Appendix A

INTERSTATE RAIL NETWORK AUDIT

Evaluation Methodology

ARTC

AUSTRALIAN RAIL TRACK CORPORATION LTD

April 2001

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1. OVERVIEW OF METHODOLOGY

Up until 1997, the market share of non-bulk freight carried by rail fell steadily. Road efficiency improvements, which have generally exceeded rail, have contributed to this decline. The Minister for Transport has called for the ARTC to undertake an audit of the interstate network. To this end, ARTC commissioned Booz·Allen & Hamilton as the prime consultant to undertake an economic and financial appraisal of the inter-capital rail network, and to establish a business case for investment which encourages modal shift to rail.

This section provides a brief overview of the methodology employed to develop the business case for investment in the Interstate Rail Network. A detailed schematic of the five stage evaluation methodology used in the study is shown in Figure 1.1. A brief discussion of each methodology stage follows:

Stage 1: Audit of the ATC Performance Targets
The first stage of the study determined the extent to which the ATC (Australian Transport Council) targets have been met and what influence they have had in retaining or gaining market share.

Stage 2: Performance Scenarios and Investment Options
In addition to the ATC performance scenarios, two market based scenarios were identified in consultation with industry. These scenarios identified performance required against key market drivers in each corridor to attract modal shift from road. A minimum market requirement and a challenging performance requirement were derived for each corridor. Engineering consultants determined the optimal least capital cost required to achieve the targets.

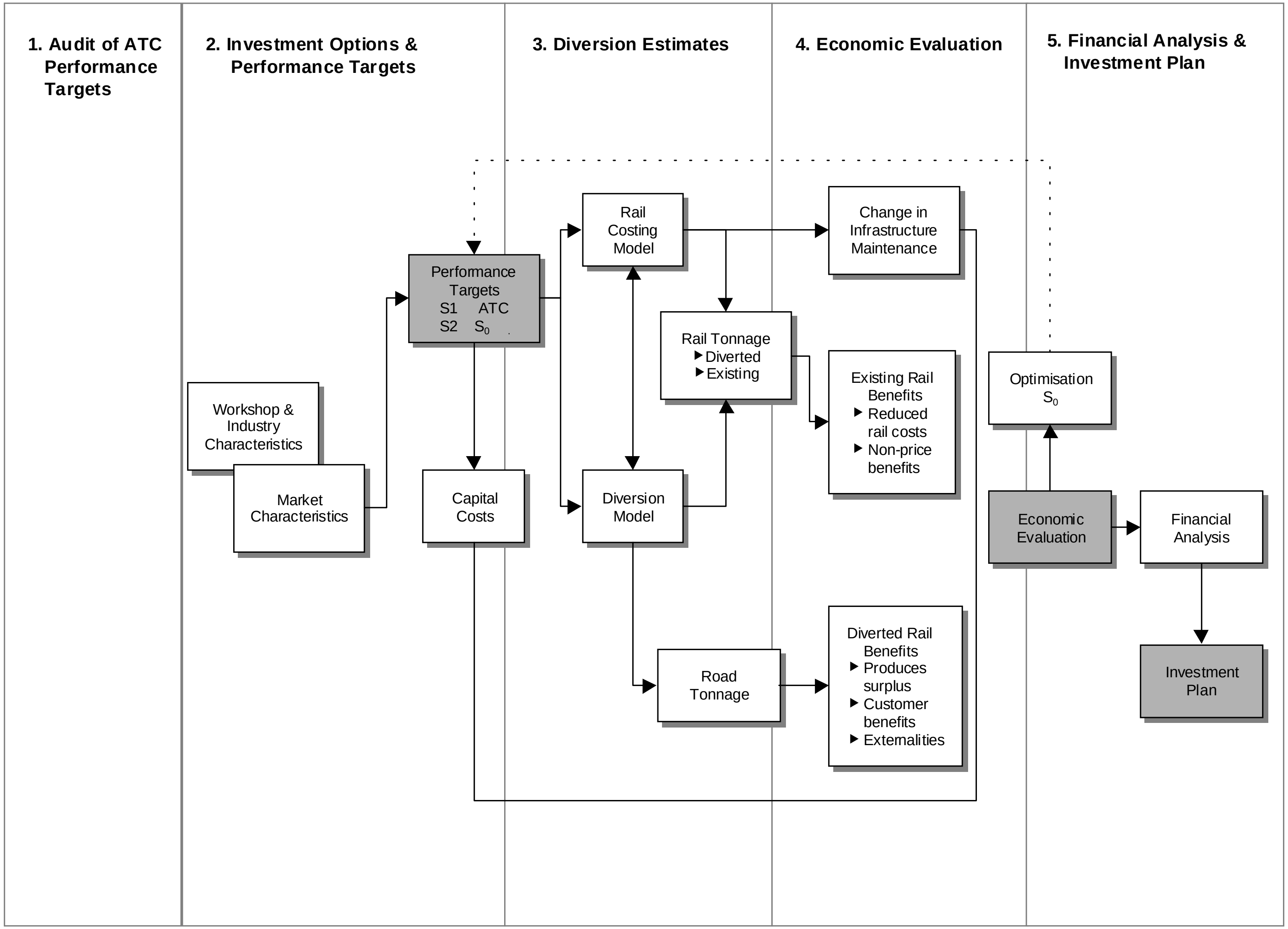
Stage 3: Rail Diversion Estimates
Rail's diversion under each investment option was estimated by comparing how rail's package of price and service characteristics compare to competing modes in servicing the market. The evaluation is based on improvements to key market drivers, increasing rail's competitiveness and subsequently its market share.

Stage 4: Economic Evaluation
The economic evaluation follows a conventional cost-benefit framework, with the benefits focusing on improvements in operating and service performance for existing and diverted rail freight traffic. The evaluation tests the costs of marginal additional investments against the marginal benefits of that investment to derive the optimised level of investment.

Stage 5: Investment Plan and Financial Analysis
This stage brings together the evaluation results to determine the priority for future investment in the Interstate Rail Network. The financial analysis identifies the entities to which calculated economic benefits could be expected to accrue. This is then used to draw some conclusions on the capacity for private sector contributions towards the investments.

The remainder of this Appendix report provides further detail on the structure and assumptions associated with each stage of the methodology.

