortgage in a stream of constant payments. Initially, each payment is mostly interest but towards the end of the mortgage period, each payment becomes mostly principal.

9 *NSW Minerals Council, op-cit, p9.*

10 *As reflected in the depreciation curve on p8 of the RIC submission.*

Similar results are generated by using an annuity approach to calculate capital charges based on the replacement cost of the asset, its economic life and a real interest rate. This is the approach used to value capital assets in the West Australian rail access regime. As the economic life increases, the amount of depreciation in each payment reduces. Therefore for long-lived assets, the approach will generate constant payments which are very close to the product of the replacement cost and the interest rate (albeit using a **real** interest rate). The advantages of this approach are that it provides sufficient revenue over the life of the asset to fully fund replacement when it falls due and secondly it takes the subjectivity out of establishing the initial discount to apply to ORC. In the NSW context, however, it is difficult to see how using an annuity approach and expensing MPM can co-exist without double-counting. Furthermore, in establishing DORC as the preferred asset valuation methodology, IPART effectively discounted using an annuity approach.

Sticking with the DORC approach, an alternative NPV-based method of establishing depreciation might be to consider that in a second hand market, the value of an asset with 'n' years life remaining is the difference between replacing it today and the present value of delaying the replacement cost expenditure for 'n' years. Take for example an asset with a replacement cost of $1000. The choice is to pay the replacement cost now (i.e. $1000) or purchase a second hand asset and delay the replacement cost for 5 years. The present value of $1000 in 5 years time is $681 (@8%), implying that someone should be prepared to pay up to $329 for the second-hand asset. If the asset had 10 years life remaining, the maximum value would be $537 and with 20 years life remaining it would be $785.

While this approach has some intuitive merit, there are issues to consider related to how the economic life of the assets influences value and how higher maintenance costs and obsolescence likewise influence value. Figure 2.5 illustrates the implied depreciation curve of an asset with a 20 year life.

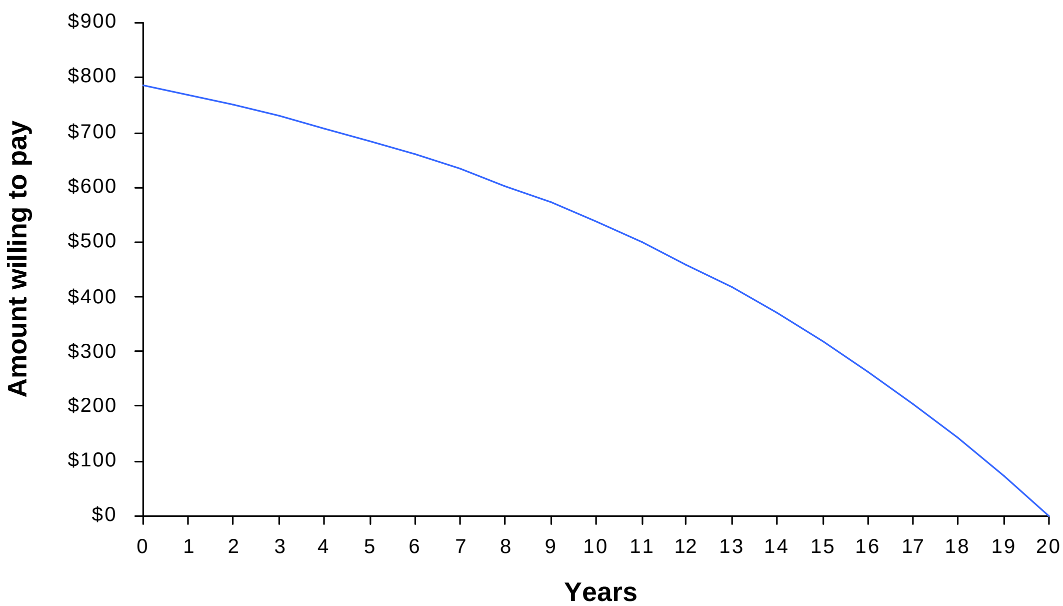

Figure 2.5 Depreciation based on the alternative NPV approach (20 year life)

If a buyer is willing to pay $785 for an asset which will delay the need for spending $1000 for 20 years (@8%) but the asset life is only 20 years (i.e. it is a new asset), then there is a disconnect between the time value of money approach (realising $785) and the replacement value of the asset ($1000). Take for example an asset which costs $1000 and lasts 11 years. Its value after 1 year would equal the value of delaying expenditure of $1000 for 10 years (i.e. $537). It is difficult to reconcile the economic value of an asset (which is a function of its cost and service/economic potential) with the simple notion of the time value of money and it might only be coincidental that the latter generates a reasonable proxy of the former.

A related approach is to assess the second-hand value of RIC's coal infrastructure as the optimised replacement cost of the assets less the difference between the future MPM expense of operating existing assets compared to new assets, in NPV terms, over the remaining economic life of the assets (as determined by mine life)[11]. This is essentially a by-pass argument based on the premise that rather than build an alternative railway, an investor would be willing to pay up to the cost of the new railway adjusted for the benefit of the MPM holiday which would be enjoyed if new infrastructure was constructed.

Criticisms of this approach

The Minerals Council argue that the assumptions needed for application of the Agility approach are so restrictive as to make it totally inapplicable to this application[12]. RIC acknowledge the short-comings of the approach in this context but argue the value that it brings to the DORC debate is that "it focuses on the impact of the inappropriate use of the straight-line depreciation method. Clearly, for the DORC methodology to replicate investment value, the depreciation calculation should recognise the profile of depreciation inherent in changes to investment value over time, otherwise the DORC asset value will seriously underestimate investment value"[13].

While in a competitive market the value of assets is typically based on 'forward looking' estimates of potential income discounted to a present value, it is not clear that, in establishing the initial discount from ORC to DORC, a 'forward looking' NPV-based method should be preferred. The example outlined above illustrates the practical difficulty in relying on just the time value of money to determine the depreciation curve. Alternative by pass interpretations of second-hand value similarly require a restrictive set of assumptions and might only coincidentally deliver a reasonable estimate of starting depreciation.

11 *NERA, op-cit,p6.*

12 *Minerals Council, op-cit, p6.*

13 *RIC, op-cit, p11.*

2.5 Actual cost approach

In competitive markets there is a strong correlation between cost and price. In the case of the Hunter Valley rail system, it is evident that historically coal freight rates were set well above the cost of supply and the existence of monopoly rents in rail freight rates has been acknowledged by Government.

The Minerals Council[14] argue that the initial discount on ORC (or accumulated depreciation) should be established by measuring the capital already returned to the track owner. The capital already returned to the track owner will include actual depreciation charged (ideally measured by accounting records) and monopoly rents (which the Council argues can only have been return of capital[15]).

The Council suggests that consideration should be given to estimating actual depreciation by reconstructing estimates of capital expenditure, maintenance expenditure and depreciation by reference to current asset condition and that current asset condition will indicate an extreme upper limit to depreciation that has been charged[16]. The Council argues that the value based on current condition needs to be reduced to account for MPM charges and past charges which exceeded full costs.

Criticisms of this approach

Given the lack of accurate historical records, it is impossible to establish with any certainty what depreciation has been included in coal freight rates and access prices to date, notwithstanding general accounting policies of the RIC and the SRA before it. There has been no direct link between cost and price in the past and so actual depreciation charged, in an accounting sense, has little actual relevance.

In providing an independent assessment of DORC, it is not the role of Booz·Allen to correct past injustices and take account of previous overcharging in setting the current asset value. Past monopoly rents are therefore not considered relevant to this DORC determination.

2.6 Discussion

Because there has been no direct link between cost and price in the past, there is a need to draw a line in the sand and hypothecate a depreciation regime which is consistent with a competitive market (if one existed) as a means of establishing an appropriate starting value for DORC in this new regulated environment.

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14 *Minerals Council, op-cit.*

15 *Letter from Dennis Porter 2nd February 2001 "Comments on RIC Submission on Draft Report"p2.*

16 *Minerals Council, op-cit, p11 The Council sites RIC published policy to depreciate tRICk and infrastructure on a straight line basis based on an economic life of 30 years.*

It has been argued that there needs to be consistency between the accumulated depreciation and on-going depreciation methods, otherwise "the asset base will potentially become dysfunctional…For the DORC value to fulfil its purpose of accurately replicating investment value over the long term then it is crucial to calculate ongoing and accumulated depreciation via consistent and compatible methods"[17]. On the basis that IPART has already determined the on-going depreciation method as being based on mine life, then this requires accumulated depreciation to also be based on mine life. The ACCC's views in relation to the regulation of transmission revenues have been quoted in further support of this position[18].

We do not accept this view as being relevant to the task of establishing an initial DORC value. For new assets being acquired under an existing regulatory regime there would need to be consistency between the DORC and on-going depreciation, but for sunk assets being migrated to a new regulatory environment, we do not believe there is a need for a consistent approach nor is a consistent approach necessarily desirable. Indeed, IPART has acknowledged the potential for alternative methods to be applied to accumulated depreciation by nominating various alternatives to be taken into account.

RIC states that "the theory and economic basis of a DORC valuation is to estimate the investment value of infrastructure and hence replicate the price that a new entrant would pay for a particular second hand asset"[19]. On this basis, RIC argue that a DORC value tied to the future economic benefits from rail infrastructure in the Hunter Valley (i.e. mine life) is justified.

It is important to note, however, that the DORC value is to replicate the price that a new entrant would pay for a particular second hand asset **in a competitive market** for those assets, assuming one existed. In such a case, it could be argued that the physical life of the asset, to the extent it is less than economic life, would be a key driver of 'second hand' value. For instance, consider the value of track which was life expired and needed to be replaced next year versus track which was brand new. Irrespective of the remaining mine life, in a second hand market, the value of the track would be different in each case reflecting the different service potential of the assets. The fact that the forward looking economic value of the infrastructure assets (based on remaining mine life) might be significant may justify reinvestment but does not necessarily impact on the 'second hand' value of the individual assets employed.

RIC suggests that "the design or economic lives of assets depend on and will vary based on the existence and degree of an appropriate program that is integral to

17 *PriceWaterhouseCoopers, op-cit, p3.*

18 *ACCC, "Draft Statement of Pricing for the Regulation of Transmission Revenus", 27 May 1999 pp46-48 quoted in KPMG Consulting, "Advice on Estimating Accumulated Depreciation", letter to Mr Ross Farmer, 16 February 2001.*

19 *RIC, op-cit, p10.*

maintaining the asset in a fit for purpose state"[20]. In this context, we are assuming economic life refers to the period within which an asset retains its ability to perform adequately at an acceptable economic cost. Clearly this period can be extended with MPM and it is also clear that if the asset was sold with future MPM included (akin to an extended warranty) it would be worth more than the same asset sold without MPM. Given in the Hunter Valley context the industry is directly funding MPM, it would not be appropriate to value the assets taking account of their potential extended life as if MPM were included.

Consider two sets of assets - one where the necessary MPM expenditure has not been spent and the asset condition has been allowed to deteriorate to a very poor standard and the other where MPM has been spent and the asset remains in good order. The former requires considerable catch-up MPM in the near future to ensure the assets remain fit for purpose. Other things being equal, it is difficult to argue that the assets in the better condition are not worth more. They require less expenditure in the near term to maintain serviceability, yet a valuation approach based on mine life would prescribe the same starting value.

A counter argument might be that because the customer pays directly for maintenance and MPM under the NSW Rail Access Regime, the track owner is likely to be indifferent between the two sets of assets in terms of value. The net revenue return after MPM and maintenance would be the same. For the customer, the additional expenditure on MPM to be funded in the future might be considered a transfer of expenditure not spent (or funded) previously. This might be a reasonable approach if customer charges had been less in the past because of the low MPM. If instead charges were the same and the surplus was returned to Treasury as dividends, then the argument that present condition should be irrelevant when establishing starting depreciation is much harder to accept.

The economic value of the Hunter Valley rail infrastructure assets is influenced by both the future service potential of the assets (i.e. their remaining physical life) and the future earnings potential of the assets. Indeed, it is the lesser of the two which ultimately drives the value[21]. Because of the strong demand in the Hunter and the expectation that continuing MPM will be required to renew the service potential of the assets, we have adopted the view that it is the asset condition (remaining asset life) which should drive value. This approach would take no account of the 'strategic ownership value' of the monopoly Hunter Valley rail infrastructure but in this regulatory process, that is appropriate.

It has been suggested that a condition-based approach to estimating accumulated depreciation is flawed because it "assumes that the rail assets can be separated into uniquely identifiable components that have value independently of other

[20] *RIC, op-cit, p38.*

[21] *RAC, on the other hand, argue that the future service potential (or physical life) of the assets and their future earnings potential are aligned and equate to mine life. This position is not supported because it internalises the impact of future MPM (funded by industry) into the present asset value.*

components and are wholly disposed of and replaced on a cyclic basis"[22]. This is not the case. The point is that average condition (expressed as the proportion of life remaining) across all the major components is being used to proxy accumulated depreciation of the asset as a whole. The approach does not rely on components having value independently of other components.

The hypothesis supporting an asset condition approach outlined in Section 2.2 implies a constant DORC value through the 'steady state' period. RIC suggests that this is a misinterpretation of DORC and that the value must be declining as time progresses towards the end of mine life[23]. We do not necessarily agree with this assessment. The issue is the extent to which the end of mine life begins to influence the earnings potential of the assets. For instance, if an asset has an economic life of 10 years, the issue is the extent to which its earnings potential over the next 10 years will be impacted, if at all. If mine life lasts beyond the next 20, 30 or 100 years it should have no impact on value. In practice, mine life continues to be extended with a strong likelihood that existing mines will be replaced by new mines not yet in production. If Port Waratah Coal Services is investing in excess of $300 million for expansion, it is a clear signal of robust coal volumes expected for quite some years to come.

A key issue is whether the Hunter Valley network can be considered a single asset with a life spanning the economic life of coal mining in the Hunter Valley or alternatively as a collection of individual assets which are constantly renewed, with future economic life of coal mining in the Hunter Valley only influencing the view that the first approach is appropriate while investment decisions rather than the value of assets today. RIC is strongly of the view that the first approach is appropriate while we would suggest that the latter approach better represents the price a new entrant would pay for a particular second hand asset in a competitive market. The former potentially includes the 'strategic monopoly value' of the assets which would be inappropriate for the DORC valuation.

It is acknowledged that there is no one correct answer to this issue and the mine life analysis does add some value to the process, if only to confirm that the final value is within a reasonable range.

A number of initial discounts, measured using alternative approaches, are presented in Table 2.1.

22 *KPMG Consulting, op-cit,p3.*

23 *RIC, op-cit, p12.*

Table 2.1 Initial discount to move from ORC to DORC

Approach	Initial discount (%)
Asset condition	44
Mine Life – RAC assessment 1984 start; 2039 end	27
Mine Life – BAH assessment 1974 start; 2032 endt	43
Actual Depreciation[1]	>100%

Note 1. Minerals Council Analysis, Minerals Council op-cit, pp11-13

On balance, we believe using asset condition as the basis for establishing the starting value is a reasonable approach. It essentially assumes that depreciation was charged in line with the 'average' decline in asset condition since the network was newly constructed and that no further depreciation was charged since the steady-state condition of the network was reached (i.e. all MPM has been expensed in line with current practice).

The Minerals Council has argued that "the effect of the expensed MPM in improving or maintaining asset condition should be taken into account in determining past depreciation based on asset condition[24] and that some further justification to depreciation is required. This is not the case and misses the central point that the DORC valuation is a proxy for the likely value of the assets in a competitive second-hand market. The valuation is forward looking (i.e. driven by remaining service potential) and past sources of funding are not directly relevant here (even if they could be accurately determined). Use of a condition-based approach to depreciation does not automatically imply doubly counting of MPM and no further adjustment to condition-based depreciation is therefore necessary or justified.

RIC have argued for a reference point approach with the results from a range of alternative methods used to determine a balanced outcome. While we could support this approach in principle, we do not believe any of the alternative methods deserve equal weighting with the condition-based approach. The mine life approach, which was strongly criticised by the Minerals Council and FreightCorp, is highly sensitive to the assumptions employed, although somewhat coincidentally, Booz·Allen's assessment of mine life delivers much the same result as the condition approach. The actual depreciation approach promoted by the Minerals Council is flawed given the paucity of historical information and absence of any historical nexus between cost and price.

It is acknowledged that the asset condition approach itself involves considerable subjectivity and engineering judgment. While as objective and robust as possible, the assessment of current condition was based on limited information and is subject to error. In our view, actual condition (measured as percentage of asset life expired)

24 *Minerals Council, "Submission to Booz·Allen on Revised Draft Final Report on Valuation of Certain Assets of the Rail Access Corporation", February 2001.*

could reasonably lie anywhere in the range of 40 to 50%. Our assessment of 44.3% reflects our best judgment based on the information available.

It can be argued that the DORC valuation should not be undertaken in isolation from the other factors affecting access prices in the Regime, such as on-going depreciation and WACC, and to the extent that previous decisions have put a 'stake in the ground' on these other factors, then this needed to be reflected in the DORC approach. We do not hold to this view as far as this initial DORC is concerned but acknowledge the need for internal consistency within the Regime going forward. For example, the need for consistency between the on-going depreciation method and DORC valuation methodology is accepted for future investment but not necessarily for this initial assessment as discussed above. Similarly, there will need to be consistency between the risk assessment embodied within the regulated WACC and the actual risk environment for the infrastructure owner, having regard to the potential for asset stranding, technical obsolescence and related issues. Consequently, in the regulatory review in 5 years time, it would be inappropriate to simply reassess accumulated depreciation based on asset condition. Charges will have reflected on-going depreciation based on mine life. Similarly, there might be double counting if RIC expends MPM to improve asset condition and the industry funds both the MPM and a higher return on invested capital (brought about by the improved asset condition). This initial assessment will provide a 'line in the sand' as far as future DORC assessments are concerned.

2.7 Implications for depreciation

If the asset condition-based logic is adopted, it has some implications for on-going depreciation charges, although IPART has already made a determination in relation to this issue.

At some point in the future, the maintenance and renewal regime will change to ensure the condition and value of the infrastructure declines towards zero at the end of the economic life of the network (i.e. when we run out of coal). At this point MPM and maintenance expenses could be replaced with a depreciation charge (in practice MPM and maintenance will not decline immediately to zero). The adjustment to condition and hence the construct of maintenance, MPM and depreciation charges may change in advance of point D (in Figure 2.3), once the economic end point is known with greater certainty than at present, and may not decline to zero as other activity emerges as illustrated in Figure 2.6.

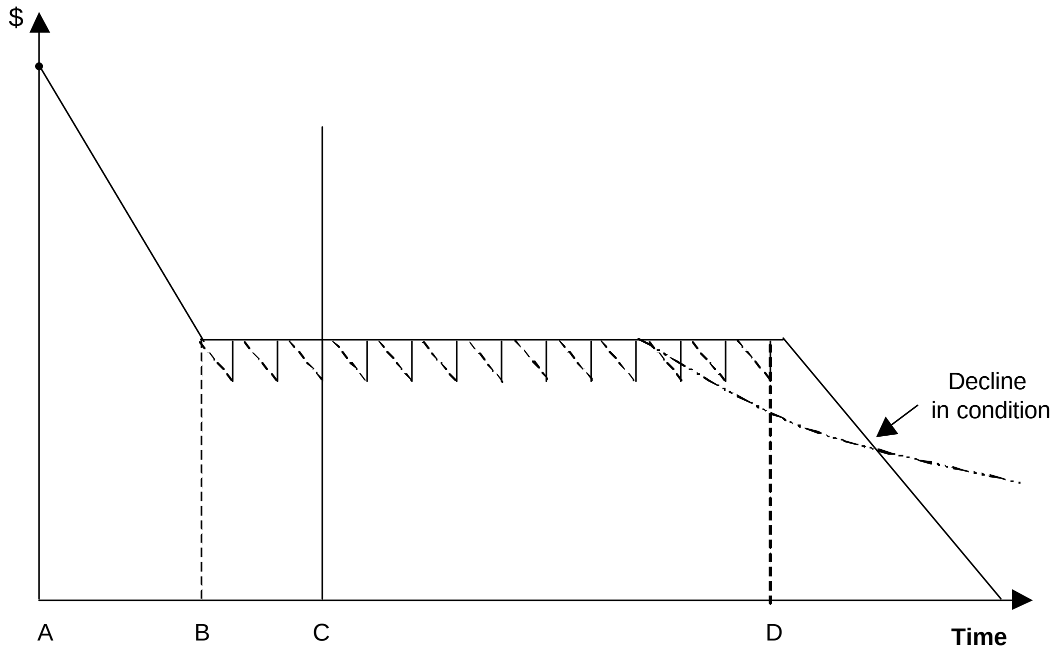

Figure 2.6. Adjustment of condition towards the end of the economic life

The key issue with the approach described in Section 2.2 is the potential *sterilisation* of future demand by having to raise charges to provide sufficient revenue to return the outstanding capital to investors towards the end of the economic life of the Hunter Valley coal network, notwithstanding the lower MPM, maintenance and return on capital.

The alternative is to follow the approach illustrated in Figure 2.7, which provides for an accelerated return of capital based on an estimate of remaining economic life. This is the approach adopted by IPART in the Regime. The depreciation profile would be updated periodically based on a reassessment of remaining economic life (e.g. point E). While this approach would ensure that capital was returned well in advance of the end of the economic life of the asset, it potentially over-recovers from current users to the benefit of future users, given the great uncertainty surrounding future coal volumes.

Which is the best approach is an empirical question. Intuitively it would make sense not to charge users depreciation at times when they are also paying to renew the asset at a steady-state condition. Depreciation should only be charged when the MPM and maintenance regime starts to adjust to reflect the end of the economic life drawing near. Yet the risk is that this might leave too much of the remaining capital value to be recovered from users towards the end of the economic life of the infrastructure at a time when volumes are probably in decline. The risk of obsolescence is also a material issue, particularly for signalling and communications assets.

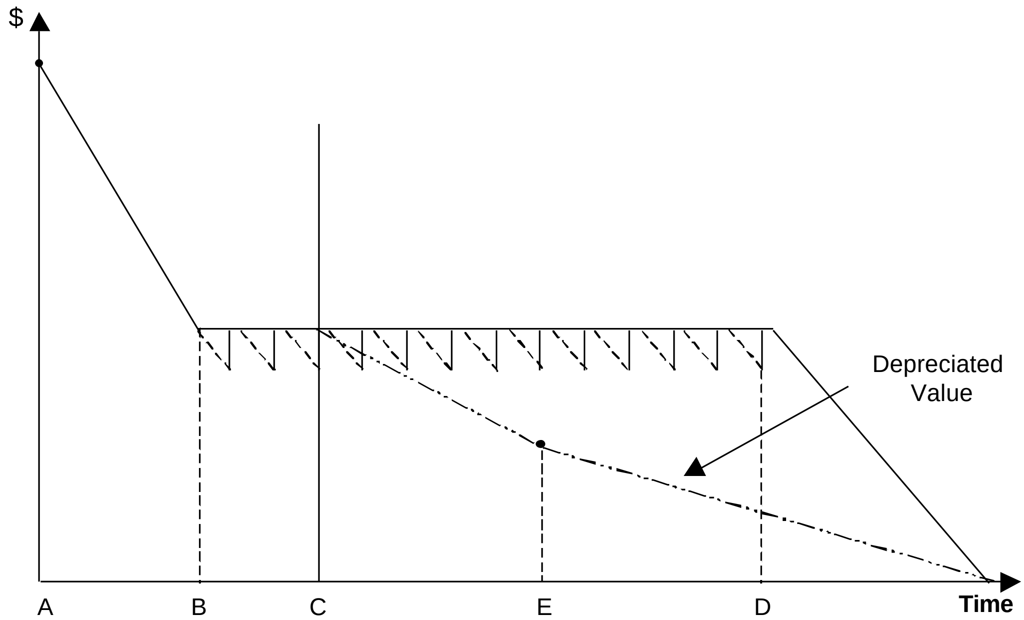

Figure 2.7 'Average' asset condition profile with MPM

If the approach of charging depreciation to current users illustrated in Figure 2.7 is adopted, it implies an average depreciation charge of approximately $10.4m per annum ($343m divided by 33 years[25]). Assuming an average MPM spend in the Hunter Valley of $15-20m per annum, gives a total charge of $25-30m per annum. The depreciation charge would rise to $17 million per annum if recovery was left to the final say 20 years of the economic life of the Hunter Valley coal network ($343m divided by 20). The issue then is how MPM and maintenance would change over the final 20 year period and whether in total the charge is likely to increase. It is unlikely that MPM could drop immediately to zero and it would be inevitable that maintenance costs would increase as asset life is extended beyond normal replacement cycles.

The risk of asset stranding and potential under-recovery by RIC needs to be balanced against the risk of over-recovery from existing users to the benefit of future users, given that existing customers are fully funding significant upgrading and renewal expenditure and future prospects for the Hunter Valley coal network remain strong.

While an extension of the logic supporting a condition based approach to the DORC might imply zero depreciation is appropriate going forward, there is no need for consistency between methods applied to accumulated depreciation and on-going depreciation in this particular case (as argued on page 13). IPART has already made a determination in relation to on-going depreciation supporting straight-line depreciation based on remaining mine life.

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[25] $343 being the DORC value from Table 7.1 divided by 33 years, being remaining mine life derived in Appendix G.

2.8 Implications For Capital Expenditure

The discussions with stakeholders did however raise a potential inconsistency in the original IPART determination in relation to the treatment of capital between regulatory reviews. If the initial DORC assessment includes infrastructure required to satisfy demand in 2004, then it is appropriate that capital expenditure not be added to the regulated asset base over the period 1999-2004, unless demand greatly exceeds initial expectations.

If instead 1999 demand was used as the basis for determining the optimised infrastructure, then capital expenditure should be added to the asset base as it is incurred. This may be a complicated process as both 'regulated' and 'unregulated' traffics may drive actual investment decisions on shared infrastructure.

This issue is discussed further in Section 4.2.

3.0 EXISTING AND EXPECTED RAIL NETWORK REQUIREMENTS

The first step in the valuation process was to examine existing and future rail network requirements with respect to the carriage of coal in the Hunter Valley. The curent and future network requirements over the period 1999-2004 drives the assessment of the optimised rail network. Only the rail task originating from Category 1 and Category 2 mines was to be considered[26].

