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Paper title: **Interstate rail track upgrading options to 2014**

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Abstract

As part of the AusLink White Paper released in June 2004, extensive funding was announced for upgrading interstate mainline track. The main aims are to reduce the transit times, increase capacity and reduce track maintenance costs. However more work will be needed to remedy severe speed restrictions imposed by steep grades and tight curves on NSW track.

Particular attention is given to three proposed NSW rail deviations. These deviations are between Glenlee and Aylmerton, Goulburn and Yass, and, Bowning and Cootamundra. All are designed to remove the impact of excessive curvature. The combined length of these deviations is 164 km and they would replace 197 km of track on “steam age” alignment. The benefits for a 'standard' intermodal freight train include a time saving of 84 minutes and a fuel saving of over 1000 litres of diesel. The regional benefits of track upgraded for faster and heavier freight trains may also include high-speed tilt passenger train services.

The paper estimates combined benefits from the three rail deviations of about $24 million per year from reductions in train operating costs and track maintenance costs, and the potential reduction in net external costs with Sydney - Melbourne inter- city land freight.

Introduction

Australia's Defined Interstate Rail Network (DIRN) is the rail equivalent to the National Highway Network, and links the mainland capital cities. Excluding Tarcoola - Darwin, this network is approximately 7200 km in length. Most of this network is managed by the Australian Rail Track Corporation (ARTC). The ARTC owns the South Australian standard gauge network, leases the Victorian standard gauge track, has wholesale access arrangements with Western Australia, and on 5 September 2004 assumed a 60-year lease on NSW interstate mainlines.

On 7 June 2004, the AusLink White Paper (Department of Transport and Regional Services, 2004) announced a $1.8 billion rail upgrading programme. This includes an initial $872 million track upgrade over five years as part of the ARTC – NSW lease agreement; and, a special allocation of $450 million in the 2004 Federal budget to upgrade the Sydney - Brisbane line with some track straightening. There is also interest in developing an Melbourne - Parkes- Brisbane 'inland route' (see, for example, Arup-TMG (2001) and Laird et al (2001)).

The main aims of the existing track upgrade are to improve transit times for freight train operations along with increased capacity and reduced maintenance costs, all of which combine to improve reliability. For instance the Melbourne - Sydney freight objective as stated in a formal agreement signed on 4 June 2004 is to reduce Superfreighter transit time from 13.5 to 10.5 hours. However, completion of this scope of work will only partly remedy severe speed restrictions imposed by substandard alignment. Here, 25 per cent of the Melbourne - Sydney and 40 per cent of Sydney - Brisbane track has either steep grades (steeper than 1 in 66) and/or tight curves (less than 800 m radius) whilst only 4 per cent of Melbourne - Perth track has substandard alignment.

BTRE (2003a) projections indicate that under a 'business as usual' scenario, intercapital city freight movements between Melbourne, Sydney and Brisbane will rise from 18.6 million tonnes in 2002 to 28.7 million tonnes by 2014. Of this, only 3 million tonnes would go by rail.

Drawing on research supported by the Rail CRC, and Queensland Transport, the Australian Research Council and NSW Rail Infrastructure Corporation (RIC), this paper will include the outcomes of train simulations for three proposed major deviations in Southern NSW. Preliminary estimates of reductions in train operating costs, track maintenance costs, and net reductions in land freight external costs for each proposed deviation site will be developed to demonstrate the value of these proposals.

Benefits from major track upgrading

In this section, we examine the benefits to train operators, track owners and the wider community from completion of a major upgrade of a section of track.

The ARTC Track Audit (2001, Final Report, page 86) notes a distribution of financial benefits from basic optimised (So) track upgrades as 70 per cent above rail gains, 5 per cent below rail gains, and 25 per cent externality gains. However, the above rail gains are mainly captured by the freight customer, and both above and below rail benefits are "offset by operators competing for modal share" to leave just 17.5 per cent of the gains available to pay for private investment.

The savings accruing to train operators and track owners from track upgrading have also been addressed by Michell and Laird (2002), and in rail studies for Queensland Transport (2003) including “The Straight Track Study". A summary of the methodology developed for Queensland Transport (2003) to calculate the savings from track upgrading to train operators and track owners estimate is outlined in Appendix A. In addition, a brief outline of land freight transport external costs in Australia is given by Queensland Transport (2003) and Laird et al (2003) and summarised in Appendix B.