Figure 1.1 : Schematic Overview of Evaluation Methodology



Note – S_0 is based on maximum NPV

2. AUDIT OF ATC PERFORMANCE TARGETS

The Audit assessed the influence that track improvements to achieve ATC performance targets have had on improving rail's market share. The ATC performance targets, agreed in 1997, are a set of rail targets initiated to standardise performance across jurisdictions and address rail's declining share of the interstate freight market. The ATC Track performance targets specified for the interstate rail network are:

- Less than 2% of track subject to temporary speed restrictions
- At axle loads up to 21 tonnes
  - Maximum speed of 115 kph
  - Average speed of 80kph
- At axle loads of 21-25 tonnes
  - Maximum speed of 80kph
  - Average speed of 60 kph
- Train lengths
  - 1500m on North- South corridors
  - 1800m on East-West corridors

A review of the interstate network performance in 1997 and 2000 was completed. The review determined the extent to which improvements during this period had met ATC targets. The assessment was undertaken on a line segment basis, with performance information provided by the track owners: ARTC, RAC, Westrail and QR.

The results of the audit were summarised by corridor in an attempt to determine the extent to which the works had influenced rail's market share. As a number of operating variables contribute to changes in rail's mode share, it is difficult to isolate the impact that improvements to achieve ATC standards have had on market share. Nevertheless, the analysis was able to show a relationship between infrastructure improvements and increases in rail's market share.

Having quantified improvements since 1997, the next phase of the audit determined the extent to which rail's market share had changed in each of the market corridors. Rail, road and sea volume data were collected between 1997 and 2000 from a variety of sources. In validating the data a number of checks across different data sources and previous studies were undertaken. The collected data were assembled to estimate the size and modal shares of each market corridor. Changes in rail's modal share was determined by comparing the modal share in 1997 and 2000.

The data and market volumes collected in this phase were used throughout the study. This data formed the Base Case and was used to establish the evaluation of the investment options. In the Base Case, it has been assumed that current operations continue and that the current competitive positioning of both road and rail remains unchanged in each market segment for the evaluation period.

3. PERFORMANCE SCENARIOS AND INVESTMENT OPTIONS

3.1 Markets Assessed

The Audit has been conducted with reference to six key interstate markets. These interstate markets are identified in Table 3.1.

Table 3.1 : Interstate Intermodal Markets Reviewed

North – South	
1.	Melbourne – Sydney
2.	Sydney – Brisbane
3a.	Melbourne – Brisbane
East – West	
4.	Melbourne – Adelaide
5.	Melbourne – Perth
6.	Sydney – Perth
Inland Route	
3b.	Melbourne – Brisbane

The Melbourne – Brisbane inland corridor was evaluated to the extent necessary to assess whether an investment decision on this corridor would alter the beneficial investments on the coastal corridor. In the circumstances, an investment decision on the inland route should not be made on the basis of this study as insufficient market analysis was undertaken.

The Adelaide – Perth market corridor was not seen as a critical investment priority and therefore, was not assessed in this study.

An industry workshop held in October 2000 identified the six separate market corridors. The rationale for selection included:

- Significant freight volumes
- Important strategic positioning relative to other freight markets
- Opportunity to benefit from rail investment

The derivation of the performance scenarios and investment options is based on achieving commercially sustainable shifts in modal share in the intermodal intercity market. Traffic such as bulk (eg. steel), which also utilise the interstate rail network, already have a high rail market share in comparison to road. Such traffic is not the priority for investment and therefore not incorporated in the derivation of the investment options and performance scenarios. Intrastate intermodal traffic generally involves lower volumes and shorter line-hauls providing less opportunity for modal shift. These traffics do, however, receive some benefit from the upgrade and subsequently do accrue benefits in the economic evaluation of each investment option.

3.2 Performance Scenarios

The performance scenarios specified for each investment scenario have been considered in terms of improvements to key market drivers. The key market characteristics collectively represent rail's competitive position in each market corridor.

Rail's competitive position is dependent on how its package of price and service characteristics compare to competing modes in servicing the market. Price is the primary driver related to modal selection, but without improvement in other key market drivers modal shift is unlikely to occur.

Price reductions have not been incorporated as a "stand-alone" performance target in this analysis. Price savings are incorporated into the evaluation methodology through operating cost savings. The impact of cost and price reductions under each investment option is discussed in greater detail in Section 4.

Changes in operating costs (and price), as described above, is one element of the package of modal selection characteristics. There are several non-price characteristics which make up rail's service package. These include damage, invoice accuracy, shipment tracing, credit terms / payments, competence of sales staff, handling of complaints and proactive notification of a problem. However, we have confined the analysis to those factors listed in Table 3.2, which customers have indicated are the most important factors in improving rail market share.

Table 3.2 : Modal Selection Characteristics

Service characteristic	Description
Transit Time	Terminal to terminal travel time
Reliability	On time running performance
Service Availability	Serviceable market

Transit Time (hrs)

Transit time is the terminal to terminal transit time. In the evaluation we have assumed an average actual rail transit time. For some of the North – South market corridors, the average transit time identified in the Base Case is in excess of the timetabled rail transit time.

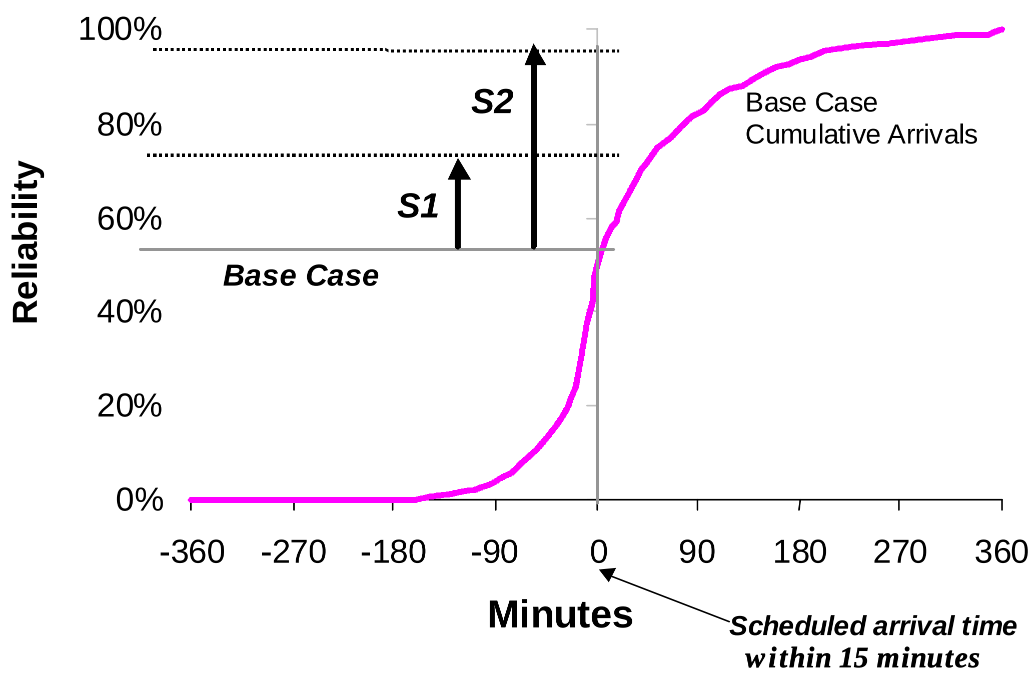
The transit time improvement performance scenarios have been derived in consultation with the rail industry. S1 target transit time reductions are the minimum requirements identified by industry participants in the Audit exercise. S2 target improvements reduce rail's transit time to compete with road's competitive time in many of the market corridors.

