Viability of Providing Double Stack Access on Railway Lines in Southeast Australia

Ted van Geldermalsen, Denis Leviny
Maunsell Australia Pty Ltd, Melbourne, Australia

1 Introduction

Provision of double stack operations on Australia's rail network is a significant technical and financial challenge that is considered by many as offering the potential for better infrastructure utilisation and productivity gains in rail operations. It is also seen as having the potential to influence the rail industry's efficiency and competitive environment and hence drive further modal shift to rail on key transport corridors.

The introduction of double stack operations will require greater horizontal and vertical clearances to structures on the rail network than are currently required for the conventional single stack operations operating on the southeast Australian rail network. It will also change the nature of train operations and terminal design.

The possibility of increasing clearances to enable double stack container operations on railway lines in southeast Australia has been under consideration for some time but the constraints associated with tunnels and road bridges built across the tracks at single stack clearance height, and overhead electrification in metropolitan areas have placed this goal beyond short-term reach in most corridors. Whilst all of these constraints are resolvable, the cost to undertake this work is often high and consequently track owners have been reluctant to commit to a targeted infrastructure upgrade program. Nevertheless, a policy of requiring increased clearances for new construction has been in place on most corridors with the aim of facilitating increased clearances at some future date.

In order to determine whether investment in double stack clearances should continue, or perhaps be accelerated, a conclusive analysis was required into the viability of double stacking, including an indication as to which routes should be given the highest priority.

This paper is based on a pre-feasibility study undertaken by Maunsell Australia for the Victorian Department of Infrastructure and the Australian Government Department of Transport and Regional Services. The objective of the study, titled 'Double stack access in south eastern Australia – financial, economic, social and environmental evaluation', was to determine whether the potential operating cost savings of double stack rail operations were likely to be sufficient in the foreseeable future to justify the additional cost of continuing to provide double stack clearances on new infrastructure. It was intended that, if double stack access was found to be viable, a uniform set of clearance standards would be implemented on a corridor-by-corridor basis. If it was not viable, then consideration should be given to discontinuing the current practice of building new infrastructure to double stack clearances and avoiding the incremental cost imposition on construction of these structures.

The key issues addressed by the study were:

- Is there sufficient demand for double stack operations in southeast Australia, now or in the foreseeable future?
- If there is, can the infrastructure redevelopment and costs involved be economically, socially and environmentally justified?

As a pre-feasibility study, the report aimed to establish the strength of the case for providing double stack clearances, and to shortlist those routes that were most likely to justify further examination. In order to ensure that no routes were eliminated prematurely, at each step of the analysis the most favourable assumptions and inputs toward the double stack case were

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used. The aim was to ensure that the list of routes taken through to more detailed evaluation would be robust, the intent being that the list would be further refined during a more detailed assessment at a later stage.

2 Corridors investigated

The corridors that were investigated for double stack access are shown in Figure 1 and included:

- Melbourne – Adelaide
- Melbourne – Sydney
- Melbourne – Crystal Brook, South Australia via Parkes
- Melbourne – Brisbane via Parkes and North Star
- Melbourne – Brisbane via Parkes, Merrygoen, and coastal route
- Victorian Regional corridors