3.1 Historical rail task

There are five coalfields that utilise the Hunter Valley rail network:
- Hunter Coalfield
- Gunnedah Basin Coalfield
- Newcastle Coalfield
- Western Coalfield (Ulan mine only)
- Gloucester Coalfield

These coalfields comprise a total of 35 existing mines and an additional 11 prospective mines. A detailed discussion of coal production, demand and prices relevant to the future demand for rail transport is presented in Appendix A.

In the period since 1991, the volume of coal produced in the study region has steadily increased. Figure 3.1 illustrates the total annual tonnages transported by rail for export for the five coalfields in the study region over the period 1991 to 1998. Annual tonnages broken down to coalfield level are provided in Appendix B.

The majority of coal produced for domestic purposes is transported by conveyor to local power stations. Until recently the exceptions were approximately 80,000 tonnes of domestic coal which was transported by rail from the Gloucester coalfields (Stratford loader) and 180,000 tonnes from the Newcastle coalfields (Newstan loader) to BHP in Newcastle. Both operations have now ceased, however approximately 800,000 tonnes of domestic coal is still transported by rail from the Western coalfields (Ulan loader) to the Eraring unloader in Newcastle.

In addition, new contracts allow for the annual transport of 1 Mtpa (Million tonnes per annum) of coal to Delta Electricity's Wyee unloader and up to 3.5 Mtpa of coal to Macquarie Generation's new Ravensworth unloader.

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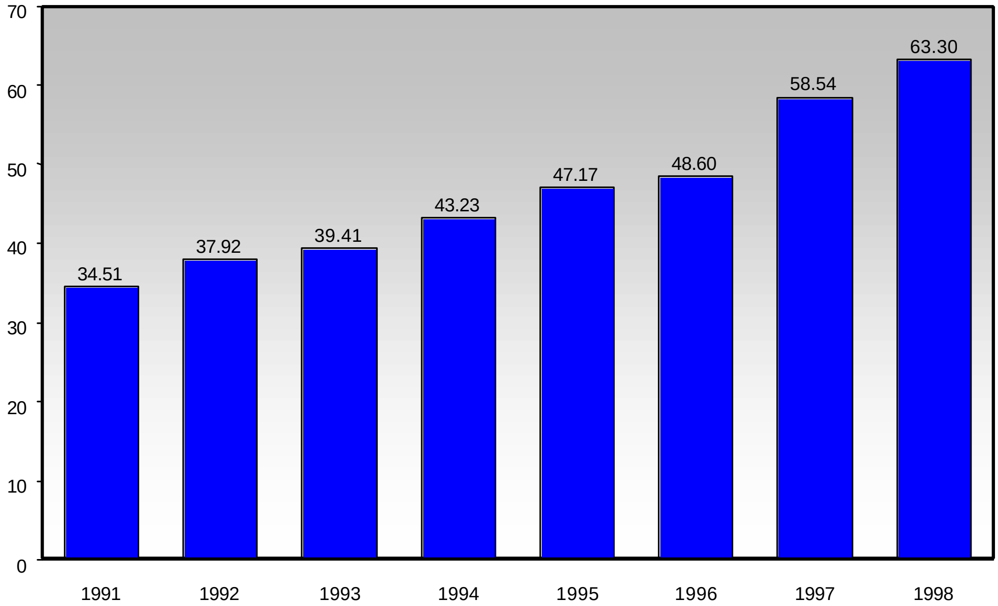
[26] Category 1 and 2 mines are described in Section 3.5 of IPART's *Aspects of the NSW Rail Access Regime: Final Report* (Review Report No. 99-4, 28 April 1999). Category 1 mines are those utilising the following loading points: Bloomfield, Branxton, Camberwell, Dartbrook, Drayton, Hunter Valley, Liddell, Mt Owen, Mt Thorley, Newdell, Pelton, Rix's Creek, Saxonvale and Bengalla. In addition, Ravensworth Coal Loader was later added as a Category 1 loading point. These mines "pay their train operator (or RIC) the ceiling test amount plus a declining 'adjustment component' (representing monopoly rent)". Category 2 mines are those where there is no payment of monopoly rent, but which "pay a positive rate of return which is less than the maximum rate". Category 2 mines are Ulan, Stratford, Newstan and Teralba.

Figure 3.1: Rail Export Coal Task for Total Study Region 1991-98 (Mtpa)



Source: AME Mineral Eonomics Pty Ltd, DMR and Booz·Allen & Hamilton analysis

3.2 Forecast Coal Tonnages[27]

Forecast tonnages to be moved across the Hunter Valley rail system over the five years to 2003-04 are dependent upon a wide variety of assumptions, including:

a) The level of foreign demand for coal from the region;
b) The level of domestic demand for coal from the region;
c) The shifting of production as particular mines become exhausted and / or new mines open up;
d) The nature of supply side constraints (if any) as they relate to the transport infrastructure (particularly rail and port); and
e) Any changes in rail's modal share of the coal transport task, either for reasons related to those above or otherwise.

As a consequence, forecasts can vary widely depending on the assumptions made. For this analysis we have relied heavily on independent forecasts from a number of different sources, namely:

i) AME Mineral Economics Pty Ltd (AME);
ii) The NSW Department of Mineral Resources (DMR); and
iii) The Australian Bureau of Agricultural and Resource Economics (ABARE).

Forecasts from the RIC have also been considered.

[27] The discussion in this section is focused around the broad issues of comparability of data sources and future developments in the Northern Coalfields. As such, these forecasts incorporate assumptions by the various sources about the likely opening of new mines and some Category 3 mine data. Final forecasts relevant to this study *exclude* Category 3 mines and new mine proposals (unless these are subject to firm undertakings). The final forecasts in Section 2.3 are therefore generally lower than those discussed in this section.

AME forecasts for mine production (by individual mine) are available for the years leading up to 2004 (inclusive) and for 2009. The forecasts seek to reflect industry opinion and to effectively "factor in" industry assumptions about the impact of a), b) and c) above[28].

The AME data thus indicates what quantities of coal are predicted to be exported through Newcastle and what quantities are predicted to be utilised for domestic uses. Allowance is also made for the startup of new projects and mine closures.

Analysis of AME data suggests that some 83.3 Mtpa of coal will be flowing over the Hunter Valley rail system in 2003-04[29]. This compares with DMR estimates of 82.1 Mtpa in 2002-03 and 94.9 Mtpa in 2007-08[30]. These DMR projections are based on industry analysis and survey work which produced a "base case" mine production scenario and thus also included assumptions about the opening of new mines. The DMR figures do not include any allowance for usage of the rail system for domestic coal transport.

Broad ABARE projections for Australian coal exports over the next five years can be used as a consistency check on the accuracy of the above data. These projections reflect ABARE views on the international demand, supply and price issues discussed in Appendix A and can be taken to suggest that some 78.2 Mtpa of coal will be moving across the Northern Coalfields rail system to Newcastle for export in 2003-04[31].

Table 3.1 compares DMR and (derived) AME, ABARE and RIC forecasts for across the Hunter Valley rail system for export in 2002-03 and 2003-04. Actual data for 1997-98 are also reported. While domestic flows are expected to be small in comparison, recent developments in the market for domestic rail transport have added an additional level of complexity which will be discussed below.

28 Although the forecasts are in calendar years they have been converted to financial years for ease of comparability with other sources.

29 This estimate includes assumptions that several proposed mines will actually open.

30 DMR (1999) Strategic Study of the Northern NSW Coalfields.

31 Derivation of rail haulage task to Port Waratah Coal Services (PWCS) from ABARE and AME data (Mtpa).

	1997-98 (actual)	**2003-04 (forecast)**
Total Australian coal exports	162.6	201.0
NSW Nth. Coalfields share of Aust. Coal exports	=0.4*162.6=65.0	=0.4*201.0=80.4
Less - road transport to PWCS - Barge transport to PWCS	0.7 1.8	0 *2.2*
Equals rail transport of coal to PWCS	62.5	78.2

Table 3.1: Export coal rail haulage task

Source	1997-98 (actual)	2002-03 (forecast)	2003-04 (forecast)
Derived from AME*	60.8	78.1	82.4
DMR	61.4 (approx.)	82.1	na
Derived from ABARE	62.5	75.0	78.2
RIC**	61.6	75.9	80.9

** Excludes coal transported from Ulan to Eraring for domestic power generation and from Stratford and Newstan for BHP steelworks.*
*** Forecasts as at December 2000*

Taken together various the forecasts suggest that the export coal haulage task by rail will probably be in the range 78-83 Mtpa by 2003-04. As noted, however, this estimate includes assumptions that several planned mining operations will actually proceed.

Until recently the transport of coal by rail for domestic purposes was mainly limited to the transfer of coal from Ulan to the Pacific Power generating facility at Eraring and the transfer of coal from the Stratford and Newstan coal loaders to the BHP steelworks at Newcastle.

However, new developments will mean that this pattern is likely to alter over the next five years. Such developments include:

- Competition between Northern Coalfields producers has intensified, with local power producers demonstrating more flexibility in their choice of suppliers.

- The cessation of steel production at the BHP steelworks in Newcastle, resulting in the removal of some 0.2-0.3 Mtpa of coking coal from the local rail system.

- The construction of a coal unloading facility by Macquarie Generation at Ravensworth in November 1999. This will add up to 3.5 Mtpa to the system. Macquarie Generation have indicated that a typical contract for such coal may be only 1-2 months in duration and that coal could be sourced from virtually anywhere in the system.

- The signing of a contract between Delta Electricity and two Hunter coal producers for the delivery of 1 Mtpa of coal via rail to a refurbished Wyee unloader. The contract duration is for three years from July 2000.

- The likely continuation of delivery by rail from Ulan to Pacific Power's generation facility at Eraring of some 0.8-0.9 Mtpa until 2007.

- The (mandatory) cessation of coal deliveries by road from Bayswater mine to the Ravensworth coal loader by July 2001. This coal (and coal from nearby MtArthur North) is to be loaded with at a new Bayswater / Mt Arthur North coal loader and transported on a new spur line.

- An ongoing emphasis on the use of rail transport for coal haulage for both domestic and export purposes, associated with the gradual phasing out of the transport of coal by road.

AME projections allow only for the cessation of coal deliveries to Newcastle steelworks and continued delivery from Ulan to Eraring, while, as noted previously, DMR projections do not include usage of the rail system for domestic coal.

It is not within the scope of this Report to closely examine whether supply side transport constraints will become a major issue over the next few years. It should be noted, however, that current expansion work being carried out by Port Waratah Coal Services (PWCS) will increase notional coal export capacity at Newcastle to 89Mtpa by September 2001. This is above the current range of estimates for forecast exports in 2003-04.

3.3 Final Forecasts Relevant to the Study

In order to produce final forecasts for this study, AME data were combined with the domestic trends described above to produce an estimate of the Hunter Valley rail task for 1999-2000 to 2003-04. This estimate was then further refined so as to be consistent with the scope of the current study. These refinements involved:

- Exclusion of Category 3 mine production;

- Exclusion of *all* proposed new mines or associated coal loaders / transport infrastructure *unless* such work was the subject of explicit undertakings regarding the production and delivery of coal by an agreed date; and

- A small adjustment to allow for production at Newstan mine (not normally part of AME's database).

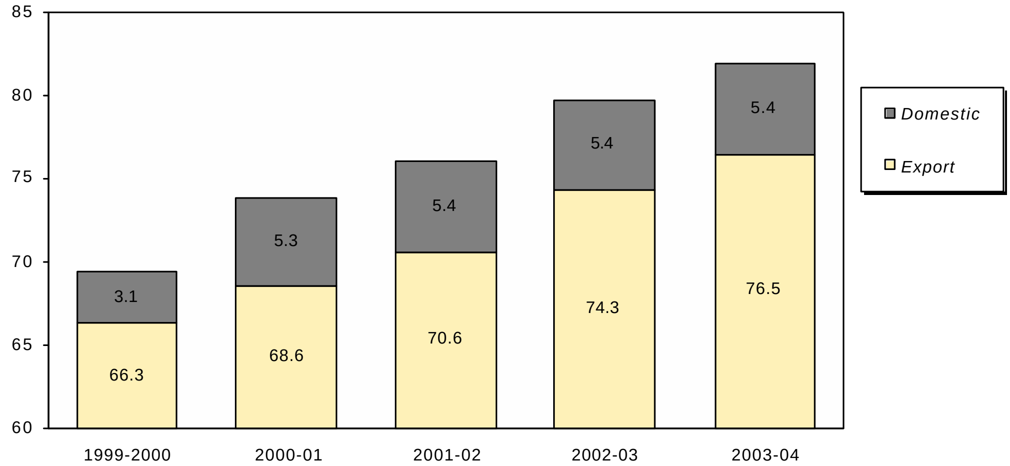
The only proposed mine which is subject to a specific undertaking to produce coal by an agreed date is the Mt Arthur North project, which has an agreement to provide (at least) 2 Mtpa of export coal after January 2003. This coal, along with coal from neighboring Bayswater is expected to be loaded at the new Bayswater / Mt Arthur North loader.

Forecasts of the Hunter Valley rail task relevant to the DORC valuation for the years 1999-2000 to 2003-04, are presented in Table 7.2 and Figure 7.2.

Table 3.2: Relevant Hunter Valley coal rail freight task (Mtpa)

	1999-2000	2000-01	2001-02	2002-03	2003-04
Export	66.3	68.6	70.6	74.3	76.5
Domestic	3.1	5.3	5.4	5.4	5.4
TOTAL	69.4	73.9	75.9	79.7	81.9

Figure 3.2: Relevant Hunter Valley rail system coal task 1999-2000 to 2003-04 (Mtpa)



Source: AME Mineral Economics Pty Ltd and Booz·Allen & Hamilton analysis

Much of the projected expansion in production over the next few years will occur in the Hunter coalfields. In part this is a product of the assumption that international coal prices are unlikely to improve over the next five years and that the Hunter coalfields have a transport cost advantage relative to more distant ones.

In terms of the spatial distribution of the forecast rail transport task over the next five years this implies increasing use of line sectors lying between the Hunter coalfields and Newcastle, but only modest increases in usage (if any) of line sectors serving more distant coalfields.

3.4 Train Movement Forecasts

The data on the coal freight task of the Hunter Valley rail system in 1999-2000 and 2003-04 was used to develop a rough approximation of train numbers using various sectors of the system in both years. Average train consist data obtained from FreightCorp has been used to convert tonnes into trains.

The most intensely used section of the network is between Maitland and Whittingham Jn with almost 12,300 trains per annum predicted to flow across the section. Flow diagrams of one-way loaded train movements are provided in Appendix C.

4.0 OPTIMISED STAND-ALONE RAIL NETWORK

4.1 Approach to Optimisation

The existing infrastructure configuration could be considered from today's perspective to be sub-optimal in both layout and in structure. However, in undertaking the optimisation, we have followed a fairly pragmatic approach and not considered radical and purely theoretical combinations of technology, structure and layout. The further the 'optimised' network is from the actual infrastructure on the ground, the more subjective the analysis becomes both in terms of the capital valuation and any on-going adjustments to maintenance and MPM costs which might be required to ensure consistency.

Similar arguments apply to track structure. The existing track structure was designed and constructed to suit 25 tonne axle loads (TAL) yet much of the present coal traffic operates at 30TAL. The existing track structure has been improved where reasonably possible (for example by installing HH rail) and might be considered to be a quasi-30TAL configuration – but it is clearly not an optimised 30TAL configuration. This results in relatively higher maintenance and renewal costs. While a track structure designed for 30TAL should reasonably form part of the optimised asset base, notwithstanding the higher cost relative to a quasi-30TAL track, to do so would require on-going adjustments to MPM and maintenance costs to ensure compatibility and consistency. The optimised infrastructure has been assessed based on the present design loads, limiting the need for subsequent adjustments to MPM and maintenance costs.

RIC considers a 30TAL track configuration should form the basis of development of an optimised network and raise several cogent arguments in favour of an optimised 30TAL approach to ORC valuation of the track structure, not least being application of MEERA principles. An optimal 30TAL track structure would include heavier rail and concrete sleepers, deeper ballast and better turnouts than are presently installed. The "replacement" cost element of the DORC process would consequently reflect something that does not exist, and would result in an increase of around $80,000 per km, or some $50M increase in ORC value. Benefits of having such a track structure would include reduced maintenance and renewal costs. However, actual ongoing maintenance and renewal costs, which are charged to operators, reflect the current track structure. After careful consideration it was determined that optimisation and ORC valuation should reflect the existing track structure configuration.

The HRATF have expressed concern regarding the inclusion of 60kg HH rail where presently 53kg SC rail is in place, noting that the consequence would be access charges reflecting a higher valuation while not obtaining the matching reduction in maintenance and renewal costs resulting from use of the better rail. This is the same point as made by RIC and discussed in the previous paragraph, except stated from the opposite point of view. The principles of MEERA have been applied in what was intended to be a reasonable fashion, which is to say the ORC has been determined for the quasi-30TAL track, neither providing for an optimised 30TAL track, nor for a 25TAL track. It should also be noted that there are three rail types presently located in Hunter Valley track – 53kg SC, 60kg SC and 60kg HH. The 53kg SC rail is inadequate in life-cycle cost terms for 30TAL traffic. 60kg SC rail is structurally capable of handling 30TAL traffic, but requires careful management of the rail head. MEERA reasonably requires allowance for use of 60kg HH rail, while it would be unreasonable to allow for use of 68kg HH rail which would be the likely optimised 30TAL configuration. That is to say, the rail selected has been judged as the most appropriate for use in this DORC process.

In undertaking the optimisation analysis, the focus has been on eliminating from the existing network any redundancy and over capacity, relative to the infrastructure requirements of the coal business, rather than any radical reassessment of the optimal design and configuration of the Hunter Valley rail infrastructure.

The HRATF consider the optimisation task should cover a series of alternatives, such as Category 1 mines separately from Category 2 mines. In practice, taking Category 1 mines in isolation would, eliminate some double tracking between Newdell and Drayton Junctions. Lines in the south from Scholey Street to Newstan, in the north from Maitland (Telarah) to Stratford and in the west from Bengalla to Ulan would be only for Category 2 mines.

FreightCorp generally agreed with the philosophy and findings outlined in the optimisation paper, though added some specific comments that are addressed in the relevant sections below. The scope of bridges was questioned. It is FreightCorp's position that road and pedestrian over bridges should not be included, "… footbridges (7 assets included) which are provided for passenger station access and pedestrian crossings and road overbridges (24 assets included) particularly those funded by the Roads and Traffic Authority (RTA) which form part of the road network should not be included". Freightcorp's position is expressed "… infrastructure in general which forms part of a road network rather than being an economic contributor to coal haulage…" should not be counted towards RIC's asset base. FreightCorp continues, "The exclusion of these assets is required by the optimisation process which … [assumes] coal is the only user …".

In general it is the newcomer that must pay for the continuance of access for those interrupted by any new infrastructure. It follows that, with the exception of the New England Highway overbridge west of Hexham <u>and other similar new bridges</u>, virtually all overbridges and road crossings would have been funded by RIC and its predecessors.

RIC noted that the duplication between Newdell and Drayton Junctions should be included. This section of track has indeed been included in the 2004 valuation.

4.2 Impact of future needs on the 1999 DORC valuation

Future needs have been assessed based on the likely growth in traffic over 5 years to 2004. The infrastructure required to meet this future level of demand is used to determine the optimised network. Both FreightCorp and the HRATF have argued against using the 2004 demand as the basis for the infastructure required, and hence the valuation to be applied, in 1999. Both would prefer 1999 demand to be used as the basis for the infrastructure required in 1999 with annual increments to be added to the asset base over time.

To remain consistent with the original IPART determination, the DORC assessment should include an allowance for growth. Not to allow the infrastructure provider to recover the costs of investment for growth may discourage future investment to the detriment of the entire industry. It is particularly harsh to only compensate the infrastructure owner for the costs of infrastructure required to meet actual demand at any point in time when investment decisions are based on imperfect information about future demand and involve a significant time lag. Such an approach will encourage very conservative stewardship of the assets. Yet compensating the owner in advance for the cost of meeting future growth may discourage actual investment over the regulatory period. The issue is further complicated by 'unregulated' traffics sharing infrastructure with 'regulated' traffics and the combined demand driving investment needs.

RIC have supported the use of capacity requirements to 2004 to determine the regulatory asset base (RAB) but suggest that assets not built as at 1 July 1999 be excluded. New assets would be added to the RAB as they are constructed valued at actual efficient cost (rather than using a greenfields value). The Minerals Council accepts that efficient actual costs can reflect the circumstances of actual construction conditions where actual new construction is involved[32].

For this Report 2004 demand was retained as the basis for determining the optimised infrastructure, consistent with the original IPART determination. To adopt RIC's approach and exclude some assets from the RAB only because they are not yet constructed seems illogical (a stand-alone cost test deals with a hypothetical situation and a more efficient configuration may be assumed much of which may not actually exist). We do, however, accept RIC's position that any new construction post-1999 should be included in the RAB at efficient actual cost. To the extent that this assessment of the DORC undervalues any future capital expenditure, as compared to actual efficient cost, then appropriate adjustments should be made to the RAB as required.

Ensuring appropriate incentives are in place for further investment in rail infrastructure is of major concern to RIC and other industry stakeholders. This is a matter which relates to the access regime more generally, rather than this DORC

32 *Minerals Council, op-cit, p15*

valuation, and therefore should be addressed by Government as custodian of the regime.

4.3 Greenfields/ Brownfields

The TOR called for both a greenfields and a brownfields assessment of the replacement cost of the optimised network. Greenfields assumes construction occurs across an area free of any development while brownfields assumes construction takes place around all existing above rail development and community infrastructure. The latter includes costs of surface restoration and other surface diversions. Because the valuation is to exclude land, tunnels, cuttings, embankments and other formation works, it is difficult to conceptualise any real difference between greenfields and brownfields in this case. Consequently only a single valuation was developed assuming greenfields construction.

The most material assumption related to greenfields construction is that the replacement costs are calculated assuming fulltime track possession (i.e. no traffic). As a result, costs will be lower than current replacement and renewal costs which are carried out under traffic. Because the valuation is to determine the capital charges which go to the recovery of the owner's historical investment, this assumption is considered appropriate.

4.4 Maximum Capacity Considerations

Track capacity at various locations was reviewed to develop an understanding of potential critical capacity constraints. Note that the capacity considerations described below are based on professional judgement, not detailed train modeling.

In reviewing the capabilities of the signaling system, it appears that a 15 minute headway between trains has been designed into the train control system. In theory 96 trains per day could run, yielding a capacity well beyond current requirements, even allowing a typical 70% to 80% operating utilisation (for double track).

Hanbury Junction was initially identified as a likely critical capacity constraint. Examination of the curve and grade diagrams for the core network, however, showed clearly that the long 1:80[33] grade on the Mininbah bank immediately east of Whittingham Junction was likely to provide a significant capacity constraint due to the slowly moving trains joining from the Saxonvale / Mt. Thorley branch. On further review, RIC's Operating Instructions[34] list a Tonnage Signal at the base of the bank. This prevents a coal train departing from the signal until the bank is clear, impacting significantly on capacity[35].

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33 Approximate average – actually varies between 1:77 and 1:88

34 Northern Instruction Pages, Section 3, Page 10.

35 In somewhat greater detail, the circumstances are that a Newcastle-bound train must clear a signal near the top of the bank at 226.005km before the next train can pass the Tonnage Signal at 231.823km.

A simple calculation reveals that a typical train having three 90 class locomotives, 91 wagons of 120t gross, on a 1:80 grade with an 800m radius curve will proceed at about 15.3kph. Knowing the length of the train, the headway can be determined.

Allowing no operational inefficiencies nor allowing time for any train starting from rest, the theoretical headway is about 28 minutes. Allowing for a typical 25% loss of time on average for actual operations, then the headway would be approximately 35 minutes. This yields about 15,000 train paths per year, not allowing for maintenance or speed restriction losses, track recording car runs or track inspections. The Mininbah Bank is bi-directionally signalled, allowing trains to proceed up the bank in parallel. However there are severe limits on such movements due to opposing train movements.

In summary, the likely **current** capacity of the core network in the Hunter Valley is constrained by the track and train control configuration between Whittingham Junction and Maitland, and the approximate coal traffic capacity is 12,000 trains per year, net of other train paths. At a current average of about 6,500 tonnes/train over this section of track, this yields about 78Mt per annum of coal capacity. Adding approximately 4Mt from Stratford, Southland and Bloomfield yields a total coal transportation capacity of approximately 82Mt per annum in the Up direction (towards Newcastle).

The 82Mt capacity figure compares well with FreightCorp's consistent high end rate of current delivery of 220,000t per day[36] which is equivalent to 80.3Mt per annum.

Having deduced that the current Hunter Valley network has an adequate number of train paths for current and near term increased traffic (i.e. to 2004), except at the Mininbah bank, then it was reasonable to make provision for the Mininbah bank constraint, and to proceed with the determination of an optimised infrastructure configuration.

In identifying the infrastructure configuration required for the July 1999 and 2004 coal transport task, it is recognised that in fact the current system is used by a range of traffic, while the optimisation process requires the minimum configuration needed for coal traffic to be assessed.

With a coal only perspective, current constraints such as Hanbury Junction can be ignored except in so far as coal traffic might require configuration improvements. On the other hand, constraints such as the Minimbah Bank must be taken into account as they directly affect coal traffic.

To aid in identifying the minimum infrastructure, especially at the port terminals with their associated extensive track layouts and complex junctions, meetings were

[36] Personal contact 5 June 00.

held with RIC, train control and FreightCorp personnel in Newcastle at which operations over the whole coal transport network were reviewed.

4.5 Train Numbers

Numbers of trains were generated from several sources:

- The related demand review findings (see flow diagrams in Appendix C);
- FreightCorp train configuration and movement statistics; and
- Discussions with train controllers and FreightCorp (to establish typical daily peak train flows).

Peak train numbers were established by taking the train numbers from the demand analysis (which apply to loaded trains travelling to the port terminals), allowing for the same number of trains heading in the reverse direction, then using a formula which reflects the assumption that practical capacity is about 70% of theoretical capacity.

FreightCorp's commentary includes minor qualifications about these figures, but concludes that they are "… fair and reasonable".

Somewhat in contrast the HRATF has offered quite extensive comments about train numbers and sizes, noting in general that train sizes can be expected to increase. Without the introduction of new operators and/or the letting of contracts for more coal wagons and/or the transfer of coal wagons from other routes, the train sizes and numbers discussed in this Report represent the best available knowledge – confirmed by FreightCorp as noted above.