Reliability

In the study reliability is defined as the percentage of trains which arrive within 15 minutes of the scheduled arrival time. The measure does not consider the causes of delay and represents the on time average running performance of train services. The Base Case performance data have been derived from data collected from both ARTC and RIC for the financial year 1999/00. Reliability is an average of services in both directions (ie. forward and backward).

The S2 performance target of 95% is related to matching road's current reliability performance. Figure 3.1 graphically illustrates the improvements in reliability specified under each of the investment options for the Melbourne – Sydney market corridor.

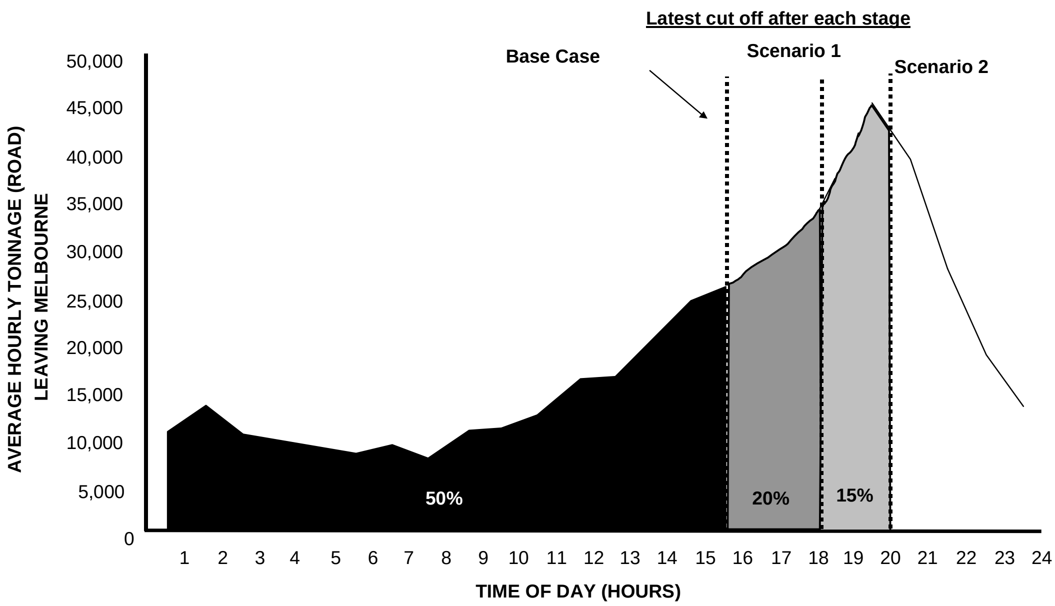
Figure 3.1 – Cumulative Arrivals Melbourne - Sydney



Service Availability

"Service availability" is defined as the current proportion of the market for which rail is able to offer a broadly equivalent departure time as road. To the extent that additional departure times become available through the provision of additional infrastructure investment, the service availability percentage will increase. Figure 3.2 illustrates how the market serviceable by rail in the Melbourne – Sydney market corridor improves under the S1 and S2 investment options. With improvements in transit time, the cut-off time is moved back from 3:30pm to 6:00pm, providing access to an additional 20% of the market under S1, and to 8:00pm under S2 for another 15% of the market.

Figure 3.2 – Melbourne – Sydney Service Availability Improvement



Operational Improvements

In addition to the service performance scenarios, operational target improvements in relation to train lengths and double stacking (DS) have been specified for a number of investment options. These measures improve yields for operators enabling price reductions for end customers and additional market share. The train length targets relate to providing unrestricted train paths from end to end. Double stacking has been assessed for the inland route and the Scenario 2 investment options in the East- West.

3.3 Investment Options

Traditionally, rail market and investment studies have derived a market outcome by firstly nominating a set of feasible capital upgrade works and then generating increases in market share likely to occur as a result of the investment. This study has used a different approach in developing a number of preferred market outcomes and then identifying the best mix of investments to achieve those market outcomes.

Four different investment options have been assessed in this study for each of the six intermodal market corridors reviewed. The four scenarios include the investment to achieve ATC performance scenarios and three market based outcome investments. Two market based scenarios for each market corridor were derived from industry consultation and were used as the "bookends" to derive an optimal level of spending. Table 3.3 outlines the investment options assessed in the study.

Table 3.3 : Investment Options

Investment Options		Description
ATC Track Performance Scenarios		ATC Track Performance scenarios as defined at the 1997 Rail Summit
Market Based	Scenario 1 (S1)	Minimum market requirements
	Scenario 2 (S2)	Stretch targets
	Optimised (S_0)	Optimal investment beyond S1 where the NPV is maximised

Audit of ATC Performance Targets

The audit of ATC performance targets incorporates the investment to upgrade each market corridor to the defined ATC track performance scenarios. The upgrades required to achieve the defined performance standards were identified in the Audit of the ATC performance scenarios. The engineering consultants estimated the investment measures and capital costs required to achieve the ATC targets.

Market Based Performance Scenarios

In order to establish feasible market outcomes, an industry workshop was conducted to determine what is required to deliver a commercially sustainable shift in modal share for each market corridor. The workshop attendees were :

- National Rail
- Toll
- Patricks
- ARTC
- GSR

A number of operator, freight forwarder and customer groups unable to attend the workshop were interviewed separately :