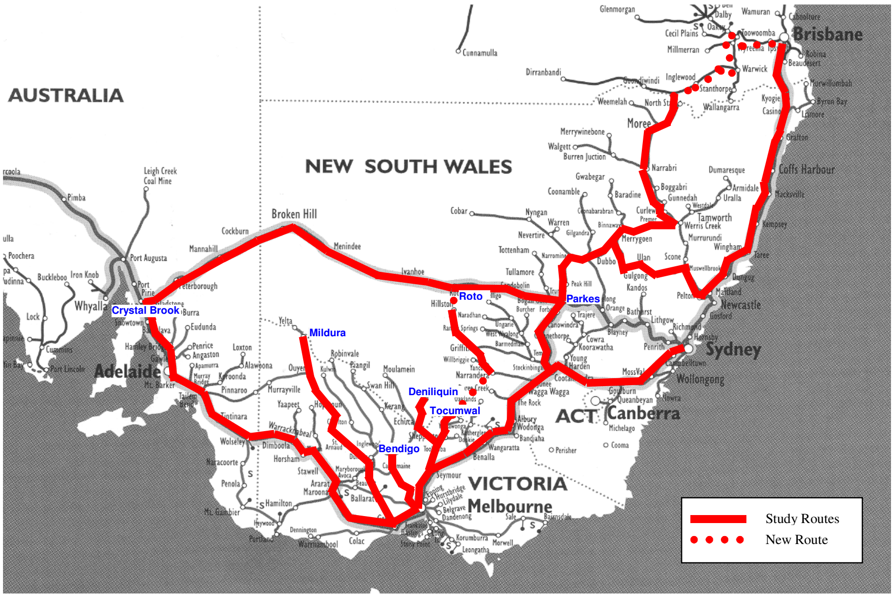


Figure 1: Rail corridors investigated for double stack access

This paper mainly reports on the interstate corridors.

3 Current double stack experience

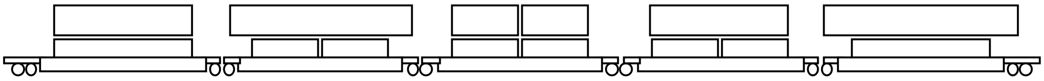
Double stacking of containers on rail wagons is not a new concept. The practice is well established on a number of longer haul routes in North America. Here in Australia, double stacking is occurring between Adelaide and Perth where it is estimated that about half of each train is made up of wagons carrying double stacked containers. There is also some double stacking between Adelaide and Darwin and a very small amount between Adelaide and Parkes.

The maximum loading height for wagons between Adelaide and Perth/Darwin is 6.3m (or 6.5m with special arrangements), which equates to the ARA maximum rolling stock infrastructure outline of 7.1m once allowance is made for a dynamic envelope around the loading. On the Adelaide to Parkes track, maximum loading height is constrained to 5.89m by a small number of structures. This effectively only allows for partial double stacking with a half height container on top.

4 Wagon issues

Double-stacked containers in Australia are loaded on two basic wagon designs; standalone well wagons are used for heavier loads and articulated well wagons for lighter loads. Well wagons are required in order to carry the containers at the lowest possible position in order to achieve the required vertical clearance. Double stacking on conventional wagons is also undertaken where half height containers are available. Figure 2 shows a representation of the two well-wagon designs typically used for double-stacked containers.

(a) Articulated well 5 pack wagon



(b) Stand alone well 5 pack wagon

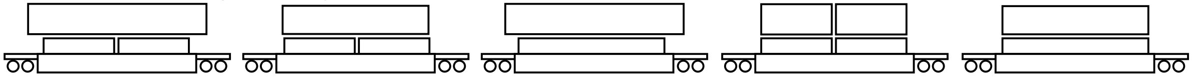


Figure 2: Typical double stack wagon designs

A number of restrictions that relate back to axle load limitations and management of the centre of gravity of the wagons complicate planning of double stack loads. Generally only light containers can be placed in the top position. Not all container types are suitable for use in the lower position, for example, tautliner containers do not have the necessary strength, and 40ft containers cannot support 20ft units on top.

The ability to load wagons for the purpose of double stacking is largely determined by:

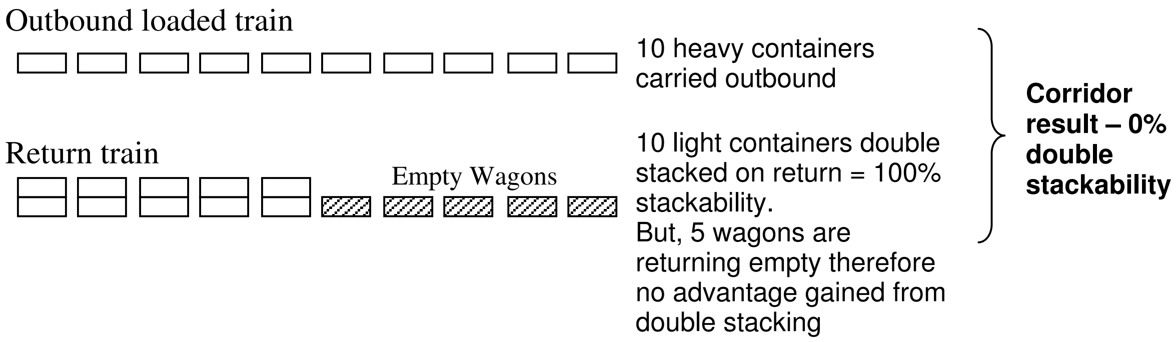
- The design strength of the wagon – many existing container flats are not suitable to modify for double stacking.
- Clearance profile requirements – generally well-wagons are essential
- Axle load limitations – in order to accommodate reasonable container weights (refer Table 1)
- Centre of gravity – only light containers are permitted in the top positions for stability and to reduce forces on the track infrastructure.