Further, the HRTAF considers the calculation of train numbers for 2003/4 from Mount Thorley and Mount Arthur North are incorrect and a train size some 20% smaller than should be assumed. The train numbers calculations are intimately linked to train size assumptions. Train sizes were determined after quite extensive consultation with FreightCorp. The resulting mix of train sizes were then allocated in a pattern judged to be reasonable through the period to 2003/4. As noted by the HRATF, longer trains would result in smaller numbers, which, in principle, would reduce infrastructure requirements. However, the capacity impact of larger numbers of longer trains, were, the routing of those trains is unknown meaning that the consequent impacts on infrastructure are also difficult to predict. Furthermore, the number of tracks, which is by far the major determinant of ORC, increases to match train numbers in steps – exceed a certain number of trains and another track is required. Consequently the only real impact on the Hunter Valley ORC of this debate is the allowance for two tracks between Newdell and Drayton. A judgement has been made that, based on reasonable train size and number data, there would be need for two tracks between Newdell and Drayton by 2003/4.

The HRATF indicates that the valuation process applies to infrastructure required for export coal movements only. The valuation actually includes all known coal movements, with the exception of the Macquarie Generation domestic coal traffic. As the coal source of this traffic varies across the rail network, no specific allowance has been made for these trains.

4.6 Optimised Track Infrastructure

The train numbers were used to determine the minimum reasonable infrastructure required across the coal network. As noted previously, the infrastructure configuration was determined using professional judgement: no traffic simulation was undertaken. Except as noted for RIC below, the optimised layout was generally found acceptable by stakeholders.

RIC have made several comments related to the optimisation process in their January submission. The issue of axle loads is discussed in section 4.1 above. RIC consider that drainage and culverts should be included in the final asset value. For the most part, drainage and culvert assets are so old as to be reasonably considered to be wholly depreciated. HRATF agree with this approach. Rather than deal explicitly with culverts we have adopted a unit track replacement value (in Chapter 5) at what we consider to be at the top end of the reasonable range. This is to allow for drainage and culvert assets and other miscellaneous assets which are difficult to identify in an exercise such as this[37], as discussed in some detail in section 4.1.

RIC also consider that optimisation, i.e. minimisation, of track between Grasstree and St. Heliers and in the Scholey Street areas is immaterial, and that the existing infrastructure should be valued. As the purpose of the optimisation process was to identify the minimum track required for coal operations, the selection of assets to be valued must exclude the track that is not so required. Take the Scholey Street instance, as displayed in Figure 4.1 below. RIC object to the section of track forming the bottom side of the triangle around the words Scholey Street, which section does not in fact exist. The function required of this track is performed by the Up and Down (Dn) Main lines shown below the Scholey Street "triangle", running from Islington Junction to Hanbury Junction. Inclusion of these tracks is quite unreasonable for a coal traffic task that amounts to something less than 8 trains per day (refer to the Optimisation Working Paper, Figure 6.1).

Figure 4.1 illustrates the track configuration, together with associated structures, signals, communications, etc., identified as being required in the Newcastle area.

37 *If culverts were explicitly valued, they would add about $9.8 million to the ORC.*

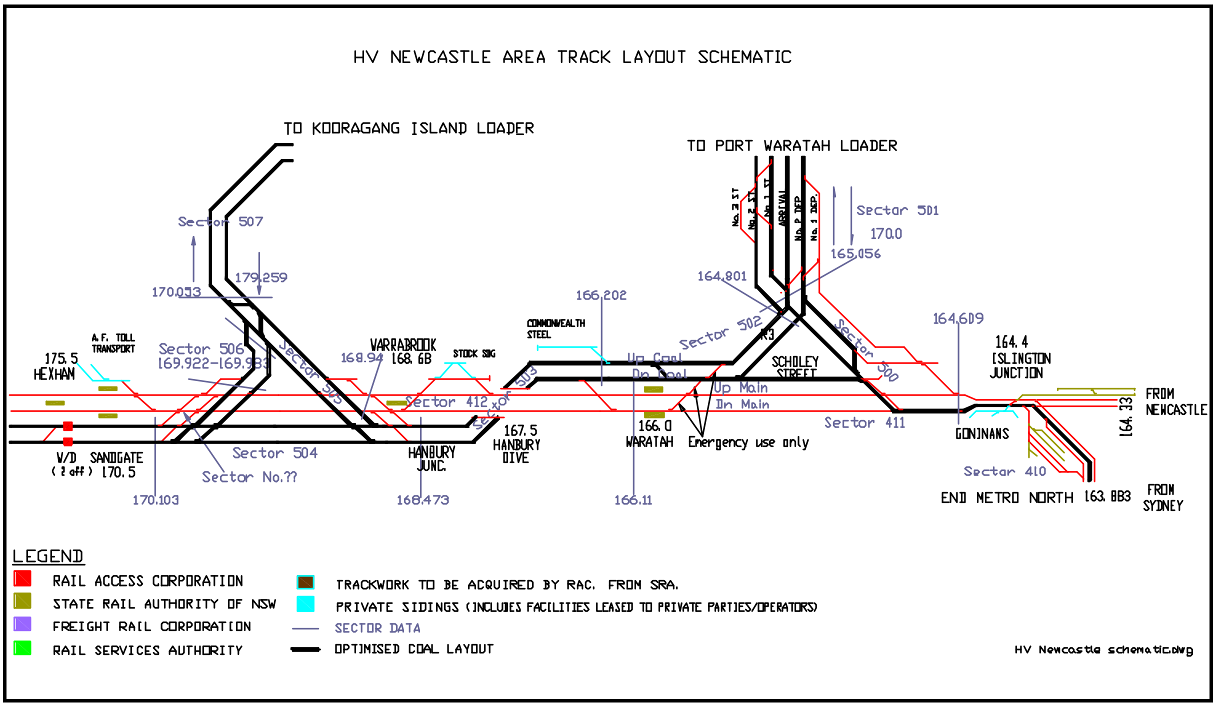


Figure 4.1 – Newcastle Area

Figure 4.2 illustrates the track configuration, together with associated structures, signals, communications, etc., identified as being required at Port Waratah terminal. Note the coal dumper loops are private sidings.

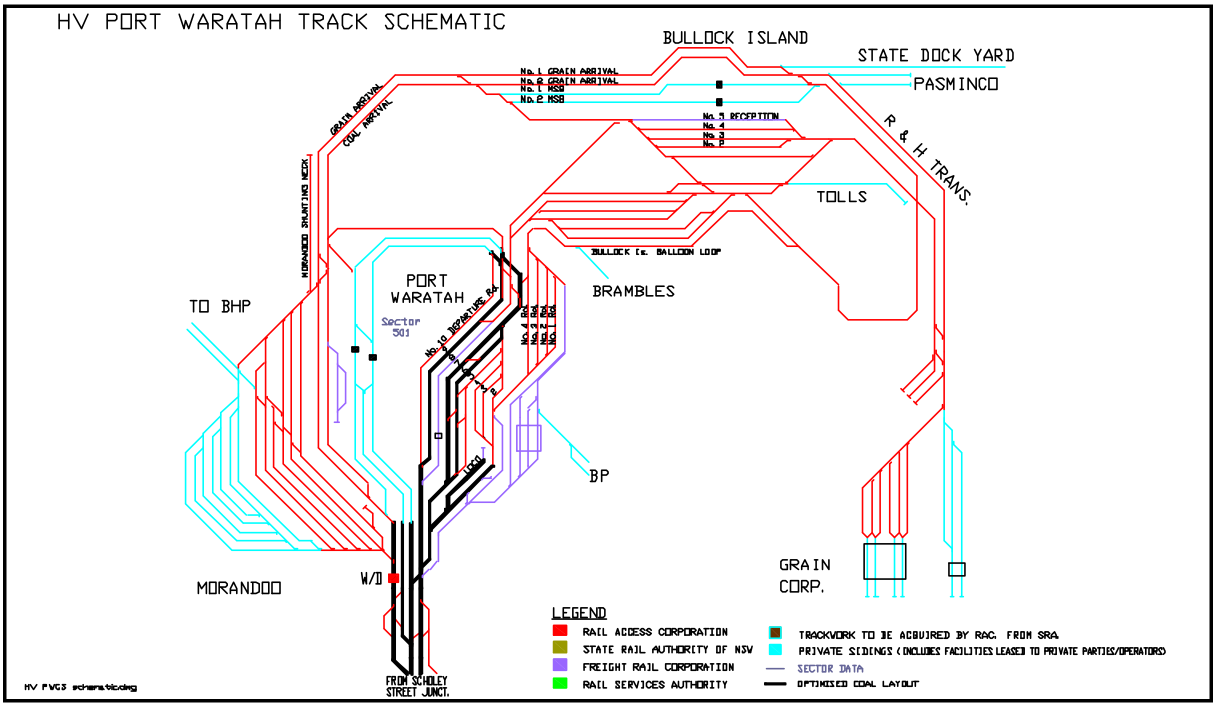


Figure 4.2 – Port Waratah Terminal

Figure 4.3 illustrates the track configuration, together with associated structures, signals, communications, etc., identified as being required at Kooragang Island terminal. Note the various loop layouts considered appropriate for 2000 and 2004.

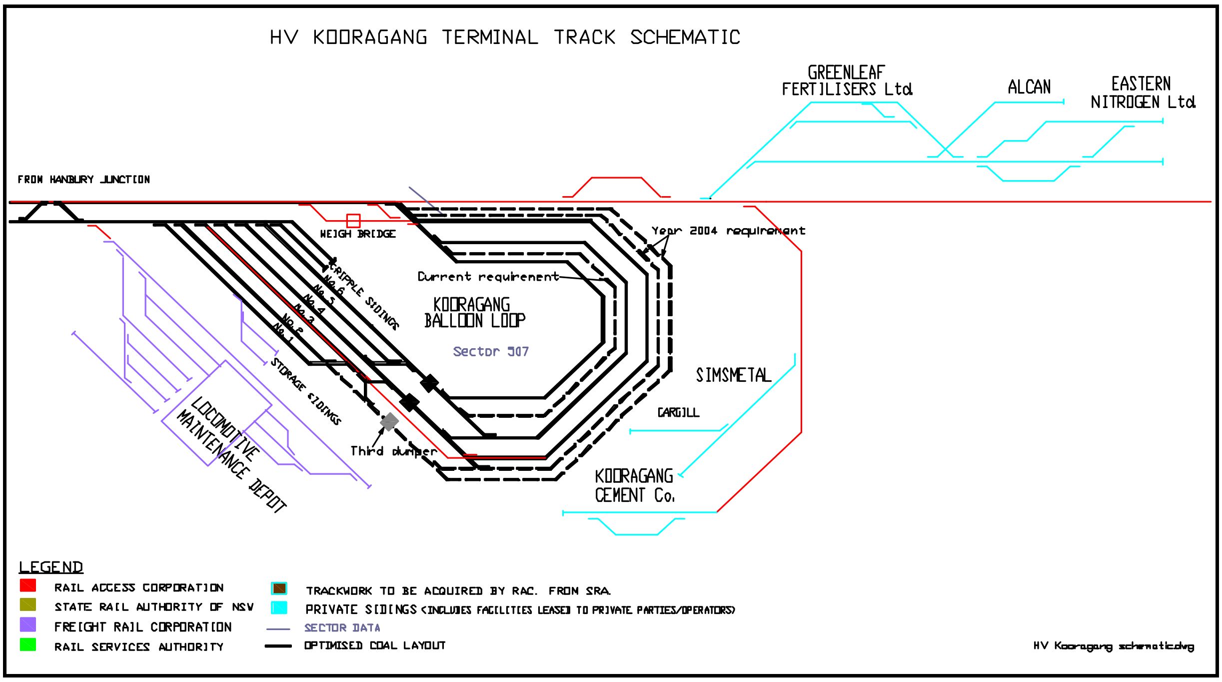


Figure 4.3 – Kooragang Island Terminal

Figure 4.4 illustrates track configuration, together with associated structures, signals, communications, etc., identified as being required between Hanbury Junction and Maitland. HRATF express concern that the extra loop shown at Kooragang island terminal should not be considered additive to the crossovers and bidirectional signalling west of Sandgate. In Figure 4.4 it can be seen that one pair of crossovers has been omitted from the optimised scope by comparison with the present layout. Together with related signalling this approximates to the value of the Kooragang loop.

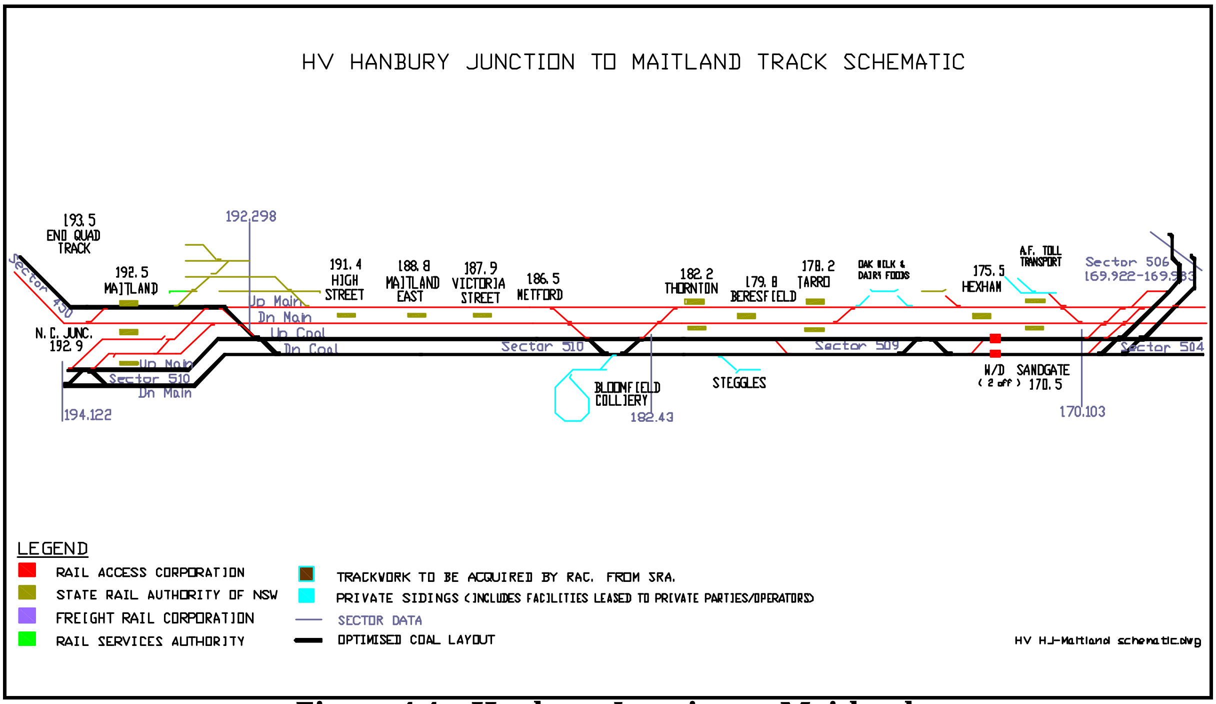


Figure 4.4 – Hanbury Junction to Maitland

Figure 4.5 illustrates the track configuration, together with associated structures, signals, communications, etc., was identified as being required between Maitland and Newdell.

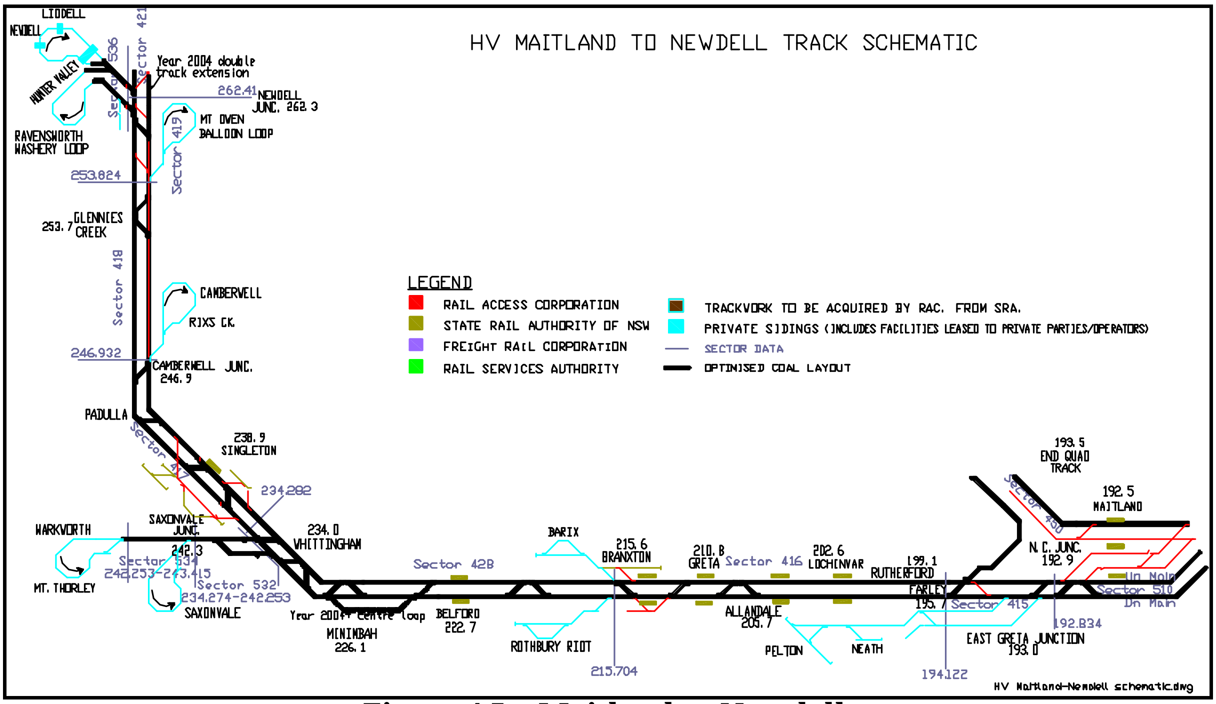


Figure 4.5 – Maitland to Newdell

Figure 4.6 illustrates the track configuration, together with associated structures, signals, communications, etc., was identified as being required between Newdell and Ulan, including Dartbrook.

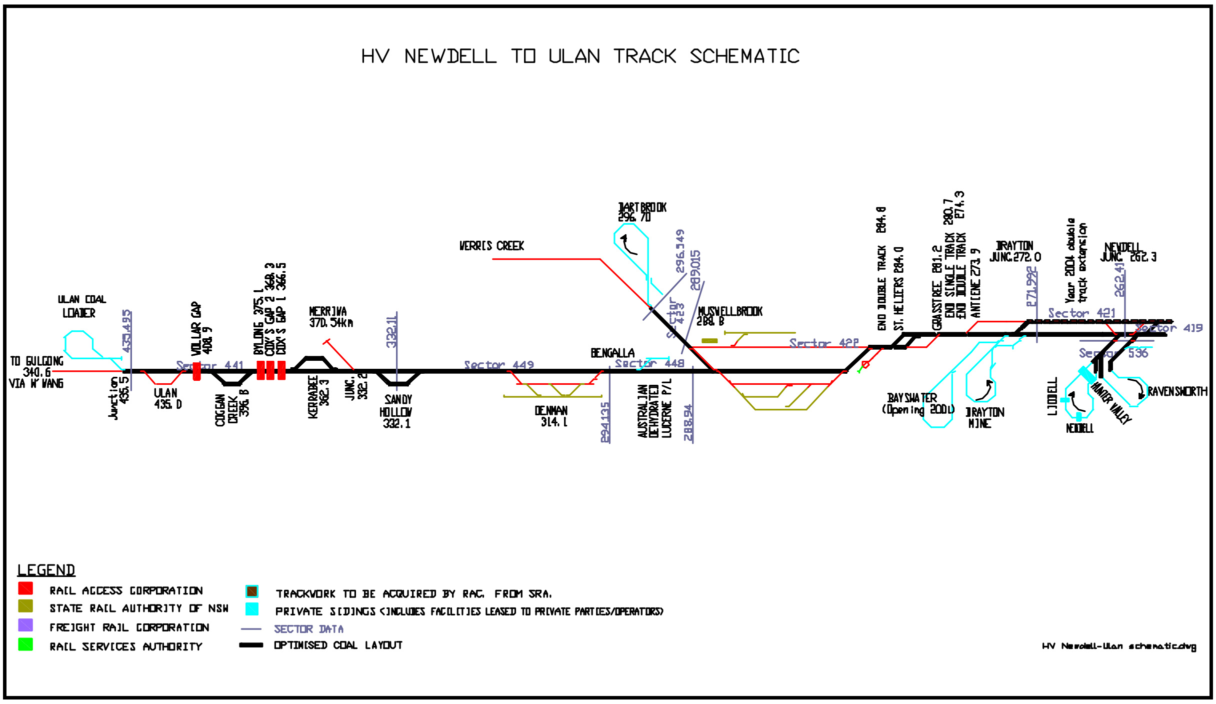


Figure 4.6 – Newdell to Dartbrook and Ulan

Figure 4.7 illustrates the track configuration, together with associated structures, signals, communications, etc., identified as being required between Maitland and Stratford. HRATF note the absence of the Telarah to Farley loop – this infrastructure is included in sector 450.

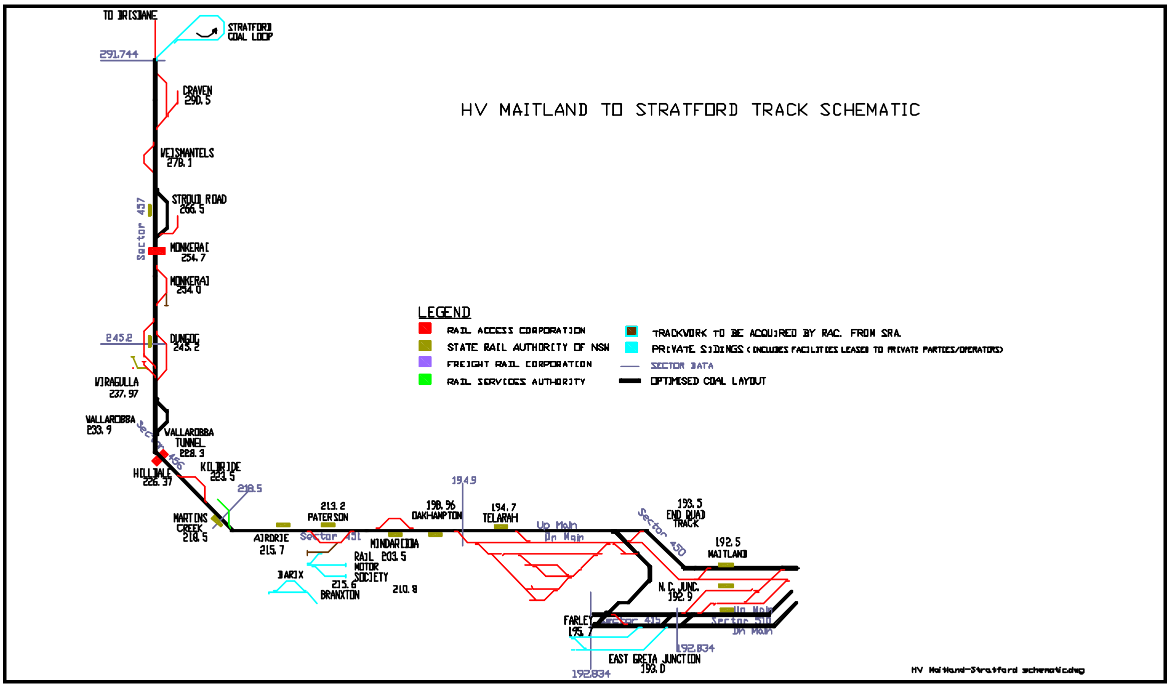
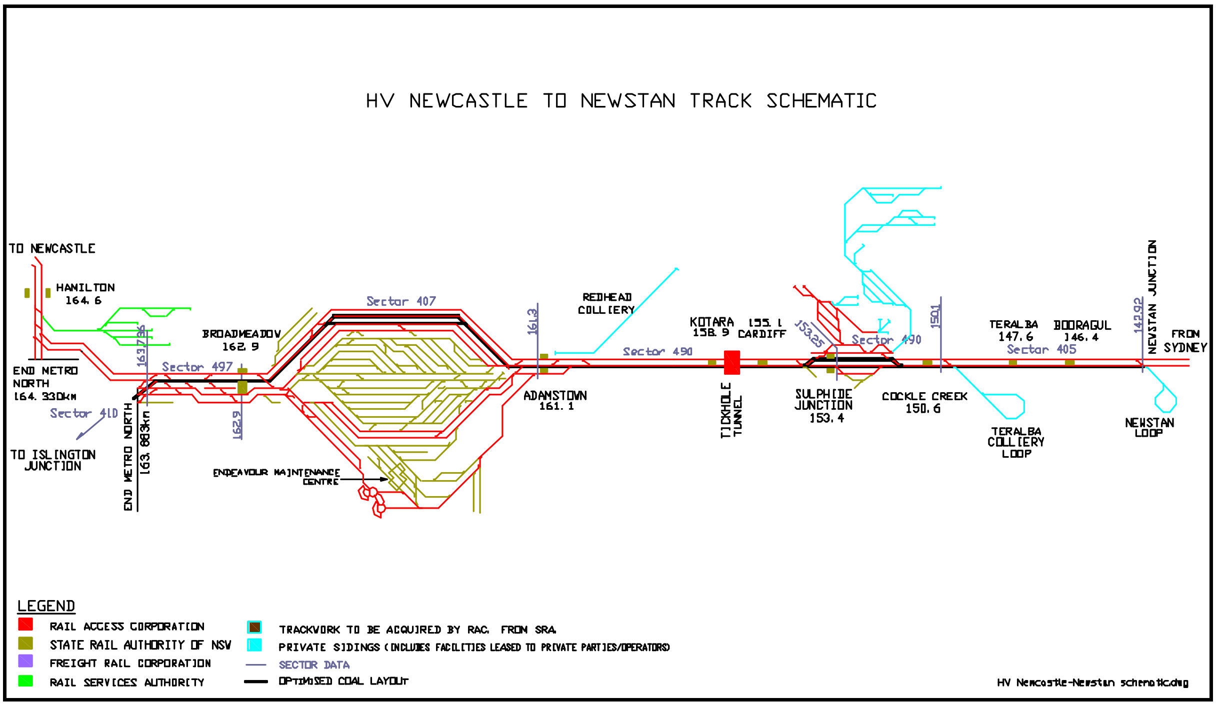


Figure 4.7 – Maitland to Stratford

Figure 4.8 illustrates the track configuration, together with associated structures, signals, communications, etc., identified as being required between Newcastle and Newstan.