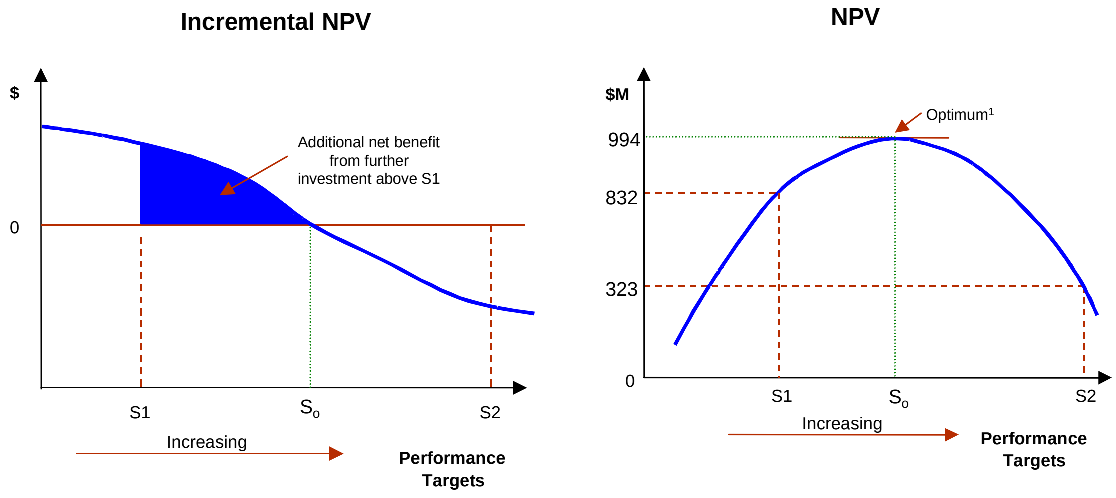
- SCT
- FreightCorp
- BHP
- FCL

The industry workshop and consultation identified two market based investment options. Scenario 1 (S1) specified minimum market improvements for each of the market corridors reviewed. The S1 upgrades address the critical present needs such as improving current reliability, transit time and service availability to minimum acceptable levels. Scenario 2 (S2) investments are stretch targets and incorporate major improvements in service characteristics. The S2 targets are largely based on matching road's current service offering in each market corridor.

The market based performance scenarios were used to generate the optimal level of investment. The S1 and S2 investments were the "bookends" from which an optimal level of investment could be derived. The optimised investment (S_o) is the point where NPV returns are maximised and incremental benefits of additional benefits equate to incremental capital costs.

A number of economic measures can be used to define an optimal outcome, such as the Benefit Cost Ratio (BCR), Internal Rate of Return (IRR) and Net Present Value / Capital Cost (NPV/C). For the purposes of this study, a measure of wealth maximisation was chosen to determine the optimal level of investment; hence the maximum NPV. Figure 3.3 graphically illustrates the location of the optimised investment in relation to S1 and S2.

Figure 3.3 : Derivation of the Optimised Investment (S_o)



1 Based on maximum NPV

The location of the optimised investment varies by market corridor, depending on the relative differential between the costs of improving the performance scenarios and the net benefits generated. On the Perth – Sydney corridor, the S2 target was not challenging enough and the ATC target was used as the upper "bookend".

Inland Route

A single pre-feasibility investment option was assessed for the inland route. This investment option is equivalent to the A2M option from Maunsell McIntyre's Pre-feasibility Inland study. An optimised investment and the ATC track performance investment options were not assessed for the Inland route. Although the capital costs did include the ATC targets for axle loads and train lengths, the target for average speed was replaced with a specific transit time that had no relationship with the ATC target. Based on the partial application of the ATC targets, a direct investment option under ATC performance scenarios could not be undertaken.

The performance scenarios for each of the nominated investment options are presented in Table 3.4 for the North – South and Table 3.5 for the East – West market corridors.

Table 3.4 : Performance Scenarios North- South Market corridors

Performance Scenarios	Mel-Syd				Syd-Bne				Mel-Bne				
	BC	**S1**	**S_0**	**S2**	**BC**	**S1**	**S_0**	**S2**	**BC**	**S1**	**S_0**	**S2**	**Inland**
Transit Time (hrs)	13.5	11	10.5	9	21	19	17.5	16	36	32	29.5	27	27
Reliability (%)	55	75	75	95	50	75	75	95	45	80	75	95	95
Service Availability (%)	50	70	75	85	25	50	60	70	60	85	85	90	90
Operational Improvement		1,500m train paths for all options				1,500m train paths for all options				1,500m train paths for all options			1,800m train paths
		-	-	-		-	-	-		-	-	-	DS
Capital Costs ($M)		249	325	908		53	73	694		287	398	1614	1510

Table 3.5 : Performance Scenarios East – West Market corridors

Performance Scenarios	Mel-Adl				Mel-Per				Syd – Per			
	BC	**S1**	**S_0**	**S2**	**BC**	**S1**	**S_0**	**S2**	**BC**	**S1**	**S_0**	**S2**
Transit Time (hrs)	13	12	11.5	9	58	57	56	52	72	69	65	69
Reliability (%)	74	80	80	95	66	80	80	95	70	80	95	95
Service Availability (%)	70	75	76	80	80	85	87	90	83	95	95	95
Operational Improvement		S1 - No change from current S2 - 1,800m train paths				S1 - No change from current S2 - 1,800m train paths				S1 - No change from current S2 - 1,800m train paths		
				DS			-	DS		-	DS	DS
Capital Costs ($M)		113	133	810		27	52	626		8	78	37

Note: *In some corridors, the specified train lengths have already been achieved*
Reliability and Service Availability targets not set by ATC objectives

4. DIVERSION ESTIMATES

4.1 Introduction

This section describes the methodology employed to estimate the diversion to rail under each of the investment options. The evaluation considers the relative service offering of road and rail in estimating a modal market share. The model uses improvements to price, reliability, transit time and service availability through a consumer utility function to estimate the diversion to rail under each investment option. In estimating diversion, road's productivity and service offering is assumed to remain unchanged.

4.2 Improvements in Price and Service Characteristics

The rail freight rates used in the evaluation are based on an average loaded container of 12 tonnes per TEU (Twenty-foot Equivalent Unit). The rail freight rate includes all customer costs and incorporates linehaul charges, pick-up and delivery (PUD) and container hire charges. The linehaul rates are based on National Rail's (NR) 2000 book rates.

As outlined in the previous section, rail's competitive position is dependent on how its package of price and service characteristics compare to competing modes in servicing the market.

Price savings are incorporated into the evaluation methodology through operating cost savings associated with the infrastructure and operational investments. Transit time reductions reduce crew times and rollingstock operating costs. Improvements in reliability similarly provide cost savings, while an increase in average train lengths reduces unit operating costs.

Assuming a competitive market, all cost savings are assumed to be passed onto the consumer through reducing rail's freight rate charges. The impact of operating cost savings on price under the investment options are greater in the longer haul corridors where PUD is a lower proportion of total costs.

Improvements to service characteristics relate directly to the performance scenarios identified under each investment option. The previous section identified the improvements to service characteristics from the Base Case for each investment option.

4.3 Consumer Utility Function

The package of price and service characteristics for both road and rail are incorporated in a consumer utility function. This approach is analogous to the generalised cost functions which are reasonably well defined for passenger travel, and include travel time, egress time, amenity benefits and so on.