Table 1: Impact of wagon design on load carrying capacity

Wagon type	Double stacked containers carried (TEU)	Wagon tare (tonnes)	Number of axles	Maximum average container weight per TEU (tonnes)	
				21 Tonne axle loads	25 Tonne axle loads
5 Pack articulated well wagon	20	95	12	7.8	10.3
5 Pack conventional well wagon	20	110	20	15.5	19.5

The mix of container weights offered for transport will determine the extent of double stacking possible in any particular corridor.

The double stackability factor relates to the ratio of containers that can be double stacked on a corridor after considering all the constraints and restrictions. It can be different depending on the direction of flow of tonnages in the corridor and the distribution of heavy and light containers. The resultant stackability factor for the corridor will be the lesser of the outbound and return amounts because of the need to balance rolling stock deployment. Figure 3 provides an example of this effect in a corridor with equal volumes of container flows in each direction but with a dominant direction for heavy containers (eg Melbourne to Perth):



10 heavy containers carried outbound

10 light containers double stacked on return = 100% stackability.
But, 5 wagons are returning empty therefore no advantage gained from double stacking

Corridor result – 0% double stackability

Figure 3: Method for calculating double stackability ratio

The other factor requiring consideration is the relationship of the stackability factor to the balance of flow in the corridor. For example, in the above circumstances if the return train volumes were double the outbound volumes then a 50% stackability ratio could be achieved. Research has identified that this ratio is substantially different for each corridor due to the different mixes of freight loading, but an average of around 66% holds on an Australia wide basis.

It is also important to note that by increasing loading outlines, opportunities occur for other traffic types to be accommodated as identified below:

- Larger containers on standard wagons – currently on most routes the maximum container height that can be carried on a standard container wagon is 9’6”, therefore the opportunity is created to carry 10’6” and higher.
- 1.5 stack (ie top loading of half height containers) – not full double stacking but this configuration suits some commodities such as steel rod, timber etc. that have a shape and a weight suitable for the use of half height containers.
- Piggyback – or frequently referred to as ‘trailer on flat car’, is widely used in North America where there are long hails and regulatory encouragement, and in Europe where there are short hauls through restrictive country such as the Alps. The practice of carting trucks on rail wagons has been used in Australia in the past but containerised traffic is more efficient based on the net to tare ratio.
- Fully enclosed Tri-deck car wagons – widely used in North America and there are some open top wagons used here in Australia. Current trends in car transportation have been towards containerisation to reduce handling and damage and there appears to no current demand for this design wagon in Australia.

5 Infrastructure issues and costs

The appropriate outline to adopt for double stack operations in Australia is the ARA ‘Structure Clearance Outline F’. Figure 4 demonstrates the increased clearance requirement of this outline compared to the current standards and also the American (AAR) standard.

Issues created by the adoption of the ARA Structure Outline F include:

- The increased height of the outline will necessitate numerous rail over bridges being replaced or raised
- The height of structure outline is not compatible with suburban electrified systems due to the height of the electric train contact wire
- The increased width of the outline at the lower areas creates conflicts with platform, signals, signage and some bridge girders/trusses.

- The wider outline to allow for the larger dynamic envelope for the higher loading is likely to involve providing increased spacing between parallel tracks such as in crossing loops.