4.8 - Newcastle to Newstan

4.7 Optimised Safeworking Systems

The optimised safeworking systems proposed to support the operation of coal traffic for the year 2004 are a mix of Train Order Working and Automatic Block Signalling.

Train Order Working

Train Order Working would be adopted on the following sections of track:
- Drayton Junction – Dartbrook;
- Drayton Junction – Ulan;
- Maitland – Stratford; and
- Islington Junction – Newstan.

All crossing loops would be locally controlled with driver's pushbuttons and have self restoring points to facilitate two stop crosses.

Train Orders would be issued from a control desk in the Control Centre at Newcastle and crossing loop functions would be remotely monitored. The control desk should have a dual redundant configuration to ensure continuity of operation in the event of failure. Control for issuing of movement authorities should be done by computer to minimise the workload on the Traffic Controller and minimise the risk of human error.

Automatic Block Signalling

Automatic Block Signalling with controlled junctions is assumed for Islington Junction to Drayton Junction. Control and monitoring of the area would be done from a control desk in the Newcastle Control Centre.

As a general principle, the signal headway for any given sector is to be determined by halving the theoretical operational headway (to allow for ad-hoc and campaign haulage) and subtracting a further 25% (to allow for reliable achievement of the campaign haulage headways). Signal headways are designed for the longest and slowest train, and for the train with the longest braking curve. Design signal headways for the Islington Junction to Singleton section is 10 minutes and elsewhere 20 minutes.

In practice, the signal spacing, and hence the signal headway, is determined by the number and location of junctions throughout the network.

The section between Maitland and Sandgate Junction would remain signalled similar to its current configuration, as this will allow trains to be bunched up closely if Kooragang Island gets overloaded and queues of trains build up waiting to unload. Full bidirectional signalling would be provided throughout this section to permit loaded trains bound for Port Waratah to bypass any trains waiting to enter Kooragang Island.

The sections between Maitland to Singleton and Singleton to Newdell (current), and Singleton to Drayton (2004) would be signalled to meet the requirements described above and should include simplified bidirectional signalling at junctions and crossings to facilitate efficient use of the network during engineering works or for bypassing failed trains.

The Minimbah bank would still require the tonnage signal for the longer and heavier trains, but the third track in this area would be signalled to permit lighter and faster trains to bypass any heavy trains which may be waiting.

4.8 Optimised Communications Systems

The optimised communications systems involves:

- Fibre optic communications backbone;
- Train radio; and
- Telephone.

Fibre Optic

Fibre Optic for Bulk Point to Point Data Transmission covering the following sections:

- Dartbrook Junction – Newcastle Control Centre
- Ulan – Muswellbrook – Newcastle Control Centre[38]
- Stratford – Maitland – Newcastle Control Centre
- Islington Junction – Newstan

Complimentary head-end facilities would need to be provided in the control desks in the Newcastle Control Centre.

Train Radio

Radio for Control Centre to Train communication covering the following sections:

- Dartbrook Junction – Newcastle Control Centre
- Ulan – Muswellbrook – Newcastle Control Centre[39]
- Stratford – Maitland – Newcastle Control Centre[40]
- Islington Junction – Newstan

Complimentary head-end facilities would need to be provided in the control desks in the Newcastle Control Centre.

38 For these more isolated areas, another option might be to lease circuits from Telstra assuming that sufficient capacity is available and it is economic to do so.

39 For these more isolated areas, the radio should be enhanced to cater for communication with trackside maintenance staff as mobile phone coverage is unreliable or non-existent

40 Maintenance staff to use mobile phones along the Main Hunter line as coverage is good

Telephone System

Telephone systems are required for maintenance and operational use for all lines at crossing loops, controlled signals and equipment rooms. These may be used by train drivers in the event of radio failure (or coverage problems) and by maintenance staff.

Complimentary head-end facilities will need to be provided in the control desks in the Newcastle Control Centre.

4.9 Asset Listing

Appendices D and E detail assets included in the optimised network. The scope of the assets valued includes:
- Track (rails, sleepers, ballast);
- Turnouts;
- Crossovers;
- Signalling and communications infrastructure;
- Bridges;
- Fences;
- Local power supply; and
- Level crossings.

Land, tunnels, cuttings, embankments, and other formation works are assets that have been excluded, consistent with the Terms of Reference. In addition, drainage and culverts have been excluded as discussed in section 4.6. Cattle stops and high voltage distribution assets have also been excluded on the grounds of lack of materiality and lack of data.

5.0 REPLACEMENT COSTS

5.1 Approach

Replacement costs have been assessed "using only efficient costs and modern engineering equivalent rail assets" and assuming clear and unfettered access to railway formation and made or natural ground, as may be appropriate for each asset class. Specifically, no allowance has been made for any construction work in the presence of railway traffic. This assumption is consistent with the logic outlined in Chapter 2 with the DORC value representing the value of the initial investment which has yet to be returned to the investor.

The consequence of these assumptions is that the estimated cost of replacing assets is much less than the cost of replacement experienced by RIC, where the considerable difficulties in obtaining lengthy track possessions, and the associated safe working restrictions, adds significantly to costs.

As a simple example of the differences between the costs associated with clear access versus traffic-constrained access, a detailed study by a materials supplier undertaken in 1985 found that concrete sleeper installation in the Hunter Valley, during which access was provided to some 20km of track over a period of several weeks (though still with adjacent lines working) cost about $20 per sleeper. The same study showed that concrete sleeper installation in the Sydney metropolitan area, at weekends, during limited track possessions, cost about $65 per sleeper. The same equipment and installation crew was used in each case, with the difference being the cost of access and associated inefficiencies. As the $20 per sleeper figure was still affected by access limitations to some degree, it was deduced at the time that the clear access cost of concrete sleeper installation was about $15 per sleeper. Hence, in this simple example, the clear access installation cost was less than 25% of the cost in the real-world metropolitan track example.

While this approach has been accepted in principle by stakeholders other than RIC, there remains a wide range of opinion regarding what rates for major materials supply and for track installation, in particular, should apply. The track km per day rates selected for this project are not as low as, for example, would apply to the Alice Springs to Darwin line crossing open desert with practically no turnouts and other sources of track installation delay. Rather, reasonable rates have been selected recognising the terrain, track configuration and material supply constraints. Despite this relatively conservative approach, RIC consider the installation rates selected are too low.

Following discussion with RIC and their consultants GH&D, some modification of rates has been assessed, as discussed in the following sections. However, the re-assessments have been mindful of the strongly expressed dissenting views of HRATF and FreightCorp, together with their consultants, who all consider the selected rates are far too high. While the re-assessments are modest in effect, the process has sought to recognise the relative complexity of the Hunter Valley system by comparison with the comparators shown in Table 5.1. It is simply unreasonable to select the lowest common denominator for track costs and then apply this to a network having an average of about 3km between turnouts and about 3.5km between underbridges, each of which have a significant impact on rates.

Stakeholders expressed some concern that the selection of 53kg rail and timber sleepers on the Newstan – Newcastle and Stratford – Maitland lines is inappropriate given concrete sleepers are cheaper than timber, 53kg rail is unavailable other than by special order, and 60kgHH rail provides for far superior rail management, including significantly less grinding. The natural consequence is selection of Class 1XC track configuration to match the remainder of the coal network. However, recognising relatively modest coal tonnages, a modified class has been applied, being effectively Class 1XC with ballast depth reduced by 50mm to 250mm.

5.2 Data Sources

Asset replacement costs were established using a range of data sources, including prices for individual components built up with assessment of installation costs, through to estimated prices for complete systems.

A high profile project such as this inevitably leads to both distortions in pricing and to reluctance on the part of suppliers and contractors to provide prices at all. As an example, while OneSteel (BHP) provided a supply price of rail, this was only after quite close examination by OneSteel of what parties would have access to the price. As the price would be quoted in this report, available effectively to all parties related to the Hunter Valley railway industry, OneSteel naturally had to judge what price was in their reasonable interests to quote. OneSteel are to be commended for quoting at all: many suppliers and contractors politely declined. However, the rail price actually used in the valuation was about 7% less than the OneSteel "quote", reflecting what was considered would be a more appropriate price for this project.

FreightCorp consider that the 7% allowance is wholly inadequate. However, in discussion with OneSteel, it was suggested that the rail supply prices recommended by FreightCorp were overly optimistic. OneSteel are adept at pricing to satisfy the local market, and it appears that the reality is that delivered costs of rail from overseas are actually fairly close to the figures used in this evaluation.

There will be divergent views on the matter of replacement costs. This introductory discussion makes clear that both supply and installation costs vary widely depending upon assumptions made relating to the scale of purchases and the nature of the construction task. As current data covering these matters is not readily available, pricing has been drawn from a number of sources, compared with similar work being undertaken elsewhere, and sense checked with both confidential sources and older publicly available data adjusted for inflation.

5.3 Track

5.3.1 Assumptions And Rates

The total cost, up to and including installation costs, for each item or groups of items was calculated based on the three major cost components - materials, plant and equipment and labour. The track construction items considered were :

Plain Track
- Bottom Ballast
- Concrete Sleepers and associated components
- 60kg Rail Supply
- Track Laying on top of Bottom Ballast
- Top Ballast
- Tamping
- CWR

Turnouts
- 1:12
  - Crossover – 2 x 1:12 turnouts
- 1:9
  - Catchpoint
  - Diamond crossing 60° approach angle

Miscellaneous
- Fences
- Level Crossings
- Sound Barriers

With the exception of turnouts and sound barriers, the items were calculated on a per km basis. Class 1XC configuration was applied to concrete sleepered track, except that a reduced ballast depth of 250mm was applied to the Maitland to Stratford and Newcastle to Newstan lines[41].

Sources used in determining the cost of construction included track materials specialists such as :
- Pandrol for sleeper jewellery costs,
- Hatch for timber sleeper costs,
- Rocla for concrete sleepers,
- One Steel BHP for rail track supply prices,
- TKL Rail for turnout estimates,
- Phoenix AG for level crossing estimates, and
- Alstom for level crossing lights and signs.

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41 *RIC spec. TS.3101*

Plant and equipment costs, and labour costs were obtained from industry sources such as ABB. These costs were also verified by comparing with estimates developed from first principles.

A number of assumed base rates, obtained from industry sources, formed the basis of this costing exercise. All costs used in the analysis were exclusive of Goods and Services Tax :

- The cost of labour was estimated at $40 per hour, while the cost of a survey crew hour was $160 per hour (surveyor, equipment and labourer).

- The cost of delivered ballast by both truck and rail was estimated at $22 per tonne. This rate is considered low by RIC and high by HRATF and FreightCorp.
  - A uniform rate for road and rail deliveries was applied due to the marginal difference in cost between the two.

- The volume of bottom ballast was assumed at 0.5 m^3 per metre run, while top ballast was estimated at 1.64m^3 per metre run. Placed and compacted density was assumed to be 1.9t / m^3.

- The cost of 60 kg Head Hardened rail was estimated at $1,250 per tonne. This was assumed to account for bulk purchase discount. This rate is considered high by HRATF and FreightCorp, while RIC considers to delivered cost to be too low (i.e. after allowing for shop welding and delivery).

- Rail deliveries of 440 metre lengths of rail was estimated at $400 per length of delivered rail. RIC considered this assumption of delivered length to be overly optimistic, suggesting that 110m lengths are all that could be handled from any available shop welding site. While the 440m length was chosen because that was used in the construction of the Pilbara railways, it is acknowledged that the actual length selected by any railway contractor would probably fall in range of 250m to 450m ex depot, with a somewhat shorter likely length than 440m given the average turnout spacing. This difference is reflected in the installation rates discussed in section 5.3.2 below.

- Track Laying Machine was estimated at $10,000 per day (base cost, no labour).

- Tamping machine was estimated at $3,000 per day (base cost, no labour).

- Turnout supply prices:
  - 1:12 Class 1 complete with concrete sleepers, plates, spreaders, bolts and fastenings was priced at $100,000.
  - 1:9 Class 1 complete with concrete sleepers, plates, spreaders, bolts and fastenings was priced at $75,000.
  - Catchpoint complete with timber sleepers, plates, spreaders, bolts and fastenings was priced at $22,000.

– Diamond suited to Class 1 track and complete with concrete sleepers, plates, spreaders, bolts and fastenings was priced at $150,000.

The total cost of construction for each item has been marked up to account for an additional 8% of overhead costs, including project management and other on-costs and a 10% margin covering profit, risk and some contingency, cumulatively 18.8%. To this was added an allowance for client costs and integration of design, etc., to provide a total of 21%. RIC initially considered 24% to be an appropriate markup, then amended this to 23.12%, while FreightCorp considered the 18.8% figure "unreasonable high" when applied to labour rates.

5.3.2 Results

The supply rates discussed in section 5.3.1 above were applied to installation rates to develop results for use in ORC calculations. The installation rates were subject to robust scrutiny by all stakeholders. To aid the process a spreadsheet was provided that fully described the make-up of the per km track and fencing, and per unit turnout and road crossing installed costs.

The results of the track replacement assessment showed that on a per km basis the cost of new track construction is $580,513, for Class 1XC track, including the previously discussed 21% markup. This figure includes approximately $15,000 extra costs than previously reported for train handling of rail ($3,000), bottom ballast distribution costs ($3,000) and top ballast placement and track lifting and lining costs ($8,000). The cost per km for Class 1XC with reduced ballast depth of 250mm was re-assessed at $564,833. A review of similar projects shows this estimate to be reasonable: the range of costs was found to be $449,000 to $623,000 per km, as shown in Table 5.1.

FreightCorp and RIC held firm views on the validity of this rate. RIC provided extensive analysis based on work by their consultants GH&D showing this should be around $635,000/km. HRATF consider the rate should be about $511,000/km. FreightCorp provide considerable detail supporting a rate of $503,000/km. We believe the adopted unit rate of $580,513 is appropriate, notwithstanding that it is towards the top end of the reasonable range. Included in this rate is $42,704/km to cover infrastructure elements not specifically identified (the amount being obtained by assuming 600m per day for track laying versus a more likely 1km per day, plus a 21% markup on rail purchases instead of a more likely 10%), resulting in a $25.2M allowance, for drainage, culverts, lubricators, dragging equipment detectors, wheel impact load detectors, automatic equipment identification installations, geotechnical monitoring stations, maintenance compounds and huts, river training works, riprap, cattle grids and other track based miscellaneous assets not explicitly valued.

Table 5.1 - Track Construction Costs per Km

Source	**$ Per Km**
Booz·Allen & Hamilton – Hunter Valley Valuation	***580,513/564,833***
Valuation of Below Rail Assets[42]	449,095[43]
New Construction Cost for Track Section	460,086[44]
Design and Construction of Trackwork using Timber, Steel and Concrete Sleepers[45]	530,965[46]
Booz·Allen & Hamilton data for track construction[47]	622,526[48]
Approximate trackwork costs in 1999 dollars for the Ulan line construction[49]	575,000[50]
Budget price allowance for greenfield track construction from a large Australian construction company[51]	575,000[52]

Details of costs by asset type are provided in Appendix F.

The HRATF noted that the cost rates of several of the comparisons listed in Table 5.1 are lower than the rate used for this assessment. It should be noted that these applied to tracks with a lesser design specification.

The HRATF have commented extensively upon track rates developed for recent Queensland Competition Authority (QCA) investigations, comparing these with those presented by RIC and those used in the IPART assessment. While a great deal of data is presented, the summed km rates are presented by the HRATF as RIC - $635,000/km and QCA - $455,000/km. The HRATF consider the $580,513/km figure assumed by Booz·Allen as unreasonably high. After allowing for the elements not included in the QCA rate and the differences in track configuration (1,500m^3 of ballast per km would not last long under 30t axle loads, and 1.7t/m^3 ballast density would last only a few trains at 30t axle loads before consolidating at least 10%), the significant differences apparently lie in the sleeper and rail costs. [(It should also be noted that the QCA track costs allow for 1500 sleepers per km, while the RIC configuration allows 1667 per km)]. The sleeper price difference reasonably follows from the design difference (sleeper length and design loading), but the rail pricing deserves attention. QCA's assumption of $900/t for the same rail as the Booz·Allen allowance of 1,250/t suggests the Booz·Allen rail rate should be reconsidered, as the

42 *Australian Railway Operator*

43 *60 kg Narrow Gauge Track*

44 *Standard Gauge Track; Includes 10% contingency margin*

45 *F. Mau, Design and Construction of Trackwork using Timber, Steel and Concrete Sleepers. Railway Engineering Symposium, I.E.Australia Melbourne, 1983, for track lengths of 7-30km.*

46 *1983 cost of $230,000 was inflated to reflect 2000 prices. The annual rate of inflation applied was 4.75% (Reserve Bank of Australia).*

47 *Confidential Client, heavy haul railway situation*

48 *68kg HH rail and track suitable for 40t axle loads*

49 *Ref. letter from Ulan Coal Mines Limited to Dr. Thomas Parry, IPART, dated 17 June 1999*

50 *Probably included turnouts and road crossings, but was constructed with minimum ballast and 53kg rail.*

51 *Confidential Booz·Allen & Hamilton information*

52 *Expected to be high because of the nature of the price*

difference is probably generous but we have taken the view that it is not unreasonable in this exercise.

The HRATF note several other rates that are significantly lower in the QCA case, notably turnouts, level crossings and fencing. It should be noted that the particular specification details of turnouts determine costs – notably in the switch and frog areas – hence how comparable these rates may be is questionable. It is most unlikely that the QCA rates for public level crossings include any allowance for signalling and the fence rates quoted from the QCA work bear no resemblance to any figures obtained for this project in NSW – recognising that gates, river crossings, and manproofing have to be allowed in the rates.

5.4 Turnouts

Two basic turnout configurations were considered: 1:12 for main line application and 1:9 for siding and terminal application. In each case concrete bearers were allowed, plus tangential switches and Class 1XC track. The main line 1:12 turnouts include Huckbolted chrome vanadium steel frogs; the 1:9 turnouts allow for Huckbolted fabricated rail frogs.

A 1:12 crossover was separately costed, plus a catch point and 60° diamond. In each case Class 1XC track was allowed.

The resulting installed costs follow. The catchpoint costs include associated signalling works, while the remainder exclude associated signalling works.
- Turnout, 1:12 - $141,443
- Crossover, 1:12 - $286,975
- Turnout, 1:9 - $110,971
- Catchpoint - $44,799
- Diamond - $191,791

Details of costs are provided in Appendix F.

5.5 Miscellaneous Track Assets

Fencing was estimated using typical rural rates plus an allowance of a double gate at 2km intervals. This resulted in a rate per single fence km of $14,494. As there was no practical means of determining the extent of man-proof fencing, the rather healthy allowance of a double gate every two kilometres is intended to balance. Details are provided in Appendix F. Following input from Ulan Coal Mines Limited and HRATF this rate was reduced by 25% from the previously reported figure. This is still more than those stakeholders consider appropriate, but is less than RIC consider appropriate. It is also about 15% higher than FreightCorp consider appropriate. However, it is most unlikely that stakeholders other than RIC fully recognise the costs of manproofing quite significant lengths of track or of quite frequent creek and river crossings (notably at underbridges at about 3.5km intervals on average) and other details that add to standard rural fencing rates, hence it is considered that the $14,494 per single fence km figure is reasonable in absence of a more detailed determination of fence specification and scope.

Main road crossings were costed using rubber type components plus installation rates recommended by a supplier. A two road lane width allowance was made, resulting in an installed cost, excluding signals and communications of $26,255 each per track crossed. Signalled level crossings then had $50,000 per track crossed added to cover signalling and safety equipment (these costs were previously reported as part of S&C works).

Farm access crossings were costed using lesser specification rubber type components to suit a single road lane width. A $12,738 installed cost including two signs resulted.

FreightCorp consider the quality of crossing allowed for farm access is too high, and suggested a rate of $5,000 per crossing would be more appropriate. While there is merit in their case, there is equally uncertainty in the scope of work. In the case of public road crossings it is assumed that the local road authority undertakes related road works, (which assumption is challenged by RIC). However, in the case of farm access crossings it is highly likely that the approach works would have to be completed by the railway constructor. Hence, while it is acknowledged that the crossing type is rather highly specified, it is arguable that the actual rate per crossing should be retained to allow for related works. Furthermore, it is arguable that better crossing facilities than have commonly been provided in the past would be appropriate for highly trafficked coal lines, in order that crossing vehicles would occupy the line for minimum time.

RIC has provided a list of crossings in three categories, signalled public, unsignalled public and private. Their totals are respectively 22, 34 and 129. RIC's rates for these are $150,000, $87,000 and $12,738 respectively. These figures result in an ORC considerably higher than previously estimated, ($8.35M, cf. $2.2M). Further detail was requested of RIC. In response RIC provided two estimates for road crossings. Their specialist consultant Currie & Brown provided a detailed estimate for an unsignalled crossing totalling $210,000 per railway track. RSA provided a detailed estimate of $390,000 for a signalled crossing, though without detailing the numbers of tracks allowed. Compare these with the QCA "public crossing" rate of $38,000 per track.

Additionally RIC have provided the following statement. "… under the Public Works Act (1912), the authority that severs a public roadway or access to private landholdings is responsible for the construction and maintenance of the 'accommodating' crossing between the authority's land boundaries. RIC's responsibility in respect to level crossings, between the railway land boundaries, has also been confirmed as part of the vesting of the SRA assets to RIC (then RAC) in 1996/7".

RIC provided a listing of 185 crossings. The ORC reported here includes 108 crossings. A detailed check would be required to determine what proportion of crossings were established subsequent to construction of the railway (as is most likely to be the case). While public policy may require RIC to maintain crossings, as RIC appear to imply, that social responsibility does not obviously flow to coal shippers. It follows that, applying the assumptions previously stated, the actual crossing numbers allowed in the ORC process are as likely as any to be reasonable.

As the range of crossing number and rate figures are so hugely divergent, the ORC has been left as previously reported.

RIC actual costs were used for sound barriers, totalling $9.1M.

5.6 Bridges

Bridge replacement costs are generally based on an estimate of the cost to replace a bridge in modern equivalent materials to the same standard (i.e. on the existing line, size of bridge and load capacity). Estimates are based on an analysis of current market costs to build bridges on new sites ('green field'). However, there are very few new railway bridges meeting this criterion, so there is little observable data to guide the development of replacement cost estimates for bridges.

Unlike other railway assets, bridges are commonly unique designs suiting particular locations. While assumptions regarding standardisation of components such as precast concrete beams assist assessment of replacement cost, the practical issue to hand is development of credible replacement costs for existing bridges, complete with existing location, dimensions and, within reasonable limits, materials. Some bridges are quite major structures which would each attract a very great deal of detailed engineering and estimation to determine location, dimensions and materials. Clearly there is no opportunity to apply any comparable effort in this project in structure assessment. Hence, in general, existing bridge forms were assessed, and unit rates applied to identify replacement costs.

A further issue to consider is bridge definition in order that the scope of bridge types to be estimated could be determined. Here, bridges are defined as structures with a deck that spans an opening and is supported on two abutments and may have intermediate piers. By comparison, culverts are either cylindrical pipes, or box structures that include a structural floor, or variations of these themes.

Bridges considered here include three types:

- Underbridges for rail traffic over waterways, gullies, roads, etc;
- Overbridges provide vehicular access over the railway,
  - RIC is responsible for some vehicular overbridges, generally where the road pre-dated the railway; while
  - the RTA, Local Councils or private companies are responsible for other road-over-rail bridges where they were constructed over the existing railway;

- Footbridges for pedestrian access across the tracks which are not associated with stations.

FreightCorp consider that all overbridges should be the responsibility of others – "These should not be included as part of the coal network assets as they do not contribute to the rail coal haulage task". FreightCorp identify 7 footbridges and 24 road bridges which they consider should be excluded.

The bridges included in the valuation assessment are those which are understood to be actually maintained by RIC. Indeed, many more bridges were identified by RIC as being present (RIC arranged to have a check of bridge details undertaken for this project, resulting in some changes to bridge numbers previously reported) but the assessment considered only those which were actually maintained by RIC. For example, the New England Highway overbridge east of Thornton, at about 180km, is not included in the evaluation.

The HRATF notes that bridges having a small span would be constructed as culverts if "modern equivalent form" were properly considered. There is certainly validity in this position. However, some circumstances also require foundations even when a span may be short, so as to provide adequate stability. This assessment has not included sufficient checking of particular bridge circumstances to allow these sites to be inspected – an example quite likely being the series of short spans over Coggan Creek in Sector 441.

The HRTAF query three apparent bridge duplications, one each in sectors 507, 510 and 536. As noted before, the particular bridge design actually utilised at any one location depends upon many factors, few of which are available for consideration for DORC assessment purposes. Add to this the common separation of railway bridge decks on heavy haul railways to allow, (i) common bridge deck units, (ii) separation of bridge decks by track for maintenance purposes, (iii) separation of bridge decks for design purposes due to torsion arising from single track loading , together with separation or combination of piers and abutments depending upon circumstances. The DORC process cannot individually check bridges in the Hunter Valley to determine what design and construction procedure would be most appropriate: the bridge data presented represents a reasonable assessment of bridge cost.

5.6.1 Data Requirements

Data critical to provision of accurate estimates of replacement cost include:

- Location of each bridge by kilometrage, line and sector
- Numbers of bridges
- Types of bridges (Underbridge, Overbridge, Footbridge)
- Dimensions of bridges (length and width)
- Bridge loadings
- Foundation details
- Material and number of substructure (abutments, piers)

- Predominant deck material

In reality much of this detail was difficult to obtain. Hence the approach adopted was to identify as closely as possible the location, size and construction materials, then apply unit rates to assess typical bridge replacement costs.

5.6.2 Replacement Cost Methodology

The replacement cost of a bridge is the cost of replacing the existing structure on the same alignment and dimensions but constructed with modern day equivalent materials and techniques. This is particularly the case with timber bridges which are more expensive to build than their modern equivalent owing to scarce resources.

Approach

The approach adopted is based on bridge type, span length and width. Each bridge replacement cost is estimated and summed to give an overall valuation for all the bridges included within the study.

This approach aims to be consistent with current valuation practices while recognising available data. The data supplied by RIC was assumed to be accurate, yet it only contains limited information on some of the factors that influence bridge cost.