The additional freight train operating costs, track maintenance costs and external costs that result from track imposed speed constraints for a standard Queensland Rail (QR) general freight train moving between Landsborough and Townsville was outlined by Laird and Michell (2004). This used information on speed constraints at 135 potential rail deviation sites identified by QR (1998) that notes tight radius curves or other constraints that require freight trains to reduce speed to less than 100 km/h. In summary, by use of Excel spread sheets with various assumptions and approximations, the following results were found:

i. the cumulative costs to a train operator imposed by speed constraints on a 100 km/h standard freight train between Landsborough and Townsville were found to be approximately $2600 per trip. This is about 20 per cent of the total operating cost of the train if it could sustain 100 km/h through running for the entire haul.

ii. the extra track maintenance costs on track with tight radius curves were estimated as approximately $200 for each standard freight train trip between Landsborough and Townsville.

iii. in regard to external costs, it was found that for each additional tonne of line haul freight gained by more competitive rail freight operations, external transport costs would reduce by approximately $16 per tonne.

To apply the “straight track model” to larger rail deviations, it is better to use computer simulation of train movements over both the existing and possible new track. This is because the Excel model is better suited to a large number of relatively short deviation sites.

Train simulation was applied (Laird et al, 2003) to gain new estimates of savings to train operators and the track owner in the context of a potential major Bowning-Cootamundra rail deviation on the NSW Main South Line. This is a potential 78.4 km rail deviation between Bowning (at 329.3 km) and Cootamundra (existing 429.6 km) that was examined as part of a project for the Rail Infrastructure Corporation of NSW (see Laird et al, 2002). A similar proposal (The Hoare Deviation) was rated as a "stretch target" or S2 project in the ARTC Track Audit (2001, Maunsell Report). The indicative total savings if the 78.4 km rail deviation was now in place were found to be in the order of $10 million per year.

Three NSW Main South Deviations

The ARTC (2001) Track Audit identified three major rail deviations on the NSW Main South Line. They were the Wentworth deviation between Glenlee and Mittagong, the Centennial deviation between Goulburn and Yass, and the Hoare deviation between Bowning and Frampton. The combined length of the potential new track was about 230 km, and it would replace about 277 km of poorly aligned track with excessive tight radius curvature, leading to transit time savings of about 90 minutes. Their estimated cost was about $770 million. Further details are given by Laird et al (2002). This paper includes how the Centennial Deviation was part of a 1982 Institution of Engineers Australia proposal to link North Canberra by rail to Sydney and Melbourne, and the potential use of passenger tilt trains.

Each of these three rail deviations could well be replaced by shorter deviations that achieve substantially the same benefits for freight train operations, at appreciably less construction cost. In this analysis, the Wentworth deviation is replaced by one from near Menangle to Aylmerton; and, the Centennial Deviation which takes high ground south of Gunning is replaced by a shorter and more direct route from Breadalbane to Coolalie as originally proposed by Mr. Greg Beasley of RIC. As well, Bowning – Frampton has been changed to Bowning to Cootamundra, on a route identified by Mr. Beasley, in recognition of the role Cootamundra has as a key junction location..

The combined length of new construction is then 164 km, which would lead to lower costs. Brief details of the three deviation sites, and the track they could replace, are given in Table 1.

It is of note that the present Campbelltown – Cootamundra track was constructed during the 1910s in a series of duplications and deviations. It is 376 km in length, and was built to ease steep ruling grades for northbound trains and replace about 355 km of track built in the 1870s. Trains traversing the track between Campbelltown to Cootamundra turn through the equivalent of 51 complete circles of track on the existing route. The three deviations would replace about 41 of these circles, replacing them with the equivalent of just 3 circles.

The benefits of the three sections of new track construction would be improved by further rail deviations: selectively between Werai to Penrose, and Cootamundra to Bethungra. This includes bypassing the Bethungra spiral. With this option, the total length of new track is 197 km replacing 257 km of 'steam age' alignment with reduction of point to point distance of 60 km.

Table 1 Rail deviation site parameters

	Existing track Length (km)	Tight radius curvature km	Equiv.Circles on old track	New Track Length (km)
Menangle-Aylmerton	58	38	14	39
Breadalbane - Coolalie	61	33	12	47
Bowning- Cootamundra	100	40	15	78
Total	**219**	**111**	**41**	**164**

Train simulation

For each of the three major rail deviations, SimTrain simulation by Samrom Pty Ltd was applied to a "standard freight train" moving in each direction over the existing track and potential new track as outlined above. SimTrain is a specialist train performance tool developed over a number of years and has consistently calibrated reliably against field observations.