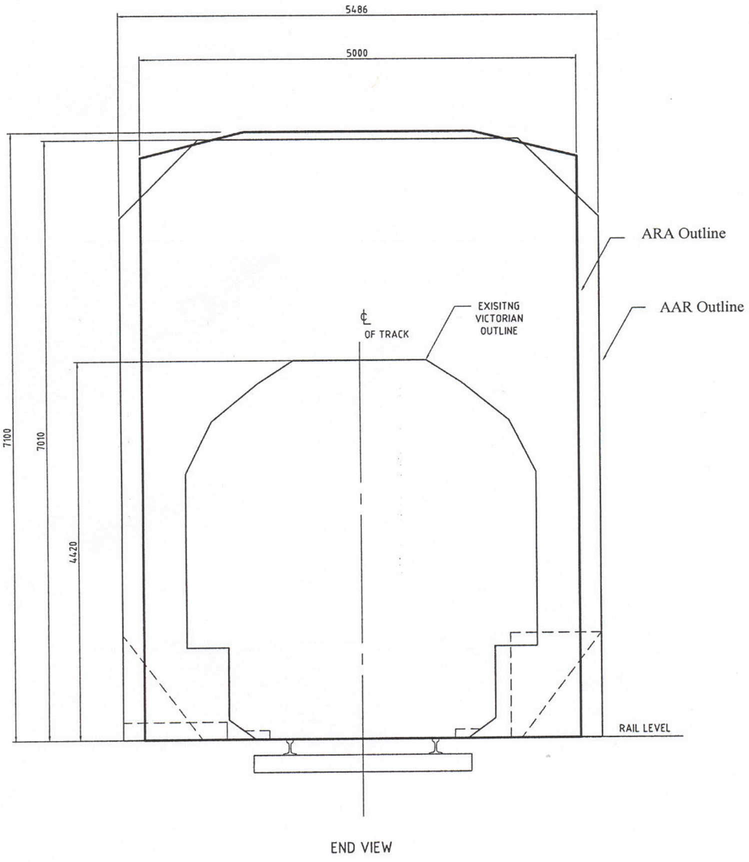


Figure 4: Comparison of structure clearance outlines

Infrastructure costs used in the evaluation were derived from a desktop study only, and relate to works over and above those identified in the base case. They have a low level of accuracy, as is appropriate for a preliminary feasibility study of this nature. It is expected that these costs underestimate the true cost and this is in line with the philosophy adopted for the study to generate the most favourable outcome for the double stack case.

Table 2 provides a summary of the expected infrastructure costs by corridor.

Table 2: Estimated infrastructure costs

Route		From Dynon/Port $million (2003)
a	Melbourne – Crystal Brook via Adelaide	226
b	Melbourne – Crystal Brook via Parkes	154
c	Melbourne – Crystal Brook via reopened Tocumwal Roto line	140
d	Melbourne – Brisbane via Parkes (inland)	727
e	Melbourne – Sydney	366
f	Melbourne – Brisbane via Parkes, Merrygoen, Hunter Valley, coastal route	753
	Sydney – Brisbane via Parkes, Merrygoen, Hunter Valley, coastal route	539

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Note: Routes from Melbourne include $74 million to provide double stack clearance through Bunbury Street tunnel