Factors influencing bridge costs include:
- Load capacity (impacts all cost aspects)
- Number of track requirements and width of bridge deck (impacts selection of optimum design, type of substructure and construction costs)
- Type of opening and resulting clear span (impacts method and cost of construction over waterway, rail, road, gully, etc)
- Height of span (impacts cost of piers and cost of falsework)
- Geotechnical criteria (impacts bridge selection and foundations cost)
- Accessibility to the site (impacts construction cost)

Many of these factors are not included in the inventory of bridges and cannot be quantified for this project. This limits the approach to valuation and cannot be overcome by averaging large amounts of data.

A simple linear cost model derived from span or area for different bridges has generally been adopted by most infrastructure agencies. The assumption is that bridge cost is generally proportional to span length or deck area. This is consistent with the approach which has been adopted here.

Unit rates

Historical bridge cost data from RIC combined with industry practice were used to develop the following generic bridge unit rates for 'green field' construction:

TYPE	UNIT RATE
Underbridge	\$15,600 / m / track
Overbridge	\$1,500 / m^2 deck area
Footbridges	\$4,000 / m span

Note that the unit rate for underbridges has been increased from the preliminary estimate of \$14,000 / m / track following review of stakeholder comments and further review of industry pricing as applies in the Queensland Rail experience (see further comment below). Specifically, these rates now include all costs. RIC considers a further 11% should be added for design costs, client costs and margins.

To allow for additional tracks (i.e. increased width) the following cost multipliers were applied to Underbridges:

NO. OF TRACKS	COST MULTIPLIER
1	1.0
2	1.8
Each additional track	+ 0.8

These cost multipliers assume that investigation, design, supervision, site establishment and mobilisation of resources reduces costs through economies of scale for each subsequent track. RIC consider these reduction factors should not apply, but construction experience suggests they are reasonable.

The formulae outlined in Figure 5.1 below, together with the above unit rates, have been used for estimating bridge replacement costs.

Figure 5.1 Bridge Replacement Cost Formulae

The overall formula for valuing an Underbridge is:

$$RV_n = S_n \times UR \times (1 + CM(T_n - 1)) \quad \text{...................... (1a)}$$

where	RV_n	*Replacement value Underbridge 'n'*	*$*
	S_n	*Total span of bridge structure*	*metres*
	UR	*Unit rate*	*$/m*
	CM	*Cost Multiplier = 0.8*	
	T_n	*Number of tracks*	

The overall formula for valuing an Overbridges is:

$$RV_n = S_n \times w_n \times UR \quad \text{...................... (1b)}$$

where	RV_n	*Replacement value bridge 'n'*	*$*
	S_n	*Total span of bridge structure*	*metres*
	w_n	*Width of bridge deck kerb to kerb*	*metres*
	UR	*Unit rate*	*$/m²*

The overall formula for valuing a Footbridges is:

$$RV_n = S_n \times UR \quad \text{...................... (1c)}$$

where	RV_n	*Replacement value bridge 'n'*	*$*
	S_n	*Total span of bridge structure*	*metres*
	UR	*Unit rate*	*$/m*

While a 'green fields' unit rate is the target, there are no recent examples of bridges being built in a 'green fields' fashion in the Hunter area, though one bridge replaced five years ago was analysed.

Estimates have been obtained from Queensland Rail, which are upgrading and replacing bridges. Also unit rates used for valuing road bridges were provided by RTA-NSW.

Modern construction techniques for railway bridges favour the use of standard sizes of precast concrete units that can be cast in a production line, transported and then placed. There is also a trend to replace short span bridges with culverts to minimise costs, resulting in a reduction in bridge numbers over time. These aspects have not been specifically allowed, but are factors that would impact upon any more detailed analysis.

RIC Historic Cost

The one bridge constructed recently in the region (in 1998 in Sector 428 at 232.167 km at Muddies Creek) has the following cost profile provided by RIC:

Design	$11,000
Supervision	$50,000
Substructure	$1,278,097
Superstructure	$282,695
Total Cost	$1,621,792
Length	44.00
Tracks	2
Piers	3
Unit Rate $ / track / m	$18,430

The average rate is $18,430 / track / m which can be disaggregated into superstructure $3,340 / track / m and substructure $132,800 / track for each pier or abutment.

The average length of bridge for Hunter Valley is about 27 m supported by between 3 and 4 piers. Muddies Creek is longer and has longer spans than average and was built under traffic constraints. Hence the cost per metre noted above seems reasonable by comparison with the costs developed for this project.

Market Rates

Queensland Rail are undertaking an extensive program of Underbridge upgrading. They state that average unit rates lie in the range from $13,000 to $20,000 / m for a single narrow gauge track concrete bridge designed for 25 t axle loads. These rates include all costs and are market based[53].

Adjusting these rates for 30t axle loading and to standard gauge, using a 20% increase results in a range of $15,600 to $24,000 / m per single track. Muddies bridge, built by RIC, is within this cost range. Use of this 25t to 30t proportional increase appears inconsistent with valuation based on replacement with assets equivalent to those existing - in this case presumably 25t axle load designs. In fact, bridges in the Hunter Valley were designed for Cooper M250 (in earlier designations) loadings, which are higher than nominal 25t due to the number of axles and their spacing (being to suit steam locomotives). Hence the 30t approach approximates an appropriate DORC approach in the case of structures.

53 *These figures have been adjusted upwards from the previous report following further discussions with Queensland Rail which identified that the previous rates had excluded certain elements, including design and supervision.*

The RTA-NSW has developed unit rates for road bridges based on structural types. The unit rate per m^2 of deck area lie in the range of $1,200 to $1,400 / m^2 for typical bridge types, while steel truss bridges are $2,300 / m^2. These rates include all costs and are based from a fair sample of contract bridge construction projects.

To be compared with rail, assume that 1 track is equal to 1 lane (3.6m of road width) – the unit rate is $5,000 / m which is a third of the rail. Reasons for the lower cost include:

- Rail bridges are designed for much higher axle loads; and
  - Rail costs reflect construction under traffic, while road bridges are generally 'green field' sites (road traffic is deviated away from the site).

Bridge Numbers

The inventory of bridges and their details was difficult to obtain in a single set of information. A number of requests were generated to ensure that a complete and up to date inventory of bridges was being valued. Various bridge data updates were combined into a single database for use on this project.

The valuation is related to the designated coal lines and main lines which carry coal traffic. There were 271 bridges valued for the coal lines for the Hunter bundle,and for the line sectors between Maitland and Stratford, and between Newcastle and Newstan.

Overbridges and footbridges in some locations span both coal and non-coal lines. These bridges are usually referenced by the Main Line Sector and not the Coal Line. A review of bridges apportioned the value of bridges between the Coal lines and the non-coal Main lines. The following rules were applied:

- 100% of the value attributed where the bridge is only associated with the Coal line;
- 50% of the value attributed to Coal and 50% to non-coal where the bridge spanned both lines or carried both lines; and
- 0% of the value attributed to Coal and 100% to non-coal where the bridge was only associated with non-coal lines.

5.7 Safeworking and Communications

Technological change determines that the safeworking and communications infrastructure that would be installed in an asset replacement programme would be significantly different from that which presently exists. Even more so than is the case for bridges, the following cost estimates are theoretical in nature, as practically no design work or even specifications exist relevant to the optimised network. A great deal of judgement has been applied in establishing the estimates.

A range of sources for pricing information were used. These included operating railways information, Currie & Brown and RIC information, commercial and contractual information available within Booz·Allen & Hamilton offices. Following considerable further discussion with RIC and their consultants GH&D regarding the scope and cost of signalling infrastructure, the following rates were developed:

- Signals - $25,887 per unit
- Turnouts - $61,124 per set
- Track circuits - $21,179 per unit
- Location cases - $20,000 per unit
- Medium interlockings - $350,000 each
- Cable and power supplies for whole network - $21,569,841

A medium interlocking would cover a small number of turnouts, such as one end of Hanbury Junction. A separate interlocking is then allowed for on each side of Hanbury Junction, for example.

RIC consider that these rates should attract a margin of 23%, but the resulting rates are then thought to be higher than reasonable. Hence, as with the track rates, some allowance is considered reasonable for client costs and integration. An additional 3% is consequently allowed.

RIC interprets this 3% to cover all overheads and margins. This is not the case. The rates quoted above include <u>all</u> costs, including design, procurement, margins, profits, overheads, etc., etc., except client (owner) based costs only. The 3% allowance added over the rates above are to cover for client costs only. RIC considers a 14% margin should be added to the above rates but in our view this is excessive.

The results for communications are:

- Phone costs for remote PABX - $250,000 each
- Phone costs for the Operations Control Centre (OCC) - $500,000
- Switching and routing nodes or hubs , cost per remote node - $200,000
- Switching and routing nodes or hubs , cost per OCC node - $400,000
- Backbone system, i.e. transmission routes, fibre optic - $25,000 / km
- Microwave - $400,000 per node
- CountryNet Radio costs, base station - $250,000 each
- CountryNet Radio costs, OCC equipment - $400,000

RIC consider these rates should attract a margin of 23%, but the resulting rates are then thought to be higher than reasonable. Hence, as with the track an additional 3% has been allowed in signalling for client integration, this is considered to be adequate to cover the client side of communications also.

As noted for signals rates, RIC consider a 14% margin should be applied to the above communications rates to cover overheads. Also as noted before, these rates include all costs except client (owner) based costs, for which 3% is allowed.

A significant increase is reported for signalling costs by comparison with the Draft Report. This arises primarily for the following two reasons. Firstly, the estimated cost for the new control centre was previously incorrectly reported. Secondly, and allowance has been made for a buried continuous trunk line signalling cable alongside track over the whole network to provide for appropriate levels of security of safeworking systems for this high tonnage system.

RIC comments that the above rates for radio base stations a $250,000 each are approximately twice their estimate, but that the numbers of installations are approximately half their estimate. Whatever the merits of the design approaches, the ORC would appear to be approximately correct, including coverage of the Newstan to Woodville Junction area. RIC also comments that "… no cost included for copper cabling in some sectors". It appears that some revisions to the estimated communications scope may have occurred, as the record shows, "Subsequent to the meeting [referenced by RIC], it has been agreed with RAC and GHD that it is unnecessary to price for twisted pair copper cable as part of the backbone system, as any trackside telephones can use the lineside cabling provided as part of the signalling system backbone."

5.8 Optimised Replacement Costs

Widely varying procedures were utilised to establish replacement costs for assets in the Hunter Valley. The Report states where costs are based upon reasonably accurate information, and where judgement has been applied. The dominant replacement cost unit rates most affecting the Hunter Valley Coal Network valuation are the $580,513/km and $564,833/km rates for plain track.

In addition to the replacement costs for the physical assets in the Hunter Valley, it is necessary to also consider the costs of financing construction. Any major rail infrastructure construction project is likely to be spread over a number of years as the project moves from initial design through to completion and commencement of operations. An issue is whether an allowance for the costs of financing construction (i.e. capitalised interest) should be included in the DORC valuation and hence the regulated asset base.

The Queensland Competition Authority, in its recent determination of QR's below rail DORC value, allowed 7% for the financing costs associated with construction of QR's coal network[54] and we understand IPART has also allowed financing costs to be included in DORC valuations in other sectors.

In this case, including an allowance for financing costs would be consistent with the general approach taken in establishing this initial DORC. Replacement costs have been assessed based on 'production rate' replacement, realising the associated efficiencies and economies of scale, and full-time possession of track. Allowing

54 *Queensland Competition Authority, "Draft Decision on QR's Draft Undertaking", Dec 2000 p147.*

capitalised interest would therefore be consistent with these greenfields construction assumptions.

An argument against inclusion of financing costs is that the Hunter Valley rail network has been 'income producing' for decades and that the financing costs associated with construction of the existing stand-alone coal network would have been expensed long ago. FreightCorp has suggested that the construction of a greenfields Hunter Valley rail network could be staged so that sections become 'income producing' within a relatively short period (several months) and when combined with normal terms of credit of up to 90 days, no adjustment for financing costs is necessary. Clearly though, full replacement of the Hunter Valley rail network, including structures, signalling and communications, would be staggered over quite some months. In the case of the greenfields Alice Springs to Darwin railway, a three year construction period is planned with debt financing costs capitalised into the asset base over this period.

On balance, we believe that it is appropriate to include an allowance for financing costs in this initial DORC in order to be consistent with the other greenfields construction assumptions we have adopted (which typically produce lower costs than otherwise). While indeed the Hunter Valley network has been income producing for many years, we have not included any allowance for 'deviations' or other works required to ensure continuity of service (and income) during major infrastructure construction. In the future, whether financing costs are included in the regulated asset base for new capital expenditure depends on actual experience and the Access Regime.

Notwithstanding the higher cost of capital for RIC, we consider that an allowance of 4% for financing costs would seem reasonable for the RIC Hunter Valley network, compared with 7% allowed by the QCA for QR. The relatively shorter average haul in the Hunter Valley and exclusion of earthworks from the DORC would both act to shorten the period over which cash outlays are outstanding during construction and would suggest a lower allowance for financing costs is appropriate.

The Optmised Replacement Cost for the relevant rail network assets of Category 1 and Category 2 mines, assessed on a stand-alone basis, are summarised in Table 5.2 below.

Table 5.2 Optimised Replacement Costs for Category 1 and 2 Mines

ASSETS	ORC Without Financing ($M)	ORC With Financing ($M)
Track	390.0	405.6
Structures	124.9	129.9
Signalling / Safeworking	87.3	90.8
Communications	25.2	26.2
Total	627.5	652.6

6.0 CONDITION ASSESSMENT

6.1 Introduction

This Chapter outlines the condition assessment of the assets employed in the Hunter Valley coal rail network.

The condition assessment is relevant to the initial discount to be applied to the optimised replacement cost calculation to arrive at the DORC values.

6.1.1 Implications Of Current Infrastructure Configuration

In identifying the infrastructure configuration required for the July 1999 and 2004 coal transport task, it should be recognised that in fact the current system is used by a range of traffic, while the condition assessment task requires the minimum configuration used by coal traffic to be reviewed.

A significant feature of this minimum configuration should be understood. The existing track structure was designed and constructed to suit 25t axle loads, while much of the present coal traffic operates at 30t axle loads. Consequently the life expectancy and condition of assets are likely to be affected, depending upon variables such as quality of maintenance.

RIC emphasises that track upgrade work has matched increased traffic. While this is the case, there remain assets such as 60kg standard carbon (relatively soft) rail that has yet to be replaced with 60kg head hardened (relatively hard) rail and sleepers that were intended to carry 25t axle loads and which now carry 30t axle loads.

Maitland to Stratford and Newcastle to Newstan are multi-use lines on which coal traffic represents a relatively small proportion of total traffic. The approach to age and condition assessment on these lines has been modified to take account of what might be considered to be typical infrastructure configuration for general traffic, modified by judgement of coal traffic effects. For example, timber sleepered track is assumed to have an average sleeper age of 50% of life and rail age is considered to be 50% of life.

The great majority of track covered by this review carries predominantly coal traffic and has been assessed in considerable detail.

6.1.2 Train Movements And Tonnage

A review of DMR's *A Strategic Study of the Northern NSW Coalfields,* November 1999, plus an earlier study dated February 1991 allowed for an approximate determination of the total coal traffic carried by the lower part of the coal network from 1983 to 1999. This period corresponds to the age of much of the older parts of the track infrastructure, and hence is material to the determination of asset condition. Over that period approximately 590Mt of coal has been exported. While details of the track over which this tonnage was actually transported are not practically available, it might reasonably be concluded that, after making nominal allowance for the location of coal loaders, variability of tonnage along the valley and vehicle tare, then (very approximately) 600MGT (million gross tonnes) of traffic has passed over the Up Coal line between Maitland and the Newcastle coal terminals.

Note that considerable coal export tonnage originated from mines that were close to Newcastle, so the 590Mt of exports' correspondence with the 600MGT of traffic is tenuous, but a reasonable best estimate.

This 600MGT figure is important as it allows some quantification of wear-determined condition. It is even more important when placed in the context of the 84MGT current operations quoted above. That is, the ramp-up of coal tonnages in recent years results in life being consumed (in wear terms) at a far higher rate today than was the case only a few years ago.

FreightCorp make the point that some assets degrade for reasons other than tonnage and this is acknowledged. The assessment has used the most appropriate life consumption approach, including tonnage, age and measured data, all dependent upon data availability and quality.

Both FreightCorp and HRATF consider that past capital expenditure and MPM works should be recognised in determining how assets should be valued. The condition assessment reported here has simply reviewed current assets in their current state.

RIC provided several sets of commentary upon the particular issue of rail life tonnage in the Hunter Valley. Currie & Brown, in a report to RIC upon the Condition Working Paper, suggested the 600MGT figure noted also should be treated at a 90% of life figure and hence the full life figure should be 667MGT. However, according to RIC, about 50% of the rail in question has already been renewed, presumably at a lesser tonnage than the 600MGT figure. Accordingly the 600MGT figure was retained, though this was again subjected to further review.

RIC's second commentary provides assessments of rail life in the Hunter Valley. A report by S.Marich, dated 16th August 2000, lists percent head wear of rails on the Ulan, UP Main and UP Coal lines in the Hunter Valley. These indicate very little rail wear has occurred. The list also indicates that all, or nearly all, rail on the UP Main and UP Coal lines dates from 1983-1986, whereas the advice provided by RIC previously was that 50% of this rail had been renewed.

The Marich report also indicates that 40% rail wear in the Hunter Valley is permitted before replacement is required, and consequently that rail life up to 8,510 MGT is predicted on tangent track.

The following points become immediately apparent.

i. The advice provided by RIC was that the Up Coal had been installed in around 1984 as 60kgSC throughout the valley except for a relatively limited amount of curves, and that the Down Coal had been installed as 60kgHH throughout. It was recognised that this advice was a generalisation (for example areas of 53kg remained).

ii. RIC / Marich report that the Up Coal was installed as 60kgHH.

iii. RIC advice was that about half the 1984 rail had been replaced in recent years by 60kgHH rail.

iv. RIC / Marich report that 26.0% of the Up Coal Rail in Sectors 509 and 510 has been renewed "since 1993".

v. According to the limited RIC asset register records received on 29 June 00, approximately 33% of Sector 510U rail is 60kg and 53kg SC, and approximately 40% is post 1991 60kgHH, the remainder being pre 1991 60kgHH. Sector 509U has about 15% post 1991 60kgHH rail, the balance being predominantly pre 1991 60kgHH rail. Adding the replacement quantities for Sectors 509 and 510 results in 27%, which is close to the 26.0% figure quoted by Marich.

vi. According to RIC, Sector 506U was replaced in 1994 and again in 1997, and is presently 60kgHH. Sector 505U was replaced in 1994 and is presently 60kgHH rail. Sector 502U was replaced in 1996 and again in 1999, and is presently 60kgHH rail.

vii. According to the RIC asset register, Sector 509D has a mix of SC and HH, 60kg and 53kg, pre and post 1991 rail. Sector 510D is reported to be all HH. Sectors 428U&D and 416U&D is a mix, not particularly following any generalisation of age or type.

Aside from data inconsistency, the outstanding concern is the reasonable derivation of a rail life assumption for use in life assessment. The assessment reported here is based upon the approximation of 600MGT of traffic having been carried between Maitland and Sandgate on 60kgSC rail. As about 50% of this rail was said to have been replaced (or was shortly to be replaced, perhaps), then this was taken as a reasonable indicator of rail life of 60kgSC rail, on average, allowing for curves, tangents, grades and train speed with rail management experienced in the Valley. An assumption was then made that 60kgHH rail could reasonably be expected to provide, on average, 1000MGT life in the same conditions.

If in fact 26.0% of this rail has been replaced, a longer rail life would be indicated for the presumed 60kgSC rail, and hence in turn for 60kgHH rail. If the rail concerned was not 60kgSC, but was in fact 60kgHH, then a shorter life would be indicated for both 60kgHH and 60kgSC rail, on average, allowing for curves, etc., etc., as before.

Given all the variables, the chances are that the overall effect is a balance, and consequently the rail life consumed by tonnage, as reported here, is likely to be reasonable. For instance, there would appear to have been more 60kgHH rail installed prior to 1991, indicating a shorter rail life than assumed, balanced by a smaller replacement rate, indicating a longer rail life than assumed.

It should be clearly emphasised that wear normally would be determined by profile measurement and analysis, and that normally an 80MGT operation would utilise continuous, automated, rail profile measurement as part of rail asset management. Tonnage has been used as a proxy for wear, as no profile data was made available. As RIC / Marich appear to have access to rail profile data, the whole issue of rail life could be reviewed utilising real rail wear data, though RIC / Marich's forecast of 8,500 MGT8,500MGT, which figure is three to four times current world best practice where that practice includes management procedures not applied in the Hunter Valley, could not be regarded as conventional, (Marich's report dated 4 April 2001 suggests this "… may seem exceptional …"). This leaves outstanding the question of what rail life should be considered in the absence of any detailed wear data, let alone world best practice data.

(In response to RIC / Marich questioning the process outlined in the following paragraph, this has been amplified from the previous report.)

Rail in sector 506U was renewed in 1994 with 60kgHH rail and again in 1998, according to RIC's maintenance personnel. . Approximately 150MGT of traffic passed in that time. Compare this with RIC / Marich's forecast, which would indicate the rail should last 720MGT on the high leg and 1440MGT on the low leg. An average multiplier of 7.2 from real life to forecast life results. Taking RIC / Marich's forecast of 8,165MGT for track having curvature of 1001-4000m as generally representative of the Valley, dividing this by the 7.2 factor suggests 60kgHH rail life might average around 1,134MGT in the Hunter Valley. That is, the DORC rail life analysis should reasonably allow a 15% increase over previous assumptions, which themselves were based upon observation of real rail life in the Hunter Valley. The end result is within a reasonable range of likely life given careful (though not necessarily world best practice) rail management and consequently life consumed estimates have been amended to suit.

Clearly analysis including actual rail type and age, and actual condition would assist. However, it should be noted that not only is the base data confusing, but RIC's interpretation varies radically with time. HRATF provide considerable detail of rail lives presented by RIC in recent times, ranging from around 400 to 800MGT for standard carbon rail, depending upon RIC source.

Quite what the rail life on the coal lines in the Hunter Valley might be is not clear, but, assuming sound rail management practices are implemented, head hardened rail should be able to achieve 1150MGT life. As is further discussed below, a range of analysis techniques are used to match rail condition and rail remaining life.

RIC's Currie &Brown report raises a further important point. They note that asset lives are affected by more than one factor, and advocate use of a degradation curve approach. In principle this is a sound approach, but in reality very precise measurement and management of assets over a significant extent of each asset is required if the approach is to be robust. No such data has been made available.

6.1.3 Data Sources And Quality

The data used to determine asset age and condition has been provided by RIC. Field visits have served to validate the RIC information and to contribute to its interpretation. Age and condition have been discussed at many meetings held with RIC both in Sydney and in the Hunter Valley.

FreightCorp has expressed concern about the accuracy of some of the data reported in the working papers. This is especially the case with respect to rail type and location, and ballast cleaning. RIC advice has been followed for this assessment.

Track age data has primarily been obtained by interviewing RIC personnel as there is very little documented information available. Track condition data has primarily been interpreted from track recording car data and rail flaw databases.

Structures and train control age and condition data has been obtained from a variety of sources, including several RIC supplied databases, plus many discussions with RIC and ARGUS personnel.

As a general statement the supplied data has required extensive manipulation to organise by sector, extensive filtering to remove mutually contradictory records, and very extensive validation and checking to create accurate details of location, asset description, age and condition for assessment purposes. The result cannot be said to be wholly accurate, but represents the best possible compilation for the purposes of the project valuation scope. As a simple example of the limitations of the compiled data, rail wear details are very sparse, materially affecting the accuracy of condition assessment. Given the tonnage and the observed wear, the lack of comprehensive wear records is surprising.

In the absence of solid data on condition, age and tonnage passed, a series of calculations have been made to estimate each, using proxies where appropriate. Hence, for example, in the absence of rail wear data, tonnage passed is used, factored with respect to rail lives discussed above.

6.2 Track

6.2.1 General

Track recording car (TRC) data has provided an essential input to the condition assessment for rail, sleepers and, especially, ballast. The TRC data used is that which provides vertical and lateral alignment, superelevation (known also as track cant) and twist (sometimes also known as warp). An example follows:

```
TRACK RECORDING CAR RAIL CALIBRATION SURVEY
TRACK CODE: 423320                      RECORDING DATE : Wed 23.02.00
POST EVALUATION REPORT GENERATED on Tue 24-Aug-99
FROM KM :  168.052   TO KM :  163.647
     NEWCASTLE to WOODVILLE JCT
C next_page
```

METRAGE	GAUGE	SUPER-EV	LINE DN	LINE UP	TOP DN	TOP UP	TWIST
168.052	1438.9	17.0	34.0	35.3	2.0	5.4	1.9
168.051	1439.9	16.9	41.5	46.4	0.1	4.4	-1.6
168.050	1439.5	15.4	51.0	53.5	0.4	4.0	1.5
168.049	1441.0	14.3	57.6	60.5	-0.3	2.6	1.5
168.048	1439.4	13.8	65.4	65.8	-0.9	4.4	3.4
168.048	1437.3	14.0	71.8	65.8	1.0	5.4	1.4
168.047	1436.9	14.0	76.1	68.6	0.9	4.6	0.1
168.046	1436.6	13.4	80.8	73.0	-0.3	0.8	0.4
168.045	1438.5	11.8	79.5	74.5	0.6	1.3	0.4
168.044	1440.3	12.5	79.3	72.5	2.0	5.3	1.5
168.043	1441.1	10.1	74.4	69.6	3.5	4.4	3.3
168.042	1440.1	8.4	67.1	65.1	4.3	3.0	3.3
168.041	1436.5	7.8	59.6	59.3	3.9	1.4	3.9
168.040	1423.6	6.8	56.4	47.1	1.3	0.3	3.4
168.040	1423.0	5.0	51.1	38.8	-2.8	-2.1	3.3
168.039	1431.0	5.5	43.5	31.1	-2.9	-2.6	2.1
168.038	1436.4	6.1	40.3	31.6	-3.5	-4.4	2.1
168.037	1435.9	5.1	34.4	26.5	-5.8	-7.4	-0.1
168.036	1435.5	8.4	25.1	20.3	-5.9	-6.8	-2.9
168.035	1435.4	9.9		15.3	-4.6	-7.8	-4.4
168.034	1435.9	11.0		9.4	-3.1	-8.4	-4.4
168.033	1436.6	12.0		4.3	-1.4	-5.5	-3.6
168.032	1439.4	12.3		2.3	0.4	-2.5	-2.4
168.032	1430.3	8.8		-1.8	1.5	-0.5	-2.4
168.031	1426.9	5.6	2047.9	-8.0	1.8	0.8	6.4

As can clearly be seen, the data is reported at 1m intervals. However, the actual interval is somewhat less, and so a double record is generated approximately once every 10m – as may be seen at kilometrages 168.048 and 168.032 above. Also evident are gaps in data and spurious data in the LINE DN column. Less obviously, but no less importantly, the TRACKCODE reported on the second line nominally corresponds to a defined section of track, but the actual length of track reported is indicated on the fourth line, which section of track need not necessarily lie wholly within the TRACKCODE. There is no pre-defined relationship between the TRACKCODE and RIC's sectors. The data has been "cleaned up" as much as possible, for instance treating Top data points over the value 30 as spurious.