Based on the above factors, the consumer utility function for road and rail users are defined:

Rail Consumer Utility:

$$U_R = \beta_C * C_R + \beta_T * T_R + \beta_{RY} * RY_R + \beta_{SL} * SL_R$$

Road Consumer Utility:

$$U_T = \beta_C * C_T + \beta_T * T_T + \beta_{RY} * RY_T + \beta_{SL} * SL_T + K_T$$

Where:

COMPONENT	RAIL INPUT	ROAD INPUT	ELASTICITY
Price (C)	C_R	C_T	β_C
Transit Time (T)	T_R	T_T	β_T
Reliability (RY)	RY_R	RY_T	β_{RY}
Service Availability (SL)	SL_R	SL_T	β_{SL}

and K_T is the mode specific constant for trucks. The constant incorporates all other comparative benefits not specifically identified in the utility function.

The change in service parameters and price leads to a change in consumer utility between the Base Case and the Investment Option.

4.4 Elasticity Measures

Having determined the changes to each of the parameters in the consumer utility functions model, the remaining requirement is to estimate the elasticity. The elasticity estimates the importance of each parameter as a *proportion of the existing rail freight rate.*

There are several reports and publications which have attempted to rank non-price service characteristics in order of importance to end customers. Perhaps the most notable of these is the BIS Shrapnel report[1]. However, in these and other reports, no relationship is drawn between these service parameters and price.

The elasticity values incorporated within this evaluation are based on previous work undertaken by Booz·Allen & Hamilton, including a study of elasticity values for relevant non-price service features completed for the NSW Rail Access Corporation[2]. This assessment used stated and revealed preference techniques.

1 *BIS Shrapnel – Freight In Australia, 1998*

2 *Interstate Rail Freight Service Levels and Demand Elasticities, 1998*

Other studies which have to varying degrees sought to estimate the elasticities for interstate rail freight, including price elasticity, include:

- Interstate Market Analysis - Rail Access Corporation
- Interstate Freight Market Analysis - Australian National Track Access
- Alice Springs - Darwin Railway Market Analysis - NT Government
- Dedicated Metropolitan Freight Routes – Rail Access Corporation

We have drawn on these studies, particularly the first two listed above, to develop elasticity measures for the current analysis. These studies could be expected to be highly relevant for estimating interstate intermodal market elasticities.

The elasticity measures used in the model are shown in Table 4.1. Different elasticities have been applied to long haul and short haul corridors to reflect the varying importance of transit time and service availability characteristics in two different general markets. The elasticities have also been calibrated across the audit period 1997-2000.

Table 4.1 : Service Elasticities

	PRICE	TRANSIT TIME	RELIABILITY	SERVICE AVAILABILITY
Long-Haul	-1.1	-0.3	0.6	0.4
Short-Haul	-1.1	-0.4	0.6	0.5

Source : Booz·Allen & Hamilton Estimates

The elasticity measures reflect the relative importance of each of the characteristics for modal selection. The influence that changes in price and service characteristics have vary according to rail's existing competitive position and the relative difference between competing mode's service characteristics. For instance, even though price has the same relative importance under both short and long haul corridors, the same percentage change reduction in price has a variable impact on two corridor types.

4.5 Logit Curve

A logit curve has been used to estimate diversion to rail under each of the investment options. The analysis estimates rail's market share under each investment option by comparing road and rail's relative service offering. The logit model is calibrated to match rail's existing market share. Projected increases in market shares and subsequent diversion to rail are derived from improvement in rail's competitive position in each corridor market.

Rail Market Share = $P_R = \frac{e^{U_R}}{e^{U_R} + e^{U_T}}$ (logit model)

Rail Tonnes = Total Tonnes x Rail Market Share (P_R)

Where: P_R = Rail Market Share
U_R = Rail Consumer Utility
U_T = Road Consumer Utility

The potential improvement in modal share under each investment option varies according to the improvement in service characteristics and rail's initial competitive position in each market corridor. Where rail already holds a high market share (such as in the markets to Perth), the relative increase in rail's market share from the same improvement in service characteristics will be lower than corridors where rail has a greater market growth potential.

The analysis for the inland route extends the above analysis to consider a three way diversion. Not all of the current Melbourne – Brisbane traffic on the existing coastal route will be diverted to the inland route. Depending on the relative importance of time, a proportion of the non-time sensitive rail traffic will remain on the existing route. The rail operators have confirmed this by suggesting a coastal route service between Melbourne and Brisbane will remain. The three way diversion model attempts to estimate the proportion of traffic that will remain on the existing route and the level of diversion from both road and existing rail services to the inland route.

5. ECONOMIC EVALUATION

5.1 Introduction

The economic evaluation brings together the analysis of costs and benefits and streams them using a discounted cash flow technique in accordance with Commonwealth and Treasury guidelines for the assessment of capital investment projects. The costs and benefits are discussed in detail below.

5.2 Capital Costs

The capital cost component to achieve the specified performance scenarios were estimated by the engineering consultants. The capital costs used in the study are summarised in Table 5.1. Appendix D provides further detail on the operational and engineering cost estimates.

Table 5.1 : Undiscounted Capital Cost Estimates ($M)

Corridor		ATC	S1	S2	Inland
North South	Mel-Syd	32	249	908	-
	Syd-Bne	2,539	53	694	-
	Mel-Bne	2,571	287	1,614	1,510
East-West	Mel-Adl	169	113	810	-
	Mel-Per	325	27	626	-
	Syd-Per	290	8	37	-

Sources : North – South – Maunsell McIntyre
Mel-Bne (Inland) – Ove Arup
East – West - GHD

Unlike the specification of project capital costs for ATC, S1 and S2 targets, as determined by the engineer consultants, the capital costs for S_0 were derived from the optimal point beyond S1 (maximum NPV). Table 5.2 details the optimal capital costs for each market corridor.

Table 5.2 : S_0 Undiscounted Capital Cost Estimates ($M)

Corridor		Optimal Scenarios
North South	Mel-Syd	325
	Syd-Bne	73
	Mel-Bne	398
East-West	Mel-Adl	133
	Mel-Per	52
	Syd-Per	78

Sources : Derived from the individual project costs making up scenarios detailed in Table 5.1 and analysis of benefits to existing and diverted traffic.
Note : The costs represent the optimal point between S1 and S2 for each corridor, and do not directly translate into the optimised investment plan. The capital costs above include all project works for each corridor regardless of viability and double counting – These are excluded from the costs that form the optimised investment plan.

Appendix D provides further detail of the breakdown of capital costs.

5.3 Infrastructure Maintenance Costs

For the purposes of this analysis, infrastructure maintenance costs have been included in the Base Case and the Investment Options, with the marginal cost of track maintenance included for new traffic on a gross tonne kilometre (gtk) basis.

5.4 Rail Operating Costs

Although there are other significant benefits associated with the suites of infrastructure improvements, rail operating cost reductions are the most recognisable benefit.