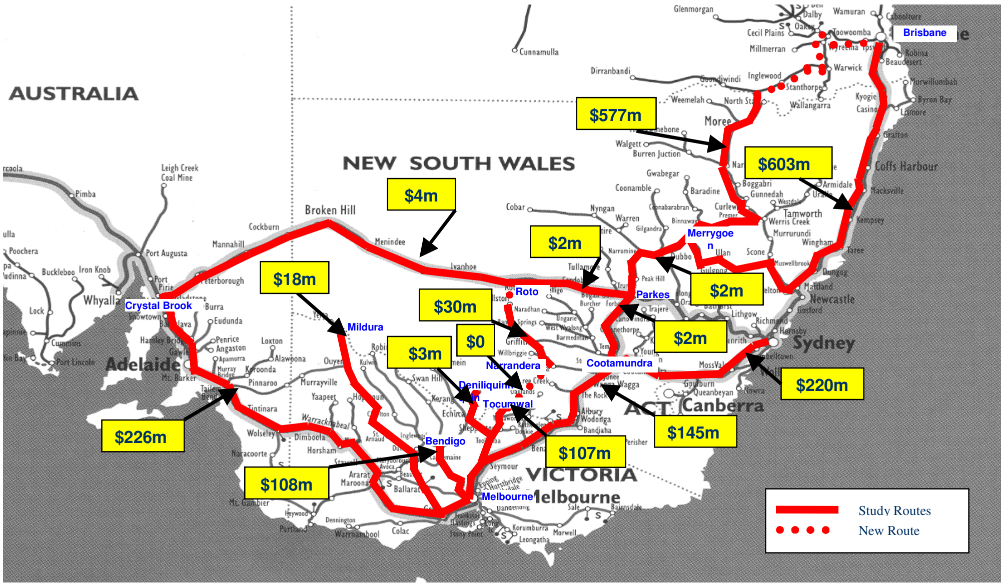

Figure 5: Estimated infrastructure costs by corridor section

6 Terminal operations and costs

Most terminals use software packages to manage the receival of freight and to allocate containers to the train based on weight, length, container design and dangerous goods separation requirements. This process generally allows a single stacked train to be loaded progressively as containers are delivered without the need to ground the container until such time as its placement on the train can be determined.

With the introduction of double stacking and the substantially more imposing restrictions on where containers can be placed on wagons, the task of progressively building the train load as containers are delivered gets much harder. As a result, it is expected that there will be an increased need to ground containers until a compatible combination can be identified for loading. For example if a batch of empty containers are delivered early then these should be reserved as top loading to match heavy containers yet to be delivered.

The process of double stacking requires the insertion of Inter Box Connectors between the top and bottom containers to secure the top container during transit. This is time consuming and introduces safety issues.

On arrival at the destination the train is unloaded and containers transferred to road trucks. Normally this is done as the truck presents at the terminal. With a single stacked train, any container on the train can be available immediately upon arrival of the wagons in the terminal, but with a double-stacked train the bottom containers are not accessible until the top container is removed. This can either be achieved by holding the truck until its container is uncovered or the top container can be placed onto the ground to expose the bottom container.

Table 3 shows the estimated additional terminal costs incurred due to double stacking.

Table 3: Estimated additional terminal costs

Additional Activity to Account for Double Stacking	Average Cost per Double Stacked TEU
Load Planning	$0.20
Double Handling for Train Load Consolidation	$1.39
Insertion of Inter Box Connectors	$0.05
Double Handling During Train Unloading	$1.39
TOTAL	*$3.03*

7 Train operations and costs

The introduction of double stacking is expected to change the characteristics of rail operations.

Trains will become shorter and heavier as a result of the improvement in the loading density. It is a fallacy that double stacking will halve the length of trains. Length will only reduce by 25 – 30% at most, due to reasons discussed earlier and because not all of the length of wagons is usable.

This will change train handling characteristics including aspects such as braking performance and wind resistance. The reduction in train weight relative to its payload will result in a marginally improved train operating cost, mainly sourced from reduction in fuel consumption, and also savings in wagon maintenance costs brought about by fewer wagons on a train. Table 4 identifies the expected operating cost savings with double stacking.

Table 4: Estimated reduction in train operating costs

Train Operating Cost	Cost Saving per TEU-km
Fuel Consumption	$0.0057
Wagon Maintenance Costs	$0.0075
TOTAL	***$0.0132***

8 Freight forecasts

Estimates of future rail freight volumes with and without double stacking are required in order to calculate the total benefits of double stack operations. Future volumes were derived from forecasts in BTRE (2003), AusLink (2003) and Maunsell (2002).

Freight estimates and forecasts were developed for the years 2003, 2015 and 2030 for each corridor based on a medium freight growth scenario. Total non-bulk freight estimates and forecasts were prepared in tonnes and then converted to equivalent TEU based on an average of 11 tonnes per TEU.

The proportion of total non-bulk freight that would be transported by rail was based on the assumption that all of the upgrade proposals in the optimised investment scenario of the ARTC Interstate Audit (BAH (2001)) would be implemented immediately. This assumption was also favourable to double stacking because the higher future rail mode share forecasts in the ARTC Audit report could then be adopted, rather than the "business as usual" forecasts in BTRE (2003), resulting in more TEU on rail and hence more benefits from double stacking.

For origin destination pairs not covered by the ARTC audit analysis, mode shares were obtained by comparing with similar corridors for which mode shares are available.

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The results of the above analysis for each corridor are shown in Table 5.

Table 5: Total freight and rail freight forecasts used in economic analysis

Freight Origin-Destination	Freight - Non Bulk (Kt pa)			Rail Mode Share	Rail Freight - Non Bulk (TEUS)		
	2003	2015	2030		2003	2015	2030
Melbourne - Adelaide	3,560	5,200	8,182	24%	77,673	113,455	178,512
Melbourne - Sydney	8,400	12,750	21,429	20%	152,727	231,818	389,610
Melbourne - Brisbane	3,160	5,000	9,000	35%	100,545	159,091	286,364
Sydney - Adelaide	1,850	2,700	4,655	73%	122,773	179,182	308,893
Sydney - Brisbane	5,100	8,125	14,625	30%	139,091	221,591	398,864
Melbourne - Perth	1,718	2,663	4,835	74%	115,556	179,177	325,258
Sydney - Perth	1,313	2,036	3,695	73%	87,129	135,099	245,242
Adelaide - Brisbane	1,131	1,734	2,764	39%	40,089	61,476	97,995
Brisbane - Perth	1,419	2,201	3,995	45%	58,065	90,034	163,436
Melbourne - Geelong - Ballarat - Maryborough - Mildura	1,863	2,855	4,549	11%	18,628	28,554	45,492
Melbourne - Castlemaine - Bendigo	784	1,076	1,445	11%	7,845	10,761	14,449
Melbourne - Mangalore - Toolamba - Echuca - Deniliquin	1,384	1,889	2,396	11%	13,835	18,893	23,956
Melbourne - Mangalore - Shepparton - Tocumwal	1,384	1,889	2,396	11%	13,835	18,893	23,956

The rail freight forecasts in Table 5 and their implied growth rates were cross-checked against ARTC and rail operator data and found to be slightly higher overall. It was considered that the variances were not unreasonable for a pre-feasibility study, such as this, where it is appropriate to use slightly optimistic estimates to ensure the most favourable result for double stacking.

The rail mode shares in Table 5 for the north south corridors are slightly higher than the projected 2015 mode shares in ARTC's recently issued North/South Investment Strategy.

The total non-bulk freight amounts include all modes of transport including road, rail, and shipping. The amounts include containerised freight and types of freight that generally can be containerised, eg palletised freight and general freight. Even motor vehicle transport is moving to the use of special purpose containers so it is not unreasonable to include this. Some bulk commodities eg grain and mineral sand are also being containerised and in such cases would be classified as non-bulk and included in the above estimates (even though they might not be suitable for double stacking due to weight).

An average weight of 11 tonnes per TEU was assumed for converting between tonnes and TEU. This is an overall average weight based on advice from some operators and data from previous studies. Advice received late in the study indicated that the average weight of rail containers might be higher than 11 tonnes, possibly up to 12.5 tonnes per TEU. The tonnes per TEU ratio influences the number of containers that are derived from a given rail freight tonnage and also the proportion of containers that are suitable for double stacking. The assumption of 11 tonnes/TEU is favourable to double stacking because it is at the low end of the likely range and hence results in more containers and hence more double stacking benefits than a higher tonnes per TEU ratio.

Based on ARTC data it was assumed that average container weight is similar in both directions in each corridor. This assumption is favourable to double stacking as discussed in Section 4.

The rail freight forecasts in Table 5 represent base case rail freight, ie the freight that is assumed to be on rail with or without double stack operations. In the economic analysis this was multiplied by the double stack unit benefits and distance to determine the overall double stacking benefits between each origin-destination.

In addition to the benefits from double stacking of the base case rail freight the cost savings from double stacking are likely to result in some diversion of freight from road to rail. This diversion generates additional benefits including cost savings to customers and reductions in externality costs associated with road transport.

The issues for estimating diverted freight demand are:

- the net cost saving from double stacking;
- the extent to which this is passed on in lower freight rates to end customers;
- the amount of this saving to customers as a proportion of the overall cost to customers of sending a container; and
- the elasticity of rail freight demand with respect to price.

The following assumptions were made when estimating diverted freight:

- Double stack clearance costs are funded externally – not recovered through higher track access charges
- All rail operating cost savings from double stacking are passed on to end customers
- A freight price elasticity of –1.0

These assumptions are favourable to double stacking because they result in the maximum diversion of freight from road to rail and hence maximum benefits from reduced externalities.

The extent to which any cost saving is passed on to customers will depend on the competitiveness of the market and the motivation of the operators. Consistent with the ARTC Interstate Network Audit the double stack study assumed that rail is a competitive market in which all cost savings are passed on to the consumer through reduced rail freight rate charges. This maximises customer benefits and externality savings but it has the effect of reducing the benefits of being able to defer infrastructure investment such as extending passing loops (because some or all of the train and track capacity that is freed up is filled with the diverted freight).

A further factor in determining diverted freight is the relative size of the cost saving passed on to customers as a proportion of the overall cost to customers of sending a container.

Figure 6 shows the alternative logistic chains for road and rail freight for most customers.

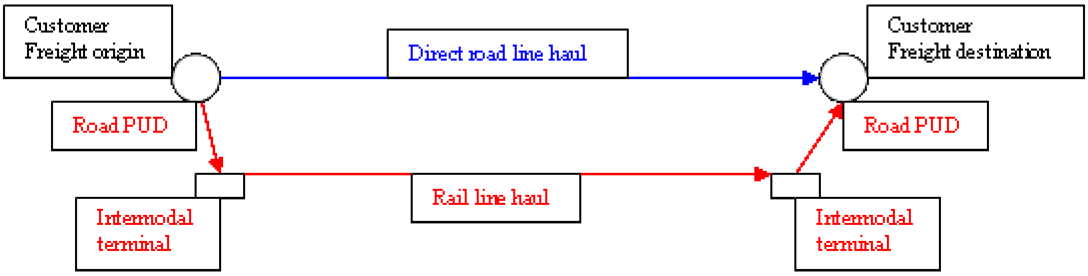

Figure 6: Logistics chain with road and rail transport

This shows that the cost of sending a container by rail is not just the rail line haul and intermodal terminal costs. It also includes the road pick up and delivery (PUD) legs at each end of the rail journey. Strictly speaking, the relevant percentage cost reduction to the customer who is considering using rail transport instead of road is the change in overall rail freight rate as a percentage of the total direct road line haul rate. However it was assumed that for customers at the margin, who are potential candidates for using rail, the overall cost of rail is similar to road and the percentage cost reduction could be determined by taking the rail rate reduction as a percentage of the total rail freight cost (including PUD).

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Rail freight rates from Pacific National were used for this analysis. Estimated average rates for pick up and delivery were added to these rates. Higher average rates for PUD were assumed in Sydney and Melbourne than in other cities reflecting the larger size and greater congestion of these cities.

The percentage decrease in total freight cost to the customer resulting from double stack operations is different for each origin destination pair and for each route variation so a separate calculation was required for each. The percentage cost reduction between each origin and destination pair was multiplied by a freight price elasticity value of –1.0 to obtain the percentage increase in rail freight between that origin and destination. This percentage was then multiplied by the base case rail freight to determine the diverted freight.

Diversion from road to rail normally depends on “service level” factors in addition to the cost changes. However for this study it was assumed that double stacking would only affect the freight price and not the rail service level. For example, it is assumed that transit time, frequency, time of departure and reliability would not change due to double stacking.

The cost savings from double stacking resulted in relatively small amounts of diverted freight. For most routes the diverted freight is only 1 – 3% of the base case rail freight.

9 Economic Analysis

The economic analysis was undertaken in accordance with the Victorian Department of Infrastructure guidelines, which specify a discount rate of 6% and evaluation period of 30 years.

Corridors were analysed in combinations rather than individually. Cases were specified that involved double stack clearances on combinations of corridors as shown in Table 6.

Table 6: Interstate corridors investigated

	Case					
	1	**2**	**3**	**4**	**5**	**6**
Base Case	No double stack other than current routes					
Interstate Corridors						
a) Melbourne – Crystal Brook via Adelaide	**DS**	**DS**				
b) Melbourne – Crystal Brook via Parkes		**DS**	**DS**		**DS**	**DS**
c) Melbourne – Crystal Brook via re-opened Tocumwal – Roto line				**DS**		
d) Melbourne – Brisbane (Acacia Ridge) via inland route (Parkes, North Star, Toowoomba)					**DS**	
e) Melbourne – Sydney	**DS**	**DS**	**DS**	**DS**	**DS**	**DS**
f) Melbourne – Brisbane via Parkes, Merrygoen, Hunter Valley and coastal route						**DS**

For example Case 1 involved provision of double stack access on the interstate main line between Crystal Brook and Sydney via Adelaide and Melbourne. Case 5 involved double stack access from Melbourne to Crystal Brook via Cootamundra and Parkes, Cootamundra to Sydney, and Parkes to Brisbane via the inland route.

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9.1 Base Case

In order to perform a cost benefit analysis it is necessary to define a base case against which the proposal can be compared. The base case should represent the most likely future scenario without the proposal, in this case the most likely scenario without double stack operations.

A relatively simple base case was defined for this analysis. The key assumptions made in the base case are:

- No change to clearances of existing structures
- New structures over rail conform to current clearance policies of track owners
- 25 tonnes max axle load at 80kph in place on all interstate lines
- Includes a nominated list of planned future infrastructure upgrades (ARTC Network Audit projects, Melbourne-Brisbane as single stack, etc)
- Excludes specified infrastructure projects that are only required for double stacking.

It was assumed that all future infrastructure upgrades and higher maximum axle loads in the base case were implemented immediately. This is not necessarily the most likely scenario but it simplifies the analysis and is favourable to double stacking.

The costs and benefits of double stack access in each future year were determined by calculating the difference between the costs associated with double stacking and those without double stacking in each future year.

9.2 Economic costs

For each of the cases that were analysed the economic analysis model combined the estimated double stack infrastructure costs of the relevant corridor segments discussed in Section 5.

Other capital costs necessary to take advantage of double stack clearances such as additional container handling areas and other new infrastructure at intermodal terminals were judged to be insignificant for the level of analysis in this study compared with the larger costs of providing increased clearances along rail corridors.

Infrastructure costs should also include the ongoing additional costs of providing greater clearances whenever structures are built or replaced over the rail lines in future. This cost should be included as a cost of double stack access if it was certain that track and road authorities would reduce clearance requirements (and hence avoid the cost) if it was concluded that double stack access is not viable. However this cost was not included in the analysis because the costs were already high without it and because it is not certain that authorities would relax the current requirements to build rail overpass structures with double stack clearances even if this study showed that double stack access was not viable.

Two types of track maintenance cost effects were relevant for the economic analysis. The first of these is the extent to which double stack operations cause higher track maintenance costs. Average axle loads are likely to be higher but fewer axles will be required for a given freight task. The difference in track maintenance from this is likely to be insignificant if axle loads are kept within maximum allowable axle loads. In addition the higher centre of gravity of the taller loads could result in additional dynamic loads. Consequently the analysis assumed that there is no additional cost or cost saving.

The other track maintenance cost that is relevant for the economic analysis is the difference in track maintenance resulting from increased or reduced distance. For example Melbourne to Adelaide via Parkes is 1,100 km further than the direct route. If double stack clearances are provided on this route but not on the Melbourne to Adelaide direct route the additional track maintenance required due to the additional gross tonne kilometres if rail operators choose to use the longer route is part of the economic cost of double stack operations.

This marginal track maintenance cost was estimated from ARTC track access prices. The weighted average variable price per thousand GTK (from 1 July 2003) for ARTC's long distance corridors is approximately $2.30. In the absence of more detailed information on the composition of this cost it was assumed that half of this represents marginal track maintenance costs that vary with additional freight and that this equates to $0.019 per TEU-km. This cost applies to the additional or reduced distance travelled by base case freight.

9.3 Economic benefits

Similarly to track maintenance, two train operating cost parameters are relevant for the economic analysis. The first is the saving in operating cost from double stack operations that results from undertaking the same freight task with fewer wagons and hence less fuel consumption. As discussed in Section 7 this saving is estimated at $0.0132 per TEU-km. This saving is a benefit of double stack operation and applies both to freight that uses rail in the base case and freight that is diverted from road. This is multiplied by the distance and total freight volume between each origin – destination pair