RIC have pointed out that the particular sample data segment shown above lies outside the project scope. This is correct, though the particular data shown above was not in fact used in the assessment – it is included here as a convenient sample. Examples could be substituted from Sectors 416, 428 or any one of many other sectors where such data is present.

Sample data from each of the past four years have been reviewed to ensure consistency of both data and its interpretation. Hence a database of approximately 2.4 million records was established for interpretation purposes, with each record identified by sector, kilometrage, recording date and source file.

Each record includes a range of mathematical and statistical analysis. This data was generated from both the particular TRC record and arrays of records. For example, if two points (TOP UP, say) are joined by a line, the angle can be calculated between that line and another line joining one of those points and an adjacent point. Measured in milliradians, this angle provides an important check on the condition of rail.

The database was created using Visual Basic applications. These allow visual interpretation of the data, an example being illustrated in Figure 6.1 below.

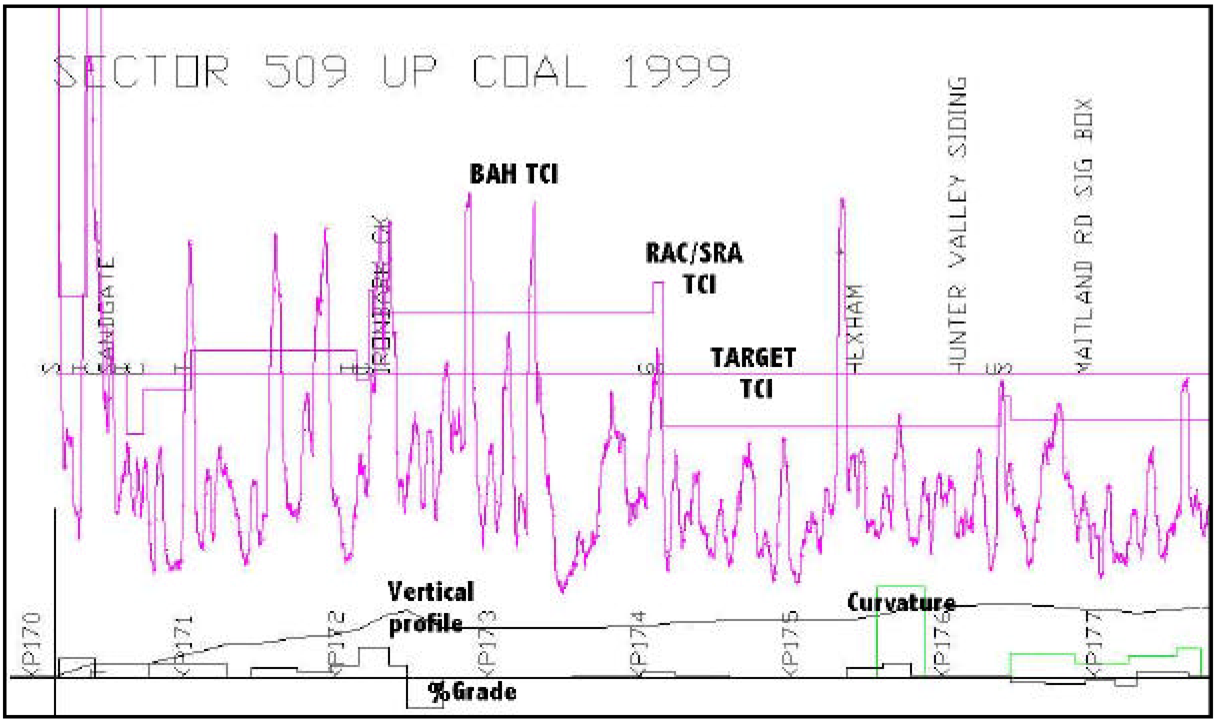

Figure 6.1 – Sample Track Condition Data

This example shows an early stage of development in which the TCIs (Track Condition Indices) as reported by RIC were being compared with TCIs generated from the Booz·Allen database[55].

55 Booz·Allen has not computed all TCIs for the Hunter Valley as other interpretative analysis was used, but a check was made to compare processes and to avoid obvious errors in comparison of TRC analysis methodology between RIC and Booz·Allen.

The example above shows a single horizontal, magenta coloured line representing TCI40, which approximates to the target upper TCI for this class of track: Sector 509U is the Up Coal line west of Sandgate – the figure indicates kilometrages and place names. The stepped horizontal lines crossing the figure represent the 1999 sample TCI data supplied by RIC. Clearly some of the track length is shown as exceeding the target TCI (that is, having a higher TCI than target, representing relatively poor track), while some of the length betters the TCI target (that is, having a lower TCI than target, representing relatively good track) - it should be noted that most of Sector 509U has TCIs better than target.

The part of Sector 509U shown in the figure clearly demonstrates the difference in approach used by Booz·Allen in condition assessment. The magenta coloured line which rises and falls along the track in accordance with local track conditions was generated by the same calculation as used to generate the RIC TCIs. Clearly much of the track shown as having high TCI (and therefore poor track) on the RIC report is in fact quite good track, but equally some of the track is in worse condition than the RIC TCI report indicates. Booz·Allen's approach analyses local conditions throughout the track length, and reports condition accordingly. The results are then summed for sector reporting. Note that Up and Down lines are separately analysed. Being the more heavily loaded, not unnaturally the results show the Up tracks to be in generally poorer condition than the Down tracks.

Turnouts were not separately recognised: they were assessed in accordance with adjacent plain line track. Both RIC and FreightCorp have queried this particular point. While this leads to some inaccuracy, the turnouts as a percentage of track represent a very small component: there is little data available on turnout age and condition. However, RIC point out that a considerable effort has been made recently in turnout maintenance and consequently condition should reasonably be considered better than adjacent track. In the absence of any better data, the condition of turnouts has been increased by 10%.

FreightCorp, HRATF and associated consultants have expressed general satisfaction with the assessment methodology, with some minor qualifications. For example, the 90% cap on life consumed (except for bridges) is questioned. The use of a cap is considered reasonable in that assets that contribute to passage of trains do indeed have some remaining life.

6.2.2 Rail

The assessment of life consumed is based upon:
- Tonnage
- Defect rate
- Impact geometry

Tonnage

As discussed in section 6.1.2 the available life of rail in the Hunter Valley is assessed as about 1150MGT for 60kgHH rail and about 690MGT for 60kgSC rail.

Figure 6.2 shows full life consumption of the rail on the left of the image, and may be compared with the new rail on the right (note in particular the difference in rail head depth)[56].

Figure 6.2 – Sample Rail Wear

Where mixed traffic is predominant on the Maitland to Stratford and Newcastle to Newstan lines, the tonnage life consumed is assumed to be 50%. Otherwise, a formula based on tonnage determines the percent life consumed.

RIC question the application of the tonnage formula. The process employed identifies the type and age of rail in any given sector. For example, Sector 428U has been assessed as having 50% 60kg rail at 17 years old plus 50% 60kgHH rail at 4 years old. Using coal tonnage data supplied by RIC, a formula determines the percentage life consumed for each rail type, based on tonnage per year plus years of life, compared with assumed rail lives of 690MGT for standard 60 kg rail and 1150MGT for head hardened 60kg rail. The result in this example is 51% tonnage life consumed. If any new rail were installed, the formula would determine the tonnage life consumed from the new % of each rail type and the matching rail ages, tonnages and relevant assumed total lives.

RIC specifically note that the formula used for life consumed calculations assumes "… that the entire sector length of rail will remain intact from the day it is installed to

[56] RIC advise that this particular rail has since been replaced under their routine renewal programme

the day it is life expired at which time it will be entirely replaced by a new sector of rail. This assumption is wrong because it ignores the impact of constant refurbishment …" It is hoped that the previous paragraph has clarified this issue: there is no assumption of single rail life per sector, nor, incidentally, of rail type or of tonnage rate. Figure 6.1 details the rail configuration across the coal network.

Defect rate

Internal rail defects or flaws are normally caused by any of a range of fatigue affects. The presence and size of these defects are found by automated ultrasonic detection systems, manual detection systems, visual identification and rail breaks. Ideally, all defect information is captured in a database, including precise location, plus age, type and size of defect (as a minimum) and associated observations such as traffic and wear. Rail life can then be analysed, with a statistical process developed by Weibull being the most common form of remaining life forecast. The RIC defect database is inadequate for this task. Hence a defect rate approach has been adopted for this project.

The number of defects per km per annum is a key indicator of the consumed life of rail from a fatigue perspective. That is, a certain defect rate would normally trigger rail renewal, regardless of wear condition. By analysing the RIC rail defect database a new database was developed containing defect data by sector, number and year. This process was difficult due to the nature of the data in the RIC database, and hence the results cannot be said to be 100% accurate. The defect rate analysis nevertheless represents a reasonable assessment of rail fatigue condition.

As rail defects can vary year by year (typically increasing over time, but with quite significant variations), and recognising the potential for inaccurate data points in the databases, the past five years' of defect rates were averaged in each sector for use in determination of fatigue life consumed.

A widely used defect rate that triggers rail renewal is two defects per km per annum, and usually the defects are summed for both rails in any track, and both rails are renewed together. Recognising that the Hunter Valley is predominantly a freight line, where risks consequent upon development of a broken rail are relatively small by comparison with track carrying many passenger vehicles, and the potential for inaccuracy in data (even after the averaging process described above) a rate of three defects per km per annum has been applied as the full fatigue life consumed limit. The consumed fatigue life was then determined by proportioning the averaged defect rate over any sector by comparison with the three defect criterion. While defect rates within sectors varied, it was considered that this process was sufficiently accurate for the purposes of life evaluation across the Hunter Valley.

HRATF sought assurance that the freight defect rate applied south of Newcastle. This was the same three defects per km p.a. as for the balance of the Hunter Valley area.

RIC and their consultants GH&D commented at length upon this approach and upon the defect rate deduced from RIC data. Essentially RIC questions the methodology, while GH&D question the selection of a three defect criterion. The following comments apply.

Regarding the critical defect rate for rail replacement, Armstrong et al. (1982)[57] report "Maintenance of way engineers often plan for rail replacements when defect rates become higher than [1.25 defects / km / yr]". This figure applies to one rail in this paper, hence strictly two rails would attract a rate of 2.5 defects / km / yr. However, normal practice would be to change both rails together. The improvements in ultrasonic detection and rail management systems would normally enable a higher rate to apply, but economies of rail cut-out and renewal of defects limit defects replacement to somewhere around 3 defects / km / year, or less, depending upon traffic. Zarembski (1991)[58] suggests that rail would be expected to be replaced at around 2.5 defects / track km / year for 40MGT track – though normally one rail's rate would initiate renewal of both rails at the site on tangent track at least. (During a visit in March 2001 to a Class 1 railroad in North America it was confirmed that 5 defects per mile, or very nearly 3 defects per km, was taken as a trigger for very detailed review of rail renewal – not necessarily leading to immediate renewal, but definitely taken as a warning sign requiring immediate management review.)

RIC and its expert consultants have particularly queried the proportioning process used to identify consumed fatigue life by consideration of the numbers of defects per km. Readers are referred to "Fatigue analysis of rail subject to traffic and temperature loading", Zarembski & Abbott, Figure 11, Field Test Results, showing a clear linear increase of defects with tonnage to the critical point where the defect rate rapidly increases. This is the principle that underlies the DORC condition analytical process.

The issue of proportioning of defects for life assessment purposes is one of convenience, with the process undertaken in the absence of data allowing a proper fatigue review, including Weibull analysis. The reason for adoption of this approach is that the defect data cannot be analysed in any coherent way that includes recognition of rail change-out. Hence, for example, RIC / Marich's analysis showing a reasonably constant defect rate makes no recognition of rail renewal. Whatever the rate of rail renewal may be, it has been occurring, and consequently the rate of defects in the old rail is increasing in order that the overall rate remain constant[59].

57 Armstrong et. al. "Impact of Car Loads on Rail Defect Occurrences", IHHA Conference, 1982

58 Zarambski, "Forecasting of Track Component Lives & Its Use in Track Maintenance Planning", IHHA Conference 1991

59 Also, the RIC / Marich work does not differentiate between Up and Down, or between sectors, and reference to the condition analysis in this report shows there are considerable variations in defect rates between these.

Consequently, it can be deduced that there are sections of old rail that must have quite high defect rates. This leads to the conclusion that these should be renewed, which implies 100% life consumed. To repeat, the proportioning of defects is a simplification of a process that cannot be properly analysed with the data made available. Conversely, to assume that growth in the rate of defects on rail presently in track is not occurring is incorrect. To quote GH&D's commentary, "This approach is an industry accepted method of determining the point at which the rail is to be replaced". The issue is then what number of defects apply, and how to anticipate when that number might be reached. A logical process to manage these questions is presented in this Report at a level of analysis considered appropriate.

RIC has subsequently provided an analysis of rail defects showing generally lower rates. If RIC's rates were applied the effect would be to reduce the consumed life of rail reported here[60]. However, there are severe doubts as to interpretations of data. For example, RIC quote Marich to the effect that the IPART evaluation determines that rail must shortly be replaced in sectors 509U and 510U. The IPART DORC evaluation actually assesses sector 509U as having 31% life remaining and sector 510U as having 29% life remaining. Given that RIC report that 50% of the rail concerned is 17 years old and 50% is 4 years old, the life remaining figure appears very reasonable, and indeed reflects well on the maintainers. As discussed in section 6.1.2.v, the rail is probably actually older and includes even older 53kg rail, which reflects even better on the maintainers, but the likelihood that this rail is significantly less than 70% life consumed on average stretches credulity.

Impact geometry

For a variety of reasons rail suffers extra wear plus surface and internal damage as a consequence of uneven alignment. Figure 6.3 illustrates a variation in vertical alignment of rail that gives raise to extra dynamic loading on track.

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[60] Interested readers are also referred to "Risk based ultrasonic rail test scheduling on Burlington Northern Santa Fe", Palese and Wright, AREMA 2000 Fall Conference, Chicago. This paper offers many insights into rail defect management that are highly relevant to this discourse. Another relevant reference is available on the UK Office of the Rail Regulator, which refers to Mini-MARPAS work that suggests 1.7 breaks+defects/track km/year is an appropriate trigger for renewal. (Ref. www.rail-reg.gov.boozalle/cost_causation_file_3.htm, page 3 of 16.)

Figure 6.3 – Profile Misalignment

Wheel/rail profiles are designed to contain contact stresses within the limits of the materials of both wheel and rail. Dynamics such as are generated by uneven rail longitudinal profiles are not accommodated when rail is loaded to material limits as is the case with 30t axle load traffic. Hence occurrences such as a weld peak as shown above, or weld dips which are common also, or poor track leading to overloading of the rail foot and consequent bending of the rail section, cause rail deterioration (and detrimental affects upon the rest of the track structure). As a general rule, a change in angle of 8 milliradians (mrad) and over will cause deterioration, and at 14mrad, considerable damage will develop. Further, it is extremely difficult to remove these longitudinal profile defects, though some railways do bend rail straight and grind smooth the result, all in order to minimise the consequences of dynamic loading upon other-than-straight rail.

Those consecutive readings in the TRC data that showed 8mrad and above changes in longitudinal profile were identified and utilised to assess rail that was experiencing life reduction due to impact. Figure 6.4 illustrates a section of track and the incidence of 8mrad geometry exceedences:

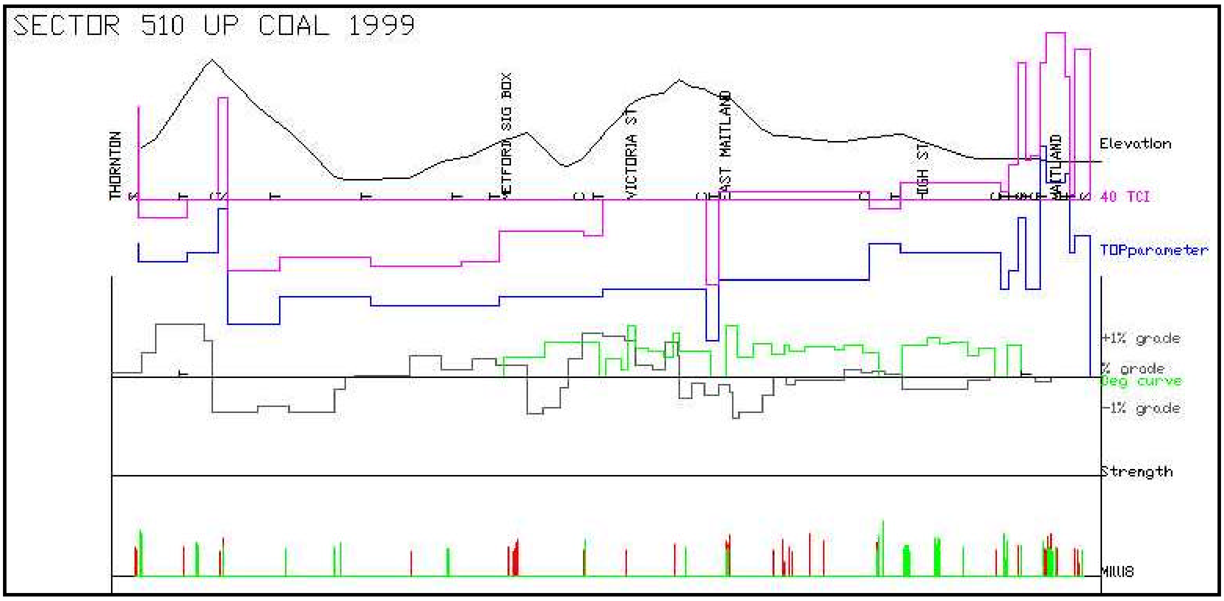

Figure 6.4 – Vertical Rail Profile Misalignments

The 8mrad exceedence locations are shown across the bottom of this illustration. It is noteworthy that exceedence density matches higher track TCIs, as also illustrated (by the magenta coloured line).

Methodology Commentary

RIC and their consultants have questioned the use of impact geometry to aid the assessment of track condition. Readers are referred to Mau et al (2001)[61] for commentary. RIC expresses the opinion, quoting a report from Currie & Brown, that use of Tonnage, Defect Rates and Impact Geometry "… are alternative ways of looking at the same issue" and "… using all three together …. results in the level of rail wear being treble counted".

On behalf of RIC, GH&D have made much the same comments. Readers are referred to the cited reference for commentary, but the issues are simple. Any imperfection in the running profile of the rail leads to dynamic loading. Any inadequacy in track support leads to accentuation of the dynamic loading. The result is acceleration of track degradation. Without the dynamics, the track and its component parts would simply have a longer life. The analysis presented here uses this understanding to link track geometry to component lives.

The difficulty faced in assessing the consumed life of the rail is the lack of detailed information on the rail asset. Tonnage has passed, defects have occurred, geometry is poor in places. The question arises, to what extent do these occur together? The simple answer is we do not know. However, certain deductions can be made. For example, percent head wear (which is previously related to tonnage passed) is not intimately related to defect growth-hence the need to manage both. Equally, poor geometry does significantly increase dynamic loads, causing local distress to the rail head at least, and the foot also, if the geometry is bad enough. This geometry has little relationship to head wear - it is primarily a weld geometry and / or a ballast quality issue.

In summary, RIC have raised an issue that has substance, but arguably only to a minor degree. A great deal more data is required to achieve more accuracy. If tonnage only were used, rail consumed life would fall to 28% from 40%, which is unreasonable.

Following upon expressions of concern by RIC and their consultants, but equally recognising that, in fact, some rail has been renewed, even if the proportion is unclear, the formula that links tonnage, defects and geometry was reviewed carefully. The outcome was a variation on the previous formula for rail life consumed[62].

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[61] Mau, Olsen & O'Brien, "Vehicle – Track Interaction", IHHA 2001

[62] IF((IF(AM5>AO5,AM5+AO5*0.25,AO5+AM5*0.25)+AP5) < 0.9, (IF(AM5>AO5,AM5+AO5*0.25,AO5+AM5*0.25)+AP5), 0.9) where AM=Tonnage Consumed, AO=Defect life consumed, AP=Rail impact consumed.

The main concerns of RIC and its advisors were addressed by ensuring that additive data did not impact upon results except where the rail really is in poor condition. The practical outcome was an approximate 2% lessening in life consumed.[63] Note also that at least one North American Class 1 railroad uses additive factors.[64] The outstanding concern regarding not using some form of additive process is that no one life-consuming process can explain the reasons for rail renewal actually experienced in the Hunter Valley. A range of issues explain rail renewal in practice: the DORC analysis used for the IPART project models real life as far as is possible given the quality of data. What is quite clear is that RIC's "optimised rail renewal program", which "requires on average 9.5km per year of rail to be replaced in the in the Hunter Coal network (excluding lines to Newstan and Stratford mines)", equating to approximately an average 50 year life across the core of the network plus the Ulan line, is highly unlikely to be achieved, and the optimism that led to that forecast has not been reflected in the DORC valuation process.

Summary results

The results are presented in Table 6.1. Key assumptions are included.

It should be noted that a cap of 90% rail life consumed is applied, recognising that, while rail might be technically in need of replacement, in fact it continues to provide support for traffic.

The overall rail and turnout life consumed was determined as being 41.4%. Individual sectors varied from 10% to 90%, as shown in the table.

63 Readers are also referred to "Design of engineering services that meet customer needs", M.Roney, 6th IHHA Conference, 1997, proceedings p.1145, where the CPRail approach to determining rail renewal is, in part, determined by adding wear and fatigue indices via a square root of sum of squares methodology.

64 Readers are also referred to "Design of engineering services that meet customer needs", M.Roney, 6th IHHA Conference, 1997, proceedings p.1145, where the CPRail approach to determining rail renewal is, in part, determined by adding wear and fatigue indices via a square root of sum of squares methodology.

Table 6.1 – Rail Condition Summary

Present asset classes

Rail 53kg	Age, yrs	60kg	Age, yrs	60kgHH	Age, yrs	Tonnage MGT	Tonnage Consumed	Ave. 5yr defect rate	Defect life consumed	Rail impact consumed	Totals consumed
100%	25						50%	0.44	15%	12.9%	67%
100%	25						50%	1.46	49%	13.9%	76%
100%	25						50%	1.82	61%	11.0%	84%
100%	25						50%	1.95	65%	15.6%	90%
100%	25						50%	1.67	56%	12.1%	80%
		50%	17	50%	4	577	51%	2.79	93%	10.3%	90%
				100%	5	67	6%	1.71	57%	7.9%	66%
		50%	17	50%	4	577	51%	0.98	33%	7.7%	67%
				100%	5	67	6%	0.18	6%	5.3%	13%
		50%	17	50%	4	324	29%	0.93	31%	7.4%	46%
				100%	5	37	3%	0.46	15%	5.6%	22%
		50%	17	50%	4	324	29%	0.61	20%	6.9%	41%
				100%	5	37	3%	0.29	10%	5.1%	16%
		50%	17	50%	4	324	29%	0.28	9%	6.0%	37%
				100%	5	37	3%	0.35	12%	4.6%	17%
		50%	17	50%	4	324	29%	0.31	10%	6.2%	37%
				100%	5	37	3%	0.29	10%	6.1%	17%
		50%	17	50%	4	122	11%	0.16	5%	7.0%	19%
100%	25						50%	0.35	12%	8.5%	61%
		50%	17	50%	4	577	51%	0.87	29%	7.8%	66%
				100%	5	67	6%	0.18	6%	5.5%	13%
		36%	8	64%	8	30	4%	0.05	2%	5.8%	10%
				100%	8	43	4%	0.00	0%	6.4%	10%
				100%	8	43	4%	0.04	1%	5.8%	10%
80%	25	20%	7				50%	0.54	18%	10.1%	65%
80%	25	20%	7				50%	0.46	15%	5.6%	59%
80%	25	20%	7				50%	0.55	18%	7.6%	62%
90%	25	10%	1				50%	0.21	7%	8.3%	60%
100%	25						50%	1.28	43%	12.6%	73%
100%	25						50%	1.88	63%	12.7%	88%
		100%	6			19	11%	2.68	89%	11.3%	90%
		100%	8			5	3%	3.13	104%	12.4%	90%
50%	25	50%	7				73%	0.26	9%	13.7%	89%
				100%	4	91	32%	0.71	24%	10.5%	48%
		100%	15			85	49%	0.57	19%	10.2%	64%
		50%	17	50%	4	91	32%	1.14	38%	8.7%	56%
		100%	15			23	12%	1.14	38%	7.9%	49%
		60%	17	60%	4	91	32%	2.82	94%	8.7%	90%
		100%	15			23	12%	1.60	53%	8.4%	65%
				100%	6	30	10%	0.90	30%	7.7%	40%
				100%	6	8	3%	0.90	30%	8.4%	39%
				100%	1.5	63	22%	0.10	3%	0.0%	23%
				100%	6	16	22%	0.10	3%	10.1%	33%
90%	18			10%	2	442	67%	0.41	14%	13.3%	90%
						331	65%	0.30	10%	11.1%	79%
						331	65%	0.34	11%	7.7%	76%
		50%	17	50%	4	607	54%	0.86	29%	7.9%	69%
		100%	15			152	19%	0.16	5%	7.1%	28%
		60%	17	60%	4	607	54%	1.00	33%	8.5%	71%
		100%	15			152	19%	0.12	4%	7.7%	28%
		100%	17			253	37%	1.00	33%	6.4%	51%
				100%	5	63	2%	0.50	17%	6.6%	24%
				100%	4		2%	0.50	17%	7.5%	25%
				100%	5		2%	0.50	17%	7.5%	25%
Rail life consumed, weighted by track length											**40%**

53kg rail has life of 460MGT	460
60SC rail has life of 690MGT	690
60HH rail has life of 1150MGT	1150
Tonnage consumed assumptions:	1.7

Tonnage is determined by current tonnage (taken as ave columns DP+DQ) times age/1.7 which equates to 600MGT at 17yrs on 509
Use ave cols BR + BS & divide by 4 for Dn.