The rail operating cost model calculates the change in rail operating costs based on infrastructure and rail operator improvements. The costs likely to be influenced by the service parameters are shown in Table 5.2 below.

Table 5.2 : Changes in operating costs induced by change in parameters

OPERATING COST ITEM	OPERATION COST ITEM INFLUENCED BY CHANGES IN SERVICE PARAMETERS		
	TRANSIT TIME	RELIABILITY	SERVICE AVAIL.
Track Maintenance	-	-	-
Crewing	4	4	-
Fuel	2	-	-
Rolling Stock Maintenance	2	-	-
Rolling Stock Capital	2	2	2
Pick up & delivery	-	-	-

2 *Directly affected by the service parameter* 4 *Partially affected*

5.4.1 Existing Rail Traffic

This discussion relates to the cost differences for *existing rail traffic*. The cost differences for *additional traffic* expected to divert to rail are dealt with separately in Section 5.4.2.

Train Crewing
Reductions in transit times will reduce train crewing costs. However, the aggregate reduction may vary depending upon the precise "piece of time" and its location which is saved.

For example, if an investment option being considered was expected to reduce train operating hours by 15%, then we would broadly expect a 15% reduction in train crewing costs.

The difficulty for a number of investment options is that the time saved is minimal. Without detailed analysis, it would be difficult to determine if a crew shift could be avoided. For example, some of the investments may reduce standard transit times, but they may also reduce the incidence of unscheduled delay, as distinct from standard running time. This may then reduce the incidence of either emergency crews, called on at additional rates, or standby crews employed to ensure a train gains a certain path if additional delay is experienced.

In the absence of detailed information concerning these specific savings, we have employed average crewing unit rates. These have been applied to the reduced crewing hours, creating a direct relationship between transit time and crewing cost.

Fuel
In a broad sense average fuel consumption can be related to distance, speed and time for a given locomotive and trailing tonnes. For this analysis, fuel consumption is assumed to be directly related to gross tonne kilometres (gtks).

Locomotive Maintenance
Locomotive maintenance is generally a function of time in use and distance travelled. Where these factors change as a result of the infrastructure improvements, reduced maintenance costs are included.

The components included as unit costs are related to locomotive hours, locomotive kilometres and a fixed component per locomotive. The components vary depending upon:

- Locomotive type
- Age
- Utilisation

Cost reductions for the options were driven by the reduced locomotive hours attributable to the investments (and locomotive kilometres where this is appropriate).

Wagon Maintenance
Maintenance rates have been developed for intermodal wagons on a per kilometre basis.

Locomotive Capital

Given the long lead time between locomotive capital purchases, it is difficult to identify the impact (if any) of the corridor improvements on locomotive capital costs. At the margin, there might be a case to assume zero cost - train operations could be expected to remain much the same. However, in the medium to long run, benefits will be achieved.

Locomotive capital has been distributed on a per kilometre and per hour basis for the evaluation.

Wagon Capital

Wagon capital costs are dependent primarily on wagon hours. A cost per hour has been included in the evaluation.

Terminal Pick-up and delivery

With the evaluation primarily based on linehaul operating efficiencies, performance improvements at the pick-up and delivery (PUD) end of the logistics chain, that may result in PUD cost savings, have been excluded from this analysis. A cents/ntk rate has been applied based on the number of containers per truck, cost per hour and an average PUD time from the rail terminal head to the origin / destination point.

5.4.1 Diverted Rail Benefits

The preceding section discussed the operating cost benefits associated with traffic volumes which are currently transported by rail.

An additional economic cost associated with the Investment Options is the incremental cost of shipping *additional* freight volumes which have been attracted to rail in response to the infrastructure improvements.

One of the key issues to be considered for diverted traffic is the employment of average versus marginal costs. With significant economies of scale, the additional cost of transporting additional tonnage can in some cases be very small, particularly when considered over the short run only.

In this case, the evaluation period is 25 years, and whilst additional tonnage may initially be absorbed at little cost, we would expect the majority of cost items to adjust to their average long run cost reasonably quickly. This position is generally reached sooner when the overall task is growing.

Nevertheless, there are two rail cost items for which we would not expect additional tonnage to incur full average costs over the evaluation period. The first of these is track maintenance, where the incremental cost of additional tonnage within a given capacity is quite low. The second is terminal handling costs (for containerised freight), for which there are significant economies of scale even over long periods of time.

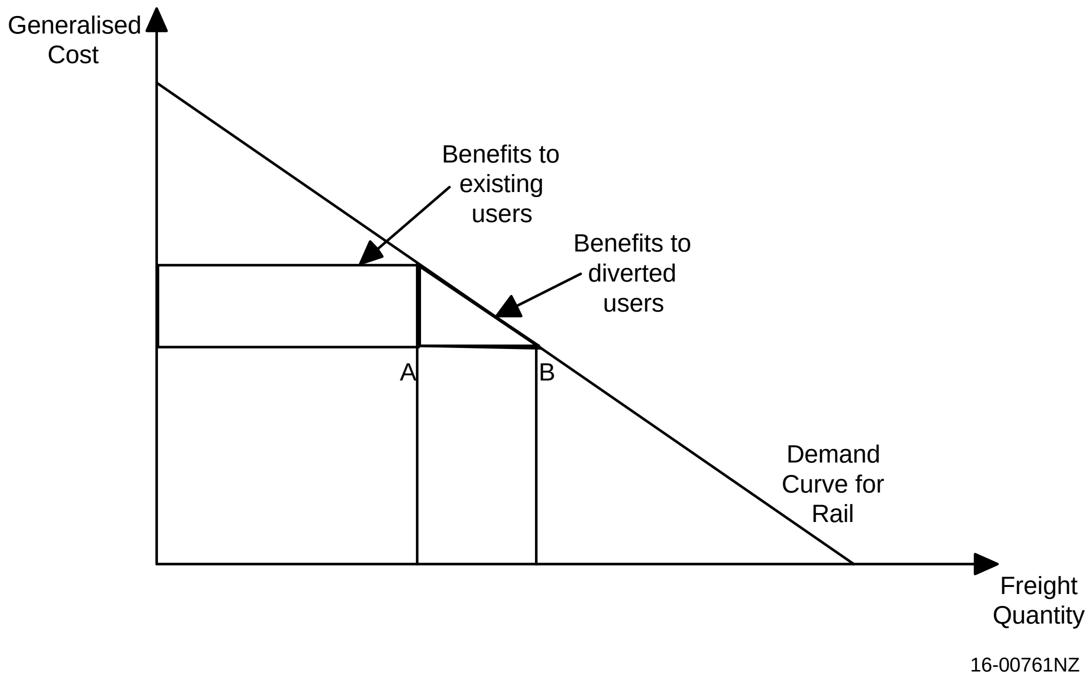
The same unit cost rates for existing rail traffic apply to diverted traffic with the exception of marginal track maintenance costs and marginal terminal handling costs.