Key SimTrain data is:

- a track file, containing details of vertical and horizontal profiles, track speed, and locations; and
- a train file containing power, trailing load, length, maximum train speed and a number of details such as braking rates, rolling resistances and fuel rates.

SimTrain deals with the combination of the track and train files at short intervals to calculate the aggregate rolling, curve and grade resistance, speed limitations within the train's immediate performance domain and other specified requirements. From this it determines the power or braking requirement for the train and the consequent transit times and fuel consumption. Basic output is a time, speed and fuel trace for a given section journey, but it can also include parameters such as braking effort.

The model has a number of user defined operating characteristics and modes. In these train simulations, economical (as opposed to aggressive) driving tactics have been used. As well, a "standard freight train" was defined as an intermodal train hauled by two NR locomotives (of mass 132 tonnes each) with a trailing load of 2600 tonnes over 1200 metres with 57 wagons.

The average results for the intermodal freight trains moving in both directions are given in Table 2. For the three rail deviations, they indicate a transit time saving of 84 minutes, diesel fuel savings of about 1090 litres per movement and a reduction of about 2.33 MegaWatt hours of braking effort. Using the formulae given in Appendix A, this gives for all three rail deviations, train operator savings of about $1370 per train and for the track owner, nearly $500 per train movement.

Table 2 Superfreighter simulation outputs (average both ways)

	Existing track Time (min)	New Track Time (min)	Fuel savings (litres)	Reduction (MWh) in braking effort
Menangle - Aylmerton	52	35	181	0
Breadalbane - Coolalie	60	36	348	1.0
Bowning - Cootamundra	105	62	564	1.33
Total	**217**	**133**	**1093**	**2.33**

Savings to freight train operators and track owners

On the basis that there are at present an average of around 12 freight trains each way each day on this section of track (comprising around 5 interstate and 7 regional freight trains each way daily) for 360 days per year, and cost reductions of $1370 per freight train, gives annual savings of about $12 million to all freight train operators. A breakdown of estimates of annual savings for all freight train operators for each major deviation is given in Table 3. The Menangle – Aylmerton deviation would normally have a few less freight trains, but a significant number of local passenger trains in replacement so the net result for that section would be proportionately similar to the two deviations further south.

The track maintenance savings are calculated as per Appendix A, information in Table 1, and using further data about the track. This gives a total for reductions due to train movements of about $4.3 million per year. If double track is used and the old line is closed (and there could well be variations on this), with track kilometres reduced by 110 km and other factors, the reduction in fixed track maintenance costs at $6000 per track km are about $0.7 million per year. Again, a breakdown for each deviation is given in Table 3.

External Costs

Along with the unit external costs given in Appendix B and by use of assumptions including a road distance of 840 km, an upgraded rail distance of 920 km, urban hauls of 50 km for each line haul mode, plus an average 25 km urban road pick up and delivery for each rail line haul, there is an external cost of $14 for each tonne of road hauled intercity freight (see also Laird et al 2003). This is against 90 cents per tonne for rail line haul and 95 cents for road pick up and delivery. Accordingly, for each tonne of intercity freight moving between Sydney and Melbourne by road diverted to rail line haul, with road pick up and delivery, there is a net reduction of external costs of $12.15.

A critical 'value' to be derived from the proposed deviations would be the increase in modal share of non-bulk Sydney - Melbourne freight that could be attributed to faster transit times and reduced costs arising from the various rail deviations.

Table 3 Summary estimates of aggregate annual benefits

	$ million (2004)			
	Train operator	Track owner	External costs	Total
Menangle - Aylmerton	1.7	1.5	1.4	4.6
Breadalbane - Coolalie	3.7	1.4	1.9	7.0
Bowning - Cootamundra	6.4	2.1	3.5	12.0
Total	**11.8**	**5.0**	**6.8**	**23.6**

Using the findings of the Track Audit (ARTC, 2001) where it was found that the So capital works would give rail a 20 per cent modal share of intercity intermodal freight and with a further 90 minute reduction of transit time would give a 26 per cent modal share, and linear extrapolation, a 30 minute reduction in transit time gives rise to a two per cent increase in modal share. On this basis, the 84 minute reduction in transit time would translate into a 5.6 per cent increase in modal share. With this assumption, and assuming an estimated 10 million tonnes of Sydney - Melbourne freight in the year 2004 (BTRE, 2003a) we gain the estimates of reductions in external costs in Table 3. This is when there is no change in road user pricing for heavy trucks. However, it is clear that an increase in road pricing for heavy trucks (with no change in rail access pricing) would lead to an increase in rail's modal share. On this basis, it is a reasonable assumption that with improved road cost recovery and mass and distance differentiation in road user charges.