The 1.7 divisor is not applied east of Hanbury Junction, as the Port Waratah terminal has been operating at current capacity since the mid 80s, and hence the recent tonnage data should be typical of rail life experience. Nor is it applied to rail laid in 90s, where the actual tonnage since 1996 is used.

Ref. flaws~1.xls defects/km/yr
Limit taken as 3 flaws/km/yr to trigger 3 rerailing. (NB a quite high rate.)

Blue represents deduced from related information - e.g. assuming up = single
Red reflects assumptions rather than measured data.
Maroon represents wear rate times 4 in junctions

90% max is applied. NB some sectors exceed 100%

Formula for Totals Consumed:
IF((IF(AM5>AO5,AM5+AO5*0.25,AO5+AM5*0.25)+AP5)<0.9,(IF(AM5>AO5,AM5+AO5*0.25,AO5+AM5*0.25)+AP5),0.9)
Where AM=Tonnage Consumed, AO=Defect life consumed, AP=Rail impact consumed.

6.2.3 Sleepers

Assessment of life consumed is based upon age and impact geometry. Both are discussed in turn below.

Age

A relatively small proportion of the track in the Hunter Valley has timber sleepers. Where these are installed it is assumed that their life is 50% consumed, on the basis that partial resleepering programmes would normally achieve about that life condition.

Most track has concrete sleepers. Early concrete sleeper programmes utilised sleepers (designated SRA5) designed for the then maximum axle load of 25t. Subsequent sleepers (designated SRA6) are designed for 30t axle loads. A check was made to determine the required rail seat resistance moment required under AS1085.14-1997 for 25t and 30t axle loads. The results were 19.5kNm and 23.5kNm respectively. As the nominal design requirement for SRA5 sleepers was 25.8kNm (ref. SRA standard TS3321, rev.2 of 2 April '85) and a 50 year design life, the assumption was made for this project that the life of sleepers prior to SRA6, and subject to 30t axle loads, would reduce in proportion to the sleeper capacity to sustain loads above the requirements of AS1085.14. The result was that early concrete sleeper types might reasonably be expected to provide a 42 year life.

A check was made with RIC standard C.3109[65], which is applicable to SRA6 sleepers. This requires a resisting moment of 31kNm, or 1.32 times the 23.5kNm required resistance, exactly the same proportion as for the SRA5 sleeper with the 25t axle loading. It might be reasonably concluded that the SRA6 sleeper was detailed to accommodate exactly the same operating environment as was the SRA5 sleeper, after allowing for axle load. It was deduced that the corresponding reduction of sleeper life consequent upon operation of 30t axle loads over nominally-designed 25t axle load sleepers reasonably followed the (RIC) designer's expectations.

RIC provides a statement from Jeff Stead, Principal Engineer Track and Structures, RIC Safety & Standards division, supporting their contention that SRA5 concrete sleepers have a 50 year minimum design life. That statement provides no verification of design capacity, no verification from the manufacturer of increased load capacity (the responsibility for the design lies with the manufacturer), and no explanation of the increased load capacity required of SRA6 concrete sleepers by comparison with SRA5 sleepers.

RIC points out that "... evidence today suggests that the majority of concrete sleepers will have life greater than 50 years". No evidence was provided to support this contention. Currie & Brown suggest that the design life of all sleepers in the Hunter

[65] RIC, "Prestressed Concrete Sleeper Specification", October 1997

Valley should be considered as their minimum life, that the mean time to replacement should be taken as 75 years, and the physical life should be taken as 100 years. This appears to be pure conjecture. It might well be argued that the sleepers in the Hunter Valley may not achieve the lives assumed in this assessment, given an operating environment that includes rail misaligments, cyclic top and old ballast, plus well-loaded coal wagons that have coal levelled by overbridges and which have hollowed wheels.

As described above, the age of concrete sleepers was determined by interviewing RIC personnel. Consequently the percentage of life consumed was simply derived. The results are tabulated below.

There are other features of concrete sleepers that should be considered. For example, the fastenings, insulators and pads have quite significant value, and certainly the insulators and pads have lives less than the sleepers. Equally, if dynamic loading exceeds the fastening manufacturer's expectations, then clips can be expected to experience a significantly reduced life. There was, in fact, clear evidence in several places that clips were experiencing fatigue – evidenced by rail slippage and broken clips – at rates that suggest there may be widespread incidence of reduced clip life.

For example, on the Mininbah Bank, east of Singleton, 3% of clips were counted off as missing. That is an unusually large percentage, even in this high tonnage, steeply graded track situation. However, there simply is not enough data to allow objective analysis of consumed life of these assets and so no allowance is made for these.

Impact geometry

As with rail, sleepers deteriorate under impact loading. Generally concrete sleepers are designed with a generous over-load allowance, and a reduction in life has already been allowed for older sleeper designs as described above. However, combine sleepers with fouled ballast and water – conditions generally known as "mud holes" or "pumping track" – and quite rapid deterioration can develop. An example of sleeper wear that can result from a "mud hole" is as illustrated in Figure 6.5.

Figure 6.5 – Sleeper wear

The appearance of track that generates the wear shown above is illustrated in Figure 6.6. The matching longitudinal rail profile for this "mud hole" is shown in Figure 6.7.

Figure 6.6 – "Mud hole"

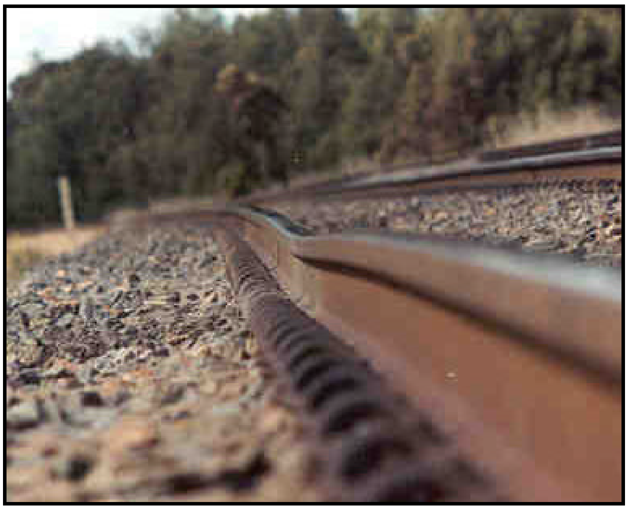

Figure 6.7 – Track dip at "mud hole"

While the total amount of track affected in this way is small, there is clearly an impact on sleeper life. The track shape illustrated above can be identified from TRC data. Hence Booz·Allen examined some "mud holes" by reconstructing the longitudinal profile from the TRC data, as shown in Figure 6.8.

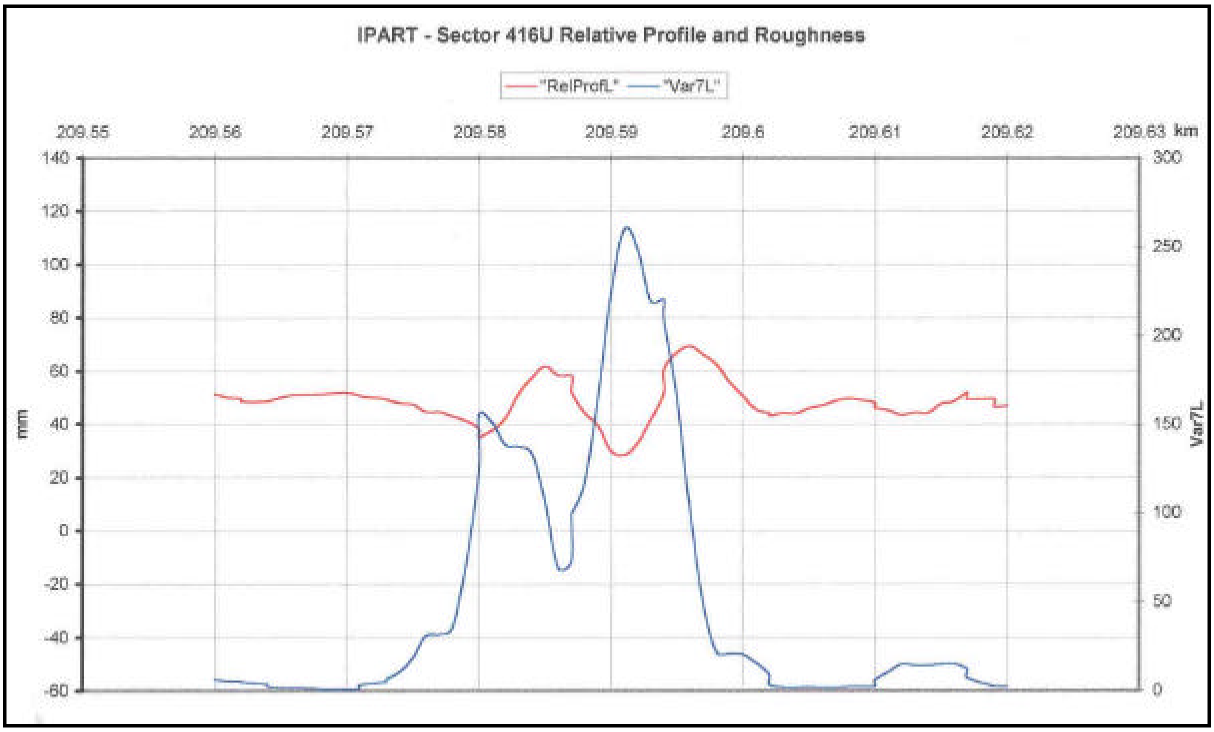

Figure 6.8 – TRC details at "mud hole"

In considerably exaggerated vertical scale, the relatively flat (red) line in the illustration above shows the longitudinal profile of the track at the above-illustrated "mud hole"[66].
The relatively peaked (blue) line in the illustration above was generated from TRC data. (Note that the vertical steps that cause odd-looking misalignments in the profiles are caused by duplicated kilometrage TRC data, as, for example, at 209.58km in the illustration above).

Two routes were followed to determine reasonable thresholds to apply to define "mud holes" for life consumption purposes. The first route utilised a theoretical impact loading analysis based upon an approach described by Broadly et al (1981)[67]. The results suggested only a little more than 1% of Up Main / Coal track was affected.

Being concerned that this approach might not reflect current TRC data, a second approach was adopted, based on 15mm and 25mm Top exceedence levels suggested by the Draft National Code of Practice for Railways[68] as indicative of development of undesirable track condition.

66 It is worth noting that there is a peaked weld at the left hand high point – this weld visible in the photo above – and there is likely to be another peaked weld at the right hand right hand high point – hence this "mud hole" is almost certainly actually caused by dynamic abrasion of ballast and sleepers rather than formation "mud" rising from below.

67 Broadly , Johnston and Pond "The Dynamic Impact Factor", Railway Engineering Conference, Sydney, 1981

68 ref Table 6.4, Volume 2 Priority 2 limits for high and low speed lines

Using this approach, TRC-derived track profiles were examined and a percentage of "mud holes" test was developed, producing approximately the same result as before.

RIC and their various expert consultants criticise this use of track geometry for determining the impact on sleeper service life as a consequence of dynamic loads. RIC note that no explanation of the analysis has been provided. Three presentations have been made on this subject, and the reference noted in Footnote 59 has been copied to RIC to assist in the understanding of the inter-relationship between track quality and sleeper life. Perhaps a quote from the Permanent Way Institution annual convention, Taking Coals to Newcastle, 1982, might assist. In a paper entitled "Maintenance of track in the Hunter Valley – The Future", Mr. John Broadley of the State Rail Authority noted the following:

"Concrete sleepers do require the maintainer to look after them. … A slower more subtle source of damage which needs control involves the deterioration of the underside of the sleepers where it sits on the ballast. Overseas experience shows that most of this is associated with poor ballast conditions, the development of slurry spots in the ballast which then forms a very effective grinding material which chews away at the base of the sleeper."

The DORC analysis procedure calibrated slurry-developing geometry with track recording car vertical roughness data and used the results to identify where the concrete sleepers were being "chewed up".

Summary results

The results are provided in Table 6.2. The weighted average (based on track km per sector) sleeper life consumed was found to be 37%. As before, the red entries in the table below show assumed data, while all other entries have been calculated.

Table 6.2 – Sleeper Life by Sector

Sector	Sleepers Timber	Age, yrs	Concrete	% SRA6 (30TAL)	Age, yrs	Age Consumed	Impact consumed	Totals consumed
405	100%	10				50%	0.4%	50.4%
406	100%	10				50%	2.3%	52.3%
407	100%	10				50%	1.7%	51.7%
410	100%	10				50%	9.0%	59.0%
411	100%	10				50%	1.9%	51.9%
415U			100%	0%	17	40%	5.0%	45.5%
415D			100%	100%	5	10%	1.7%	11.7%
416U			100%	0%	17	40%	1.6%	42.1%
416D			100%	100%	5	10%	0.3%	10.3%
417U			100%	0%	17	40%	1.3%	41.8%
417D			100%	100%	5	10%	0.2%	10.2%
418U			100%	0%	17	40%	1.3%	41.8%
418D			100%	100%	5	10%	0.2%	10.2%
419U			100%	0%	17	40%	0.7%	41.2%
419D			100%	100%	5	10%	0.4%	10.4%
421U			100%	0%	17	40%	0.3%	40.8%
421D			100%	100%	5	10%	0.1%	10.1%
422			100%	0%	17	40%	0.8%	41.3%
423			100%	100%	2	4%	0.7%	4.7%
428U			100%	0%	17	40%	1.1%	41.6%
428D			100%	100%	5	10%	0.2%	10.2%
441			100%	0%	18	43%	0.5%	43.4%
448			100%	0%	18	43%	1.3%	44.2%
449			100%	0%	18	43%	0.5%	43.4%
450			100%	100%		20%	2.0%	22.0%
451			100%	100%		20%	0.5%	20.5%
456	50%	10	50%	100%		35%	0.4%	35.4%
457	100%	10				50%	0.4%	50.4%
490	100%	10				50%	1.7%	51.7%
497	100%	10				50%	2.2%	52.2%
500U	100%	10				50%	7.5%	57.5%
500D	100%	10				50%	5.8%	55.8%
501	90%	10	10%	100%	7	47%	7.5%	54.5%
502U			100%	0%	17	40%	3.2%	43.7%
502D			100%	100%	5	10%	5.0%	15.0%
503U			100%	100%	17	34%	1.8%	35.8%
503D			100%	0%	5	12%	0.9%	12.8%
504U			100%	0%	17	40%	1.2%	41.7%
504D			100%	100%	5	10%	0.9%	10.9%
505U			100%	100%	6	12%	3.0%	15.0%
505D			100%	100%	6	12%	5.9%	17.9%
506U			100%	0%	6	14%	20.7%	35.0%
506D			100%	100%	6	12%	0.2%	12.2%
507U			100%	0%	18	43%	4.6%	47.5%
507D			100%	0%	18	43%	2.3%	45.2%
507S			100%	0%	18	43%	0.6%	43.5%
509U			100%	0%	17	40%	1.8%	42.3%
509D			100%	0%	15	36%	0.3%	36.0%
510U			100%	0%	17	40%	2.5%	43.0%
510D			100%	0%	15	36%	0.6%	36.3%
532U			100%	0%	17	40%	1.3%	41.8%
532D			100%	100%	5	10%	0.8%	10.8%
534			100%	100%	4	8%	1.2%	9.2%
536			100%	100%	5	10%	1.6%	11.6%
			Sleeper life consumed, weighted by track length					**37%**
d			SRA6 sleeper taken as 50yr life,					
			Earlier designs taken as ratio of					
			applied moments v. resisting moment					
			which yields a 42yr presumed life.					

6.2.4 Ballast

No data was found for age or condition of ballast other than some qualitative records for a few sectors. Ballast age and condition was discussed with RIC personnel, who advised that the Up Main and Coal upgrade of around 1983 included ballast cleaning, but the Down Main and Coal upgrade of around 1994 did not include ballast cleaning. It was reported that little ballast cleaning has taken place in recent years.

Effectively there is no ballast condition data available from RIC. It is clear that ballast is generally quite old, but considerable new ballast has been placed over the last two decades during maintenance works. To evaluate ballast condition objectively, TRC records were analysed to identify track profiles characteristic of poor ballast condition and used the results for assessment of life consumption.

It should be emphasised that this approach was used as a proxy for real ballast condition data. Considerable comment ensued from RIC and its advisors. As noted by GH&D, RIC's consultant, Currie & Brown, simply assumes 50% ballast life consumed[69]. The methodology described here uses objective assessment to obtain a broadly similar figure of 49% life consumed overall average, and provides objective assessment of individual sectors.

RIC's commentary in its January submission on p.30 notes that cyclic top is normally used as an indicator for "ride quality", and "cyclic top makes a poor indicator as a proxy for ballast wear". However, it is the interaction of vehicles and track that results in degraded track and hence degraded ride quality – the two are inseparable[70].

Further, RIC state that Sectors 405 and 406 received ballast upgrades in 1995, and hence should exhibit ballast having good condition, yet life consumed is here reported as 77% and 79% respectively. In practice, the track looks rough, the Up and Down TCIs average just under 48, with 0.5km peaks of 67, and it is suggested that the ballast either was not distributed under the sleepers during the 1995 work, or it has deteriorated under the rough operating conditions since.

RIC go on to say, "The traditional approach to estimating ballast condition is to sample contamination (or non-ballast) levels at the standard depths (250mm and 300mm)". This point is agreed, and access to information of this nature would immensely improve the accuracy of ballast life analysis. The cyclic top proxy was adopted because such information was not available.

The background to this approach is that bogies and vehicles interact with track in fairly easily identifiable ways. Of immediate relevance, vehicle and bogie pitch and

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[69] ref. Currie & Brown's Depreciation Methodology2 document, p.13

[70] Refer to Mau et al, op-cit, for discussion and elaboration of this point.

bounce create a feature commonly known as cyclic top when below-sleeper support is poor. This interaction is readily definable in wavelength terms, given a knowledge of vehicle and bogie masses, spring rates and geometry. It is a particularly applicable indicator when the rail and sleeper type is consistent and hence the prime variable in support conditions lies below the base of the sleeper. Fast Fourier Transform analysis techniques were used to identify characteristic wavelengths in the TRC Top data, and these were checked for correlation with bogie dynamics.

Once wavelengths associated with Hunter Valley vehicles and "soft" track had been identified, the TRC database was searched to determine the extent of track having poor support in each sector. During the site visits checks were made to ensure that the TRC cyclic top analysis matched actual track condition. Cyclic top was found to be widespread, examples being illustrated by what look like ripples on the rail in Figure 6.9.

Figure 6.9 - Mininbah Bank – Up & Down Mains Cyclic Top

As may be seen in Figures 6.10 and 6.11, the characteristic undulations in track vertical alignment are to be found over considerable areas of the Hunter Valley.

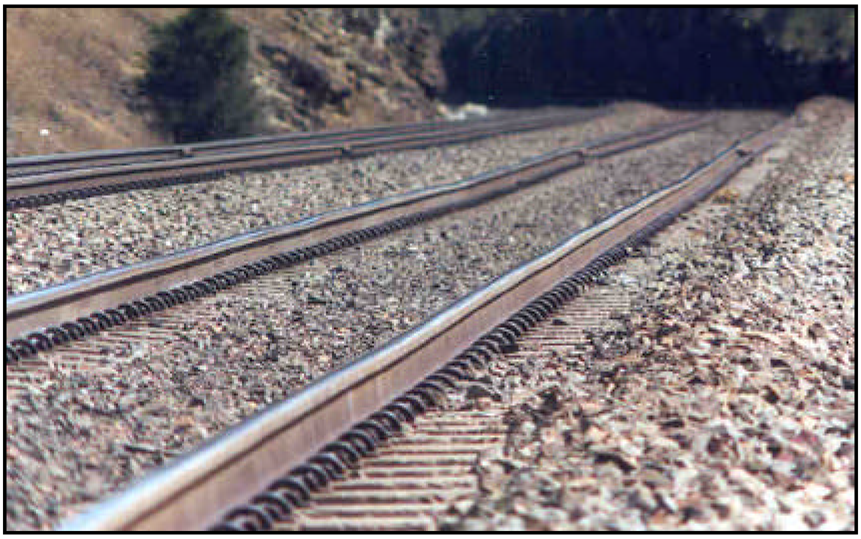


Figure 6.10 – Near Branxton – Up & Down Mains Cyclic Top

Figure 6.11 - Hanbury Junction West – Coal Arrival Cyclic Top

Currie & Brown question the assessment methodology, and simply suggest that a blanket 50% life consumed be used. The result would be a reduced valuation. Also, Currie & Brown's suggested approach would not recognise the variability of ballast condition between sectors, effectively preventing accurate assessment of sector values.

Summary results

The results are listed in Table 6.3. It should be noted that a cap of 90% ballast life consumed is applied, recognising that while ballast might be technically in need of replacement, in fact it continues to provide support for traffic.

The overall ballast life consumed was determined as being 49%, allowing for weighting by sector track length. Individual sectors varied from 21% to 90%, as shown in the table.

Table 6.3 – Ballast Life by Sector

nted Sector	Ballast, nominal 250mm	300mm	Consumed
405	100%		77%
406	100%		79%
407	100%		65%
410	100%		90%
411	100%		78%
415U		100%	78%
415D		100%	62%
416U		100%	58%
416D		100%	24%
417U		100%	56%
417D		100%	30%
418U		100%	45%
418D		100%	29%
419U		100%	42%
419D		100%	21%
421U		100%	35%
421D		100%	25%
422			49%
423			52%
428U		100%	54%
428D		100%	29%
441		100%	44%
448		100%	53%
449		100%	38%
450	100%		75%
451	100%		43%
456	100%		49%
457	100%		62%
490	100%		77%
497	100%		79%
500U		100%	86%
500D		100%	87%
501		100%	78%
502U		100%	76%
502D		100%	67%
503U		100%	62%
503D		100%	46%
504U		100%	76%
504D		100%	53%
505U		100%	75%
505D		100%	68%
506U		100%	90%
506D		100%	90%
507U		100%	77%
507D		100%	73%
507S		100%	57%
509U		100%	61%
509D		100%	40%
510U		100%	59%
510D		100%	45%
532U		100%	42%
532D		100%	39%
534		100%	53%
536		100%	66%
Ballast life consumed, track length weighted			
			49%

6.2.5 Miscellaneous

While fencing type and condition varies considerably, the great majority of the Hunter Valley lineside fencing is typically of a rural stock control type as illustrated in Figure 6.12.

Figure 6.12 - Rural fencing near Whittingham

Similarly road crossings vary considerably, from crossings constructed using ballast or old sleepers to precast concrete crossings that may even be superior to the road being served, as illustrated in Figure 6.13.

Figure 6.13 - Road crossing, Ulan line

Well established assets such as these are assumed to be a nominal 50% life consumed.

An important new asset type being installed in many locations is the sound barrier wall. These are assumed to be a nominal 2% life consumed, based on their age. An example is illustrated in Figure 6.14.

Figure 6.14 - Sound barrier wall, Scholey Street

6.2.6 Track Summary

A range of analysis procedures have been used where possible, and reasonable assumptions made otherwise, resulting in the following life consumed estimates:

	Percent Life consumed
Rail	40%
Sleepers	37%
Ballast	49%
Turnouts	43%
Fencing, crossings & miscellaneous	50%
Sound barrier walls	2%

The overall track (rail, sleepers, ballast and turnouts) consumed life is approximately 41.4%.

This life consumed figure is close to what might normally be expected of a typical railway, but it should be noted that at the MGT traffic rate experienced by the Up Coal, rapid deterioration can be expected below 50%. Hence rail and ballast programmes can be expected to be required soon, or track condition will deteriorate markedly before the next track evaluation review takes place. Given the expense of such programmes, it would be very cost-beneficial to implement a sound condition measurement and assessment regime, which would then assist valuation assessment (and implementation programmes).

6.3 Structures

6.3.1 Remaining life assessment

Bridges are generally long lasting assets but they do deteriorate and need to be upgraded or replaced. A consumed life approach to depreciation based on the construction date of the bridge has been adopted. Service lives for bridges as listed in Table 6.4 have been applied.

Table 6.4 – Bridge Service Lives

MATERIAL/TYPE	SERVICE LIFE (years)
Timber	50
Masonry – underbridge	100
Masonry - overbridge	80
Steel	80
Concrete	100

These lives consider a number of valuation reports and methodologies used for Australian bridges, including Austroads 1998[71]. The reports assume consistent maintenance of road bridges over their life. Following discussion with RIC, bridge lives applied to the rail network in the Hunter Valley have been somewhat reduced.

RIC consider that these service lives are considerably understated. In particular they note that masonry arch bridges should have a service life of 120 years. While commonly this would be the case, where frequent 30TAL coal unit trains operate, this is most unlikely. As an example, old masonry bridges in the UK have been suffering accelerated degradation in recent years due to the increased frequency of high speed train services and increased freight – they are suffering from dynamic loads causing damage in bridge crowns. Upon review, the masonry underbridge life used in this assessment has been increased from 80 to 100 years.

In the Hunter Valley, bridges have degraded and the maintenance/upgrading of rail underbridges does not appear to be keeping pace with the deterioration. Examples are the lack of protective coating on steel bridges, abutment and pier foundation concerns and deteriorating bearings, all which may lead to speed restrictions being imposed.

Changes in operating standards have also been considered. For example, the increase to 30t axle loading in 1996 has potentially accelerated deterioration of bridges built to a lesser standard and which have not been upgraded. All bridges are inspected for RIC and action initiated if they are identified as structurally deficient. They may be upgraded to meet current standards or have speed

71 Austroads "Valuation of Road Infrastructure Assets in Australia and New Zealand", Draft June 1998, Sydney.

restrictions imposed. Where a bridge was in service and had no speed restriction or load limit imposed, a minimum 10% remaining life was adopted even though its age may dictate a lesser remaining life by the formula. However, planned major bridge works or a bridge being identified as the reason for a speed restriction or load limit is taken to imply a substandard bridge in need of major upgrading. These bridges are depreciated by at least 90% to give a maximum 10% remaining life. During the condition assessment it was found that the age of bridges overrode this limit for all applicable bridges, which, incidentally, supported the selected service life criteria.