5.5 Consumer Utility Improvements

Changes in operating costs (and price), as described above, represent only one feature of the total utility function of rail users. For economic evaluations, it is necessary to estimate the total change in utility to users associated with the proposed investment. This change in utility is measured by estimating the change in the consumer utility function for rail users. The calculation of the consumer utility function was previously discussed in Section 4.3

The change in service parameters and price leads to a change in consumer utility between the Base Case and the Investment Option. Figure 5.1 gives the standard graphical representation of the benefits associated with any infrastructure improvement.

Figure 5.1 : Calculation of User Benefits



For tonnage diverted from road to rail, the benefits are:

Cost saving for diverted customers= $\frac{1}{2}\left(\frac{\Delta U_R}{\beta_C} \times \left(D_{PC} - D_{BC}\right)\right)$

where D_{BC} and D_{PC} are the rail tonnage in the Base Case and Investment Options.

Cost savings for existing customers = $\frac{\Delta U_R}{\beta_C} \times D_{BC}$

where D_{BC} is the tonnage on rail in the Base Case.

The slope of the demand curve is the generalised cost elasticity curve. Given this, the estimation of benefits for diverted freight is relatively straightforward. The "rule of a half" is conventionally employed to diverted traffic to reflect the triangle of benefits ABC in Figure 5.1 above. This acknowledges that some traffic will divert and attract benefits close to those applying to existing traffic while other traffic will divert and attract very little benefit. Failure to divide by half would overestimate the benefits of tonnage now attracted to rail.

5.6 External Costs and Benefits

We have identified six external cost items which are generally included in economic appraisals of this type: noise pollution, air pollution, greenhouse gas emissions, congestion costs, accident costs and incremental road damage costs.

Disruption costs could also be included for the investment options during the construction phase, but the quantum of these costs is not certain since estimates have not been made.

Table 5.3 summarises the externality unit rates used in the evaluation to calculate the externality benefits associated with diverting tonnage from road to rail.

Table 5.3 : Externality Costs

Externality Measure	Road (c/ntk)	Rail (c/ntk)
Noise pollution		
Rural	0.003	-
Metro	0.006	0.004
Air pollution		
Rural	-	-
Metro	0.11	0.03
Greenhouse gases	0.16	0.01
Congestion costs		
Rural	-	-
Metro	0.09	-
Accident Costs		
Rural	0.32	0.03
Metro	0.32	0.03
Incr. road maintenance		
Rural	0.64	-
Metro	0.64	-

Sources : Booz•Allen & Hamilton estimates (1998)
Moffet (1991)
BTE (1999)
NRTC (1998)

Noise Pollution Costs

Noise pollution reduces amenity and represents a legitimate economic cost which is included in transport evaluations of this kind.

Estimates of noise and vibration costs vary in the literature, largely because the reduced amenity associated with noise is essentially location specific. To help address this problem, we have included differential estimates that are often employed for urban and non-urban noise for each of the two modes. We have generated the rates using the Bureau of Transport Economics, Working Paper 40, 1999.

Air Pollution

Differences in the emissions produced by competing modes will produce differences in amenity. Again, the respective values for urban and rural regions could be expected to be different. This is evidenced in literature such as Cox (1994), which estimates an air pollution cost 50 times higher in metropolitan areas compared with equivalent emissions in rural areas.

Given these very small external costs, we have assumed a rate of zero for air pollution in non-metropolitan areas. For metropolitan areas, we generated the pollution cost from information cited in the BTE Working Paper 40, 1999.

Greenhouse Gas Emissions

The environmental costs associated with emitting greenhouse gases (including CO2) is distinct from air pollution costs discussed above.

The most consistent estimation of greenhouse gas costs across differing modes is Moffet (1991) despite there being some methodological problems associated with the valuation technique (forest sequestration).

We have employed a figure for road transport of 0.16 cents per net tonne kilometre, with rail transport estimated to be 0.01 cents per net tonne kilometre.

Congestion Costs

The removal of several truck movements from interstate and intrastate corridors will reduce the additional travel time and other costs imposed on other road users. However, this is likely to be more significant in urban areas. We have therefore included a value of 0.09 cents per vehicle kilometre for urban areas only (NRTC, 1998).

There is no equivalent cost for rail transport.

Accident Costs

Accident costs are incurred primarily in road transport. Again, the accident costs for trucks may vary between metropolitan and urban regions. Very little literature deals directly with truck operating costs, and the sparse literature does not make this separation; we have therefore assumed the same rate for urban and rural regions. A figure of 0.32 and 0.03 cents per net tonne kilometre was used for road and rail respectively (BTE, Working Paper 40, 1999).

Incremental Road Damage Costs

The avoidable damage to the road pavement is caused from the number of axle loads across a section of highway. The damage caused by an axle load is disproportionate to the mass of the axle load. Heavy axle loads cause much more damage to the road pavement than light axle loads. The damage from passenger cars can be considered almost negligible.

Heavy trucks contribute significantly to pavement damage. This damage is proportional to the number of trucks operating on a section of road. Therefore, we have modelled the avoidable road damage costs from truck volumes as proportionate to the number of truck kilometres.

For this analysis, the National Road Transport Council's (NRTC's) nationwide average cost of 0.64 cents per net tonne kilometre to road damage associated with heavy vehicles has been used in this analysis.

Passenger Benefits

Passenger benefits, such as those enjoyed through increased freight paths and decreased network congestion, are assumed to be negligible in the scheme of benefits generated from the scenario targets specified in this Audit and have therefore been excluded from this evaluation.

5.7 Future Traffic Growth

The individual costs and benefits increase over time due to the increase in total market tonnage, network capacity and the relative productivity of road and rail.

Rail freight growth has been reasonably consistent with GDP growth over recent years. This relationship has been maintained for the evaluation and a 3% annual growth forecast to existing freight figures over the evaluation period has been applied.

6. INVESTMENT PLAN AND FINANCIAL ANALYSIS

6.1 Introduction

The final phase of the evaluation draws together the results to determine where and how funds are best spent. The analysis converts the outcomes of each of the individual market corridor upgrades into a future investment priority. The financial analysis identifies the chief beneficiaries of the proposed investment plan.

6.2 Investment Plan Derivation

The objective of the investment plan was to establish the investment priority for the interstate rail network. The S1 performance scenarios, although generating a strong positive return on investment with a moderate capital cost, do not go far enough in improving rail's current market position. S2 performance scenarios generate notable market share growth, although with a negative incremental return on investment, are not justified. Based on these results, an optimal level of investment was assessed. This involved determining a point beyond S1 (S_o), where the incremental benefits and costs of additional investment equate (maximum NPV).