It may be argued that what is needed to gain an increase in modal share is a marked reduction in rail line haul transit time. This is to allow for later "cut off" times for receipt of freight for line haul and/or earlier arrival times. Other improvements and or lower rail freight rates relative to road are also needed. Either way, we suggest that the quantum improvement in rail operations from major track straightening would allow for a boost in rail's modal share.

There is also the wider question of how long rail can expect to attract more freight onto a track with 'steam age' alignment when the Hume and other highways continue to be upgraded to modern engineering standards. As argued by the New Zealand magazine 'Rails' in its September 2003 issue *"...if rail is to be more competitive in future, remember this: competitive trains need competitive tracks."*

Our estimates are qualified as preliminary ones that are in need of further refinement. The effect of any increases in rail freight from the potential track straightening also needs to be worked into the benefits. The details of route selection and its likely cost, and any benefits gained from being able to operate heavier freight trains from the new deviation having easier ruling grades are also in need of further examination, as are the benefits to regional Australia of offering high speed tilt train services on tracks upgraded for faster and heavier freight trains.

Conclusions

Commercialisation of rail freight operations over the last few decades has brought with it the need for more rigorous evaluation of improvement proposals, although these have been constrained by the limited evaluation domain of the railway and corrupted by knee jerk political reaction. More recently the dis-integration of the rail network into above and below rail has made conventional simple evaluation and justification of spending proposals even more problematic. Along with the ARTC (2001) Track Audit, this paper has attempted to deal with the broader issue of the full range of costs associated with rail improvement projects, including those internal to the rail industry as well as external (community) costs.

For years rail has been in a downward cycle of low investment, reduced market share and consequent increased difficulty in conventionally justifying any investment to recover and/or improve the rail right of way to be both efficient and competitive.

The recent launching of AusLink has, for the first time, provided a funding framework which demands that a consistent total cost approach be taken for all land transport projects desiring funding under that program. Rail will for the first time have a national evaluation benchmark to meet to get Federal funding – a necessity for the otherwise difficult proposition of restoring the North-South rail network to competitive health.

This paper has provided a brief outline of external land freight transport costs as used in the ARTC National Track Audit and in a study for Queensland Transport. The savings to train operators, the track owners and community resulting from alignment upgrades have been used to illustrate the issue, based on work done in a further study for Queensland Transport.

As an example, estimates of savings to train operators and the track owner along with reductions of external costs are discussed in the context of three potential major rail deviations between Menangle and Cootamundra. On current low rail tonnages, these are conservatively estimated to amount to approximately $24 million per year.

In Australia, State Road Authorities, along with having 'plans in the top drawer' have paid particular attention to valuation of external benefits of major road projects. Austroads for many years has had a Benefit Cost Manual that is recognised by Government. In order to get full benefits from the new AusLink programme, the rail industry has much to catch-up on in order to get 'plans in the top drawer'. It is also necessary to ensure that due recognition is given to the benefits to track owners, train operators, and the wider community from major track straightening.

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Appendix A

The Straight Track Study gives details of a simple model that calculates for a given deviation site the cost C in dollars to the train operators for ongoing use of existing track with tight radius curvature, as:

$$C = B + R * T.$$

Where $B = E \times 0.098 + F * G$ is the cost as a result of braking and regaining speed,

E is the braking effort measured in kilowatt hours,

F is fuel used, and G is the fuel cost which we take as $0.6 per litre.

As well, T is the time (in minutes) and R is a cost factor (dollars per minute). This cost factor for the 'standard superfreighter' is $5.33 based on crew time ($125 per hour) plus a daily lease cost of $1200 per day for locomotives and wagon utilisation at $40 per day.

For track costs, using data as per the Straight Track Study, a cost of $6000 per track kilometre plus a variable cost per thousand gross tonne kms as follows was determined:

For tangent track, or on curves more than 810m radius	$0.48
On curves between 601m and 810m radius	$0.80
On curves between 401m and 600m radius	$1.20
On curves less than 400m radius	$1.50

In addition to these variable costs, an allowance is made for the increase in track maintenance costs from this effect of train braking over the length of track the brakes are applied.

Appendix B

A discussion of various Australian estimates of external costs of land freight transport is given by ARTC (2001), Queensland Transport (2003) and Laird et al (2003). In brief, as noted by the former Inter-State Commission (1SC - 1990, p89), road external costs are *"...costs imposed outside market transactions and they fall on a number of individuals or groups - road users other than those individuals who give rise to the costs, individuals other than road users (such as those who live in proximity to roads), or society as a whole."* Such external costs may also be imposed by rail freight.

Table B1: Revised (and track audit) externality costs

Externality		Road (c/ntk) QLD	(TA)	Rail (c/ntk) QLD	(TA)
Noise pollution	Rural	0.003	(0.003)	-	-
	Metro	0.006	(0.006)	0.004	(0.04)
Air pollution	Rural	-	-	-	-
	Metro	0.11	(0.11)	0.03	(0.03)
Greenhouse gases	Rural	0.17	(0.16)	0.064	(0.01)
	Metro	0.20	(0.16)	0.064	(0.01)
Congestion costs	Rural	-	-	-	-
	Metro	0.09	(0.09)	-	-
Accident Costs		0.50	(0.32)	0.03	(0.03)
Increased road maintenance		1.00	(0.64)	-	-
TOTALS	**Rural**	**1.673**	**(1.123)**	**0.094**	**(0.04)**
	Metro	**1.906**	**(1.326)**	**0.128**	**(0.074)**

Reference: Queensland Transport (2003) *Rail Studies*, Land freight external costs in Queensland, and Booz-Allen & Hamilton Appendix A, page 24, for Track Audit (TA) values (given in brackets).

External costs were considered by the National Transport Planning Taskforce (NTPT - 1994, p53) that noted, inter alia *"...A pricing mechanism for road use, which relates use to cost of provision and external costs, such as congestion and environmental factors, needs to be developed. Similarly, pricing mechanisms linking use of port, airport and rail infrastructure to the costs of provision, are required."*

The Australian Competition and Consumer Commission (2002, p114) notes that government funding to accommodate investment needs is *"potentially distorting in an efficiency sense"*, but that the investment may be justified provided that it passes a strict *"...'global' cost benefit test; ie the total social benefits exceed the total social costs of the investment."*

The main current paper citing estimates of external costs of land freight transport in Australia is that of the Bureau of Transport Economics (BTE - 1999). These formed the basis of many of the six external costs noted by the National Interstate Track Audit commissioned by the Australian Rail Track Corporation (ARTC - 2001 Appendix A page 24) noted as *'... noise pollution, air pollution, greenhouse gas emissions, congestion costs, accident costs, and incremental road damage costs'*. The Track Audit estimates are given in Table B1.

A common feature of many reports on transport externalities is that although much can be written, at the end of the day, it is hard to make accurate and up-to-date estimates of the cost of transport generated noise, pollution, and the resulting health related impacts in Australia.

Moreover, as noted above, the BTE (1999) and subsequent reports relied on the work of the former Inter-State Commission (ISC -1990) which in turn used overseas estimates going back to the early 1980s. In the absence of more detailed work, one can accept the Booz-Allen & Hamilton estimates for environmental externalities for urban and non-urban areas. However, for road and rail accident costs, and greenhouse gas costs, it is appropriate to use different estimates, as given in Table B.1.

An estimate of the cost of road crashes as $14.98 billion in Australia during 1996 was given by the BTE (2000) who noted the cost of a road crash fatality as $1.5 million, the cost of a road crash requiring hospitalisation as $325,000, and the average unit cost of other injuries as $12,000. On this basis, and other data, an average unit cost of NSW road crashes involving articulated trucks was derived at about 0.5 cents per net tonne km. Data provided by the NSW Roads and Traffic Authority for the twelve years from 1988 to 2003, which shows for the National Highway System and the Pacific Highway within NSW, about 36 per cent of the lives that were lost on road crashes were in crashes involving articulated trucks.

The cost of rail accidents was estimated by the BTRE (2003b, Report No. 108) to be, under one set of assumptions, about $133 million in 1999. Based on this BTE (2003b) report with higher rail accident costs, and other factors, it is suggested that for the present, the earlier estimate of 0.03 cents per tonne-km for rail freight in Australia be maintained. The Queensland Transport (2003) notes an estimate for Queensland Rail of 0.024 cents per tonne-km for rail freight.

For greenhouse gas emissions, based on $25 per tonne, the study for Queensland Transport noted costs for road haulage at 0.20 cents per ntkm in urban areas, and 0.17 cents per ntkm in non-urban areas along with for rail haulage 0.064 cents per ntkm for non-coal trains.

The estimate of unrecovered road system costs of 1.00 cent per net tkm for arterial roads is based in part on an estimate (Laird et al, 2001) of average under-recovery of road system costs from articulated truck operations of about 1.25 cents per net tonne km. For rural roads of light construction, an estimate of 2 cents per net tonne km is more appropriate.