When a bridge reaches the end of its service life, the bridge is considered to be fully depreciated even if it remains in service, in the expectation is that bridge replacement is imminent. This is generally borne out by analysis, where all seven of the bridges with load limits, speed restrictions or identified for replacement next year were found to be very close to the service life.

Following discussion with RIC, the service life of footbridges has been amended to simply reflect construction material, as is the case with all other bridges.

6.3.2 Data adequacy

The inventory of bridges and their details were difficult to obtain in a single set of information. A number of requests were generated to ensure that a complete and up to date inventory of bridges was being valued. These several sets of bridge data were combined into a single database.

Overbridges and footbridges in some locations span both the Coal and non-coal lines. These bridges are usually referenced by the Main Line Sector and not the Coal Line. A review of bridges from Woodville to Maitland apportioned the value of bridges between the Coal lines and the non-coal Main lines. The following allocation rules were applied:
- 100% of the value attributed where the bridge is only associated with the Coal line;
- 50% of the value attributed to Coal and 50% to non-coal where the bridge spanned both lines or carried both lines; and
- 0% of the value attributed to Coal and 100% to non-coal where the bridge was only associated with non-coal lines.

The valuation is related to the designated Coal lines and Main lines which carry coal traffic. There were 151 bridges valued for the coal lines for the Hunter bundle. Additional bridge data was provided for line sectors outside the Hunter bundle – Metro North (Newstan to Woodville Junction) and North Coast (from Maitland to Craven). The additional 107 bridges brought the inventory to 258 bridges.

Where there was any missing data that was critical to the analysis the following rules were applied:

- Where the date of construction was stated as lying within a range of dates, the more recent date was adopted;
- Otherwise, where the date of construction was missing, it was set the same as a nearby bridge of the same type and material.

Table 6.5 summarises the numbers of the three different types of bridge and their overall life consumed condition assessment.

Table 6.5 – Bridge Consumed Life

Type	Number	Consumed
Underbridge	173	49%
Overbridge	75	53%
Footbridge	23	45%
TOTAL	271	49.5%

The overall figure of 49.5% is considered reasonable.

Table 6.6 lists average structure life consumed by sector.

Table 6.6 – Bridge Lives by Sector

Sector	# in Sector	C	Cons'd
405	4		65%
406	3		67%
407	1		90%
410	1		90%
411	5		25%
415	4		19%
416	10		49%
417	8		30%
418	3		83%
419	7		81%
421	4		74%
422	8		77%
423	5		24%
428	8		55%
441	19		24%
448	9		46%
449	21		63%
450	5		75%
451	22		62%
456	18		50%
457	38		42%
490	13		32%
497	1		34%
500	1		90%
501	6		39%
503	2		77%
507	4		40%
509	16		53%
510	19		26%
532	1		34%
534	1		39%
536	4		73%

6.4 Safeworking Systems

6.4.1 Overview of Systems in Use

The signalling systems in use in the study area employ a range of technologies from state-of-the-art electronic systems, such as Microlok Interlockings, to very basic electromechanical systems, such as electric staff instruments now regarded as obsolete technology. Relay Interlockings, employing both large and miniature relays, are used extensively.

The following types of signalling systems are in use:

Automatic Block (AB)

A combination of automatic block and controlled signalling is in use within the following areas:
- Newstan Junction – Islington Junction;
- Islington Junction – Maitland;
- Maitland – Telerah; and
- Maitland – Muswellbrook.

The majority of the train control and monitoring is carried out at the Broadmeadow Control Centre, although there are still some signal boxes in use along the route such as at Maitland and Hanbury Junction.

Centralised Train Control (CTC)

CTC is in use within the following areas:
- Telarah and Stratford; and
- Muswellbrook and Dartbrook.

All control and monitoring is carried out at the Broadmeadow Control Centre.

Electric Staff (ES)

Electric Staff is in use between Muswellbrook and Ulan. Monitoring is carried out at the Broadmeadow Control Centre. Switching of points is carried out by drivers using pushbutton control facilities at the trackside.

Broadmeadow Control Centre

Monitoring and / or control of trains throughout the area is carried out on a number of discrete control desks, one for each of the following areas:
- Newcastle metropolitan area;
- Coast line (North and South of Newcastle);
- Hunter Valley and Main North; and

- North West.

All desks comprise radio, telephone and train control and monitoring facilities.

6.4.2 Condition and Value Assessment Methodology

The extent and condition of signalling systems has been assessed taking into account the following:

- Signalling infrastructure drawings provided by RIC;
- Condition assessment report provided by RIC[72]
- RIC Board approved Capital Works Program for the Hunter Valley Network;
- Discussions held with RIC asset management staff in Newcastle; and
- Random site inspections carried out at strategic locations.

The steps followed in determining the condition and percentage of life consumed have been as follows:

i) An "average age" has been established for each signalling system in each sector by considering when the equipment was first installed and when and what subsystems have been subjected to major planned maintenance. This has resulted in allocating a year of build or MPM to a certain percentage of the system and combining together the results to give an average age.

ii) An economic life of 30 years has been assumed for signalling systems. This is an average figure based upon 25 years for electronic systems and 35 years for cables and similar basic items of equipment.

This economic life does not necessarily mean that systems become unserviceable after this age, but the cost of maintaining them in a safe and satisfactory condition instead of renewing can be prohibitive. Also, the technology used tends to become obsolete within this timeframe, due to development of new higher performance and cheaper technology and unavailability of spares and expertise to carry out the necessary maintenance work as new technology is introduced into service throughout the industry.

iii) The average age has been subtracted from the economic life to give the number of years of remaining life.

iv) It has been assumed that upon reaching its economic life, a signalling system has been 90% consumed and that it has 10% of its economic value remaining. Beyond its economic life, it has been assumed that consumption and value remain unchanged (at 90% and 10% respectively) as long as the signalling system is capable of fulfilling its intended functions (even with intensive

[72] RIC, Infrastructure Inspection, Country Northwest, Bundle 102, May 1999

maintenance). Up until reaching the economic life, a signalling system's life is consumed and its value depreciates in a linear fashion.

v) Actual condition has been assessed through information provided by RIC and by random site inspections at strategic sites which are representative of new, intermediate age and old equipment.

vi) Overall life consumed figures have been determined for the whole signalling system by applying a weighting factor to take account of sector length and train numbers per sector across all of the sectors, such that the longest sectors which carry the most trains make a proportionately more significant contribution to the overall result.

vii) The life consumption for the control centre has been determined in isolation to the rest of the signalling system.

Commentary

RIC have provided two sets of commentary regarding safeworking asset condition. One relates to their asset management system, and is discussed in the following section. The other relates specifically to economic life.

Essentially, RIC consider the safeworking assets should have an economic life much higher than the previously reported 20 years. There is a strong argument that, in an environment of 85MGT traffic, technological obsolescence should be taken as the main contributor to life consumption. In this context it is noteworthy that the 20 year old Control Centre is currently being replaced.

Nevertheless, RIC cogently argue that much of the existing safeworking system is in fact in sound condition, constructed of durable materials, much of which shows relatively little deterioration. Hence, despite the technological obsolescence argument, this Report now reflects a 30 year economic life for safeworking systems.

6.4.3 Findings

The findings of the study are shown in Table 6.7, which lists the signalling equipment in use in each sector, year of installation and any significant Major Periodic Maintenance (MPM), average age, remaining life, current condition and percent consumed[73].

[73] Refer to Appendix D for details of the optimised signalling arrangement

Table 6.7 – Signalling Asset Lives by Sector

	Signalling							Age			Average	Rem		%
SECTOR	Signals	Points	TC's	Loc Cases	VL's	LVL Xing	Type	% & Yr	% & Yr	% & Yr	Age(Yrs)	Life (Yrs)	Condition	Consum'd
405	13	3	31	12			AB	1989			11	19	S	33
406	18	18	28	9	2		AB	1989			11	19	S	33
407	19	22	27	12	1	1	AB	1989			11	19	S	33
410	12	11	12	1			AB	50% 1990	50% 1940		35	0	S	90
411	4	2	9	2	1		AB	75% 1965	25% 1995		28	2	S	84
412	7	4	16	2	1		AB	75% 1966	25% 1996		27	3	S	81
415	5	11	12	20	1		AB	1990			10	20	S	30
416	28	4	67	42	2	1	AB	1970			30	0	S	90
417	16	14	29	11	1	1	AB	1960			40	0	S/U	90
418	7	6	16	7	1		AB	1960			40	0	S/U	90
419	8	0	15	8		1	AB	1960			40	0	S/U	90
421	5	0	6	3			AB	1960			40	0	S/U	90
422	28	10	38	18			AB+CTC	1996			4	26	G	12
423	4	2	12	8		2	CTC	1995			5	25	G	15
438	29	10	60	23	1		AB	1999			1	29	G	3
441	21	6	21	21		1	ES	1980			20	10	S	60
448	6	1	6	6			ES	1998			12	18	S	36
449	9	3	9	9			ES	1970			30	0	S	90
450	14	16	35	8	2		AB	1988			12	18	S	36
451	19	4	40	27	2	1	CTC	1983			17	13	S	51
456	24	6	56	80	3		CTC	1983			17	13	S	51
457	32	10	80	100	4		CTC	1983			17	13	S	51
490	22	12	40	24	1		AB	1989			11	19	S	33
497	12	22	26	8	1		AB	1989			11	19	S	33
500	5	11	12	3	1		AB	50% 1990	50% 1940		35	0	S	90
501							AB+YW	66% 1975	34% 1994		19	11	S	57
502	4	2	10				AB	75% 1965	25% 1995		28	2	S	84
503	5	1	10	1	1		AB	66% 1965	34% 1995		25	5	S	75
504	6	4	9	2			AB	1966			35	0	S	90
505	1	2	2		1		AB	1966			35	0	S	90
506	1	2	6	2			AB	1966			35	0	S	90
507	28	40	75	9	2		AB+YW	1980			20	10	S	60
509	17	7	39	13	1		AB	10% 1998	50% 1994	40% 1960	20	10	S	60
610	21	10	45	20	1	1	AB	33% 1988	33% 1960	33% 1990	21	9	S	63
532	3	2	4		1		AB	10% 1998	90% 1980		19	11	S	57
534	3	2	4		1		AB	10% 1998	90% 1980		19	11	S	57
536	3	3	11		1		AB+YW	33% 1995	67% 1980		15	15	S	45
								100% 2001			0	20	G	0
									Overall % Consumed					59

Equipment ages range from brand new to 60 years old, with a large proportion of the equipment being around 30 years old. In many sectors, the signalling has been subjected to MPM, such as cable replacement, signal head refurbishment and relay refurbishment resulting in a signalling system which comprises subsystems of considerably varying ages.

Condition of systems in most sectors generally ranges from good to satisfactory and these systems should be capable of supporting the expected traffic levels for the next five years with adequate maintenance. This should not detract from the fact that the signalling systems in many of these areas, although in a satisfactory condition, have life expired from an economic viewpoint and require relatively intensive and / or specialised maintenance to keep them performing in a safe and satisfactory condition. There are, however, some exceptional areas where system condition is close to being unsatisfactory and replacement will be necessary within the next five years. These are:

- Sector 417, Whittingham – Camberwell Junction;
- Sector 418, Camberwell Junction – Glennies Creek;
- Sector 419, Glennies Creek – Newdell Junction; and
- Sector 421, Newdell Junction – Drayton Junction.

In these areas, the systems are approximately 40 years old and have had little MPM work carried out in their lifetime.

Design and construction of a new Northern Network Management Centre, to be located at RIC's regional headquarters at Wharfe Road, is in progress. As part of this project, all local train control functions currently carried out in signal boxes in the Hunter Valley will be brought under central control to give greater operational efficiency and flexibility. For the purposes of the IPART project, it has been assumed that the Control Centre has replaced the (still just current but) previous Broadmeadow Centre.

Based on the life consumed analysis shown in Table 6.7, the average life consumed is 59%. Based on the ORC dollar value of assets across all sectors, 55.6% of life is assessed as being consumed. The difference arises because the depreciation assessment relates to assets in place, which is then applied to assets identified under the optimisation process.

Condition Commentary

RIC have commented at some length on the safeworking asset condition assement provided in the Condition Working Paper. While no listing of % life consumed has been provided by asset and sector, RIC do provide details of their condition assessment along the Hunter Valley trunk corridor between Hanbury Junction and Newdell Junction. This would suggest that the condition is mostly around 95% with dips around Branxton (where we understand new signalling works are nearing completion) and Mount Owen.

The RIC commentary appears actually to be a description of a structured and well developed system for assessing performance of maintenance contractors, with the additional objective of assisting development of MPM and capital expenditure plans. This methodology is not directly relevant to the assessment of the consumed life of a signalling system, which assessment must take into account issues such as age, availability of spares and maintenance expertise, performance capability in the face of heavy and increasing traffic, etc.

In summary, it should be recognised that the Report does not address asset management (except where parts of asset management should inform the assessment of remaining life). The fact that signalling is 95% reliable (or whatever measure applies) is not relevant to the assessment.

6.5 Communications Systems

6.5.1 Overview of Systems in Use

The communications systems employed in the study area include:

Backbone Communications Links

Backbone communications links are used in all Sectors with many different types of technology in use as follows:

- Fibre optic transmission systems;
- Coaxial transmission systems;
- Microwave transmission systems;
- Standard, twisted pair, copper cable transmission systems; and
- Overhead open wire systems.

These backbone systems carry the long distance voice and data signals between the railway facilities.

Telephone Systems

Telephone systems are used throughout all sectors for internal voice communications for the operation of the railway. They include phone systems within buildings and signal post telephones for use by train drivers and trackside staff.

Radio Systems

Radio systems are used as follows:

- Service radio; and
- Countrynet radio.

The service radio is used for voice communication by trackside maintenance staff. Within the area of the study, mobile phones are now mostly used by trackside staff.

The Countrynet radio is used for voice communication between the Broadmeadow Control Centre and train drivers.

Broadmeadow Control Centre

Centralised equipment and head-end man-machine interfaces are provided in the Broadmeadow Control Centre for all of the communications systems.

6.5.2 Condition and Value Assessment Methodology

The extent and condition of the communications systems has been assessed taking into account the following factors:

- Communications infrastructure drawings and information provided by Argus via RIC;
- RIC Board approved Capital Works Program for the Hunter Valley Network; and
- Discussions held with RIC asset management staff in Newcastle and Argus staff in Sydney.

The steps followed in determining the condition and percentage of life consumed have been as follows:

i) An "average age" has been established for each type of communications system in each sector by considering when the equipment was first installed.

ii) An economic life of 15 years has been assumed for all communications systems. This is an average figure based upon 10 years for electronic systems and 20 years upon cables and similar basic items of equipment. The same comments with regard to economic life of signalling systems in Section 6.4.2 apply here.

iii) The average age has been subtracted from the economic life to give the number of years of remaining life.

iv) It has been assumed that upon reaching its economic life, a communications system has been 90% consumed and has 10% of its economic value remaining. Beyond its economic life, it has been assumed that consumption and value remain unchanged as long as the signalling system is capable of fulfilling its intended functions (even with intensive maintenance). Up until reaching the economic life, a communication system's life is consumed and its value depreciates in a linear fashion.

v) Actual condition has been assessed through information provided by Argus, through discussion with Argus staff and by random site inspection.

vi) Overall life consumed figures have been determined for the each of the communications systems. For the backbone system this has been done by applying a weighting factor to take account of sector length and train numbers per sector across all of the sectors, such that the longest sectors which carry the most trains make a proportionately more significant contribution to the overall result. For each of the Phone, Switching and Radio systems a conventional average has been determined across all of the Sectors.

6.5.3 Findings

The findings of the study are shown in Table 6.8, which lists the communications equipment in use in each sector, its age, remaining life, current condition, and percent consumed[74].

[74] Refer to Appendix D for details of the optimised arrangement

Table 6.8 – Communications Assets

	Phone Systems					Switching Nodes					Backbone					Countrynet Radio				
SECTOR	Type	Age	R/L	Cond'n	% Cons'd	Type	Age	R/L	Cond'n	% Cons'd	Backbone	Age	R/L	Cond'n	% Cons'd	CNet	Age	R/L	Cond'n	% Cons'd
405											TWP	8	12	S	36					
406											TWP	8	12	S	36					
407	LIM	10	5	S	60	ATM	0.5	14.5	G	3	TWP	8	12	S	36	Main	4	11	G	24
410											COAX	20	0	U	90					
411	PABX	10	5	S	60						COAX	20	0	U	90					
412											COAX	20	0	U	90					
415											F/O	2	18	G	9					
416						ATM	0.5	14.5	G	3	F/O (1)	2	18	G	9	Node (2)	4	11	G	24
417						ATM	0.5	14.5	G	3	F/O (1)	3	17	G	13.5					
418											F/O	3	17	G	13.5	Node	4	11	G	24
419											F/O (1)	3	17	G	13.5	Node	4	11	G	24
421											F/O	4	16	G	18					
422	LIM	10	5	S	60	ATM	0.5	14.5	G	3	F/O (2)	4	16	G	18	Node	4	11	G	24
423											F/O	5	15	G	22.5					
428											F/O (2)	2	18	G	9	Node	4	11	G	24
441											OHW	12	8	S	54	Node(6)	4	11	G	24
448											OHW	12	8	S	54					
449											OHW	12	8	S	54	Node (2)	4	11	G	24
450											COAX	20	0	U	90	Node	4	11	G	24
451											COAX	20	0	U	90	Node (2)	4	11	G	24
456											COAX	20	0	U	90	Node (2)	4	11	G	24
457											COAX	20	0	U	90					
490											COAX	20	0	U	90					
497											COAX	20	0	U	90					
500											COAX	20	0	U	90					
501	LIM	10	5	S	60						COAX	20	0	U	90					
502											COAX	20	0	U	90					
503											COAX	20	0	U	90					
504						ATM	0.5	14.5	G	3	COAX	20	0	U	90					
505											COAX	20	0	U	90					
506											COAX	20	0	U	90					
507	LIM	10	5	S	60						COAX	20	0	U	90					
509						ATM	0.5	14.5	G	3	COAX	20	0	U	90	Node	4	11	G	24
510	PABX	10	5	S	60						COAX	20	0	U	90	Node	4	11	G	24
532											TWP	12	8	S	54					
534											TWP	12	8	S	54					
536											TWP	12	8	S	54					
					60					3					61					24
															Overall Life Consumed					42

Equipment ages range from brand new to around 20 years old.

The condition of the communications systems ranges from good to satisfactory, with the following exceptions:

i) The coaxial backbone system between Broadmeadow and Maitland and Maitland and Telarah has life expired from an economic viewpoint and suffers from performance problems. RIC is planning to replace this with a fibre optic backbone system in the near future. In order to overcome short term problems, RIC is currently leasing high speed lines from Telstra to carry some of its traffic.

ii) Much of the service radio infrastructure is no longer operational and no longer provides any coverage within the area of this study. Trackside maintenance staff now mostly use mobile phones and / or trackside telephones for communication when out on site within the area of this study and the service radio system infrastructure is therefore not relevant to this study.

iii) The microwave links covering the area of the study are due to be switched off in 2001 due to loss of the 1.8GHz licence, and their functionality will be replaced by carrying the signals on existing and future fibre optic backbone systems (see item 1 above).

iv) The overhead open wire systems between Muswellbrook and Ulan, although only 12 years old, suffer from ongoing performance problems and are often subjected to vandalism.

The percentage of life consumed for each of the communications systems taken across all Sectors is:

- Backbone 61%
- Phone 60%
- Switching 3%
- Radio 24%

The overall life consumption for the communications systems taken across all Sectors based on assessed condition is 42% and based on dollar value is 33.5%. The difference arises because the depreciation assessment relates to assets in place, which is then applied to assets identified under the optimisation process.

6.6 Overall Condition

Overall, the analysis indicates an average life consumed which is considerably higher than the assumptions RIC employed in its interim DORC valuation, as illustrated in Table 6.9.

Table 6.9 Summary of Condition Assessment (% life consumed)

	BAH	RIC [1]
Track, turnouts & misc.	40.8*	26
– Rail	40#	
– Sleepers	37#	
– Ballast	49#	
Structures	49.5*	31
Signals	55.6*	) 33
Communications	33.5	)
Overall	**44.3***	**28**

1. Interim assessment

7.0 FINAL DORC VALUES

The final DORC values for Category 1 and Category 2 mines (in aggregate) are presented in Table 7.1 below. The 'current cost' replacement values have been discounted by 1.85% to arrive at 1st July 1999 values.

Table 7.1 Final DORC Values

	Current costs			1st July 1999 costs		
	ORC ($M)	DORC ($M)	Disc (%)	ORC ($M)	DORC ($M)	Disc (%)
Track	405.6	240.1	40.8	398.1	235.7	40.8
Sigs and Comms	117.0	57.3	51.0	114.8	56.3	50.0
Structures	129.9	65.6	49.5	127.5	64.4	49.5
Total:	652.6	363.5	44.3	640.5	356.8	44.3

Comparisons with RIC's interim DORC[75] and revised DORC[76] are presented in Tables 7.2 and 7.3 respectively.

Table 7.2 Comparisons with RIC Interim Values

	RIC ORC ($M)	BAH ORC ($M)	% Diff	RIC DORC[1] ($M)	BAH DORC ($M)	% Diff
Track	393	398.1	+1	291	235.7	-19
Sigs and Comms	92	114.8	+25	62	56.3	-9
Structures	239	127.5	-47	164	64.4	-61
Total:	724	640.5	-12	517	356.8	-31

1. Discount from ORC based on condition as an interim measure

Table 7.3. Comparisons with RIC Revised Values

	RIC ORC ($M)	BAH ORC ($M)	% Diff	RIC DORC[1] ($M)	BAH DORC ($M)	% Diff
Track[2]	413.2	398.1	-4	305.7	235.7	-23
Sigs and Comms	125.7	114.8	-9	93.0	56.3	-39
Structures	138.6	127.5	-8	102.6	64.4	-37
Total:	677.5	640.5	-5	501.3	356.8	-29

1. Discount from ORC of 26% based on mine life
2. Includes assets RIC identified as additional assets-i.e.culverts, formation and drainage, weighbridges

Booz·Allen has generated a single point estimate of the DORC as required by the TOR. It is acknowledged that the process has involved considerable subjectivity and engineering judgment. The analysis of current condition used to establish the starting depreciation, while as objective and robust as possible, was based on limited information and is subject to error. In our view, actual condition (measured as percentage of asset life expired) could reasonably lie anywhere in the range of 40 to

75 *The interim DORC was established by RIC following the IPART review of the NSW Rail Access Regime in 1999. The interim DORC underpins current access charges although RIC is committed to retrospectively adjusting charges following this independent review.*

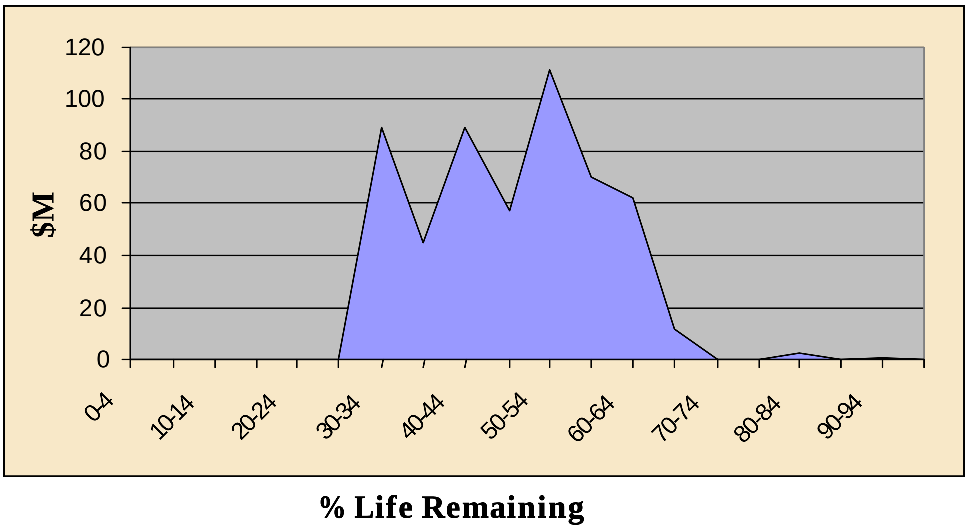
76 *RIC, op-cit, Reference point 1.*

50%, giving a DORC range of $320m to $384m. Our assessment of 44.3% reflects our best judgment based on the information available.

DORC values by individual line sector are confidential. However, Figure 7.1 illustrates replacement values on a sector by sector basis categorised by condition (% life remaining). Most of the network falls in the range 30% to 60% life remaining.

An issue to be considered is the extent to which the condition discount should be applied on a sector by sector basis, as opposed to more of a system average approach. Ideally, pricing outcomes should be 'smooth' over time and consistent between sectors, i.e. adopting present condition as the line in the sand for establishing the starting value of depreciation should in and of itself not introduce any distortions in pricing between sectors or users. To a large extent the correct approach will be driven by the treatment of MPM expenditure. If MPM is 'levelised' across sectors, then there may be justification for also levelising the condition discount to ensure consistency of pricing outcomes.

Figure 7.1 Replacement values by sector



RIC have argued that as a result of this DORC valuation, they will be constrained in effectively operating, upgrading and enhancing the network[77]. Further its investment capacity will be reduced to an amount below optimal expenditure[78]. It is not clear why this is so given that this DORC valuation deals with historic (sunk) investment and it is the Regime more generally which influences the climate for future investment. Indeed, the Minerals Council has commented that access seekers

77 *RIC, "Submission to IPART on the Booz·Allen & Hamilton Revised Draft Final Report: Valuation of Certain Assets of the Rail Access Corporation", 30 March 2001 p.4*

78 *The impact of a lower DORC value on RIC's free cash flow is acknowledged but this of itself is not sufficient to necessitate capital rationing. The entire issue of RIC's ability to internally fund new investment and its ability to tap alternative sources of capital is beyond the scope of this Report.*

are already encountering the disincentive for RIC to invest given the uncertainty surrounding the regulatory treatment of new investment.[79]

The DORC process identified a range of regime issues, which are not directly within the scope of this valuation exercise, but which require attention to ensure stakeholders have certainty in regard to future pricing arrangements. Issues raised include :

- Roll forward process and the treatment of new capital expenditure prior to the next regulatory review;
- Treatment of capacity increases to accommodate new mines;
- Scope of the revaluation in 2004, particularly in relation to optimisation; and
- Process for the update of WACC.

These are matters to be addressed by Government as custodian of the access regime.

79 *Minerals Council, op-cit, p2*