A number of adjustments were required to convert each market corridor upgrade into a collective network investment. Specific project upgrade works that were found across more than one market corridor were isolated and the benefits and project costs allocated accordingly. This adjustment was required for the Melbourne – Perth and Sydney – Perth investments where approximately $20 million in project spending was common to both investment proposals.

Priority for the optimised investment was determined on an NPV basis. The ranking system adopted in the study is consistent with maximising rail's improvement in market share and reducing the number of trucks on the road. This investment priority is also consistent with the industry's view that the North-South corridors should be the focus and priority of future investment on the interstate rail network.

In isolation the optimised Melbourne – Adelaide investment was marginal. The infrastructure spend was not justified under sensitivity testing and subsequently not recommended under the investment plan. On a return on investment basis, funds are better spent elsewhere on the network where benefits and investment returns were greater.

6.3 Financial Analysis

The financial analysis identifies the entities to which calculated economic benefits could be expected to accrue. A traditional financial evaluation from the perspective of any particular entity has not been undertaken in this study. Rather, the analysis indicates how the economic benefits are likely to be distributed, and how this could be expected to change under varying operating assumptions. In particular, the analysis identifies the impact on the distribution of financial benefit when one moves away from the theoretical approach, adopted in the economic evaluation of perfect competition in the above rail market, to a more applied analysis which is cognisant of the current competitive environment.

The economic evaluation assumed, amongst other things, that the above rail market is a competitive market. This assumption ensures that all train operating and service related benefits are passed onto the end market. Under these conditions, all benefits (with the exception of external benefits, passenger and other miscellaneous benefits) accrue to the end market, with above rail operators and track authorities deriving no benefit.

The current institutional and commercial position is clearly different from that described in the above section. Markets are not necessarily competitive, where there is an opportunity for either above rail operators or infrastructure authorities to internalise benefits.

Under these conditions, it is not possible to estimate the extent of benefit internalisation by either track authorities or above rail operators. We have therefore presented a *range* of results for the four entities identified; track owners / managers, above rail operators, customers (end market), and the rest of society.

The ends of the range represent full internalisation of benefit, and no internalisation of benefit respectively. It should be noted that in all cases, service related benefits (transit time, reliability and service availability) are assumed to remain with customers (end market). Table 6.1 provides details on the method of the apportionment of project benefits.

Table 6.1 : Method of Apportionment of Project Benefits

	TRACK	RAIL	CUSTOMER	EXTERNAL
Full Internalisation	Track maintenance cost savings Rail operating cost savings	Rail operating cost savings	Service benefits (Existing customers) and proportion of diverted benefits which are accrued from an improvement in service characteristics	Proportion of externalities savings which are accrued from an improvement in service characteristics
No Internalisation	Track maintenance cost savings	No Benefits	Service benefits Rail operating cost savings Benefits to diverted tonnage	Externalities savings

ATTACHMENT A
EVALUATION EQUATIONS

Evaluation Model Equations

Capital Costs	
Initial Capital Costs	As specified
Residual Value	Capital cost of asset * remaining life of asset / life of asset
Infrastructure Maintenance	
Track Maintenance	GTK * unit cost track maintenance ($/000 gtk)
Signalling & Communications Maintenance	Link km * (% of link with signalling * signalling cost ($/route km) * no. of annual train trips + Link km * (% of link with communications * communications cost ($/route km) * no. of annual train trips
Train Control	Total train hours * cost of train control ($/train hour)
Rail Operating Costs	
Crewing	Total train hours * cost of train crew ($/train hour) Two person crewing has been applied.
Fuel	Total Fuel consumption rate (Litres / 000 GTK) * total GTKs * fuel price ($/L) The fuel consumption rate varies for at speed travel, acceleration and idle time
Rollingstock Maintenance	Loco maintenance cost = (locomotive kilometres * per kilometre unit maintenance cost) + (locomotive hours * per hour unit maintenance cost) Wagon maintenance cost = (wagon kilometres * per kilometre unit maintenance cost)
Rollingstock Capital	Loco capital cost ($/loco hr) * loco hrs + ($/loco km) * loco km Wagon capital cost ($/wagon hr) * wagon hrs
Terminal PUD	Distance * volume * PUD cost (c/ntk) PUD cost include containers per truck; cost per hour; PUD time at the origin and destination points
Non-price Customer Benefits	
Reliability	Base Case volume * distance * (Base Case reliability generalised cost of rail – Investment Option reliability generalised cost of rail) / Reliability co-efficient
Transit Time	Base Case volume * distance * (Base Case transit time generalised cost of rail – Investment Option transit time generalised cost of rail) / transit time co-efficient
Service Availability	Base Case volume * distance * (Base Case service availability generalised cost of rail – Investment Option service availability generalised cost of rail) / service availability co-efficient
Diverted Rail Tonnage Benefits	
Producer Surplus	(Marginal rail revenue – marginal rail cost) * diverted volume * distance
Customer Benefit	½ * ((Base Case generalised cost of rail – Investment Option generalised cost of rail) * diverted volume)

External Benefits	
Road Damage	unit cost (c/ntk) * (road km * diverted tonnage)
Accident Costs	(road km * diverted tonnage) * road unit cost (c/ntk) – (rail km * diverted tonnage) * rail unit cost (c/ntk)
Noise Pollution	(road metro km * diverted tonnage) * road metro unit cost (c/ntk) + (road rural lm * diverted tonnage) * road rural unit cost (c/ntk) - (rail metro km * diverted tonnage) * rail metro unit cost (c/ntk)
Air Pollution	(road metro km * diverted tonnage) * road unit cost (c/ntk) – (rail metro km * diverted tonnage) * rail unit cost (c/ntk)
Greenhouse Gases	(road km * diverted tonnage) * road unit cost (c/ntk) – (rail km * diverted tonnage) * rail unit cost (c/ntk)
Congestion	(road metro km * diverted tonnage) * road unit cost (c/ntk)

Notes

Locomotive Costs
The use of both a kilometre and time unit measure accounts for the fixed and variable cost components of total locomotive costs.

Generalised Cost of Rail
There are several price and non-price characteristics which form a rail user's total generalised cost. The characteristics used in estimating the generalised cost are price transit time, reliability and service availability. Changes in these characteristics represent the total generalised cost of rail, which in turn affects rail's overall market share.

Road/ Rail metro
Of the total corridor distance, urban road / rail distance is taken as a proportion of the total link distance.

Road Rural
Of the total corridor distance, rural road distance is taken as a proportion of the total link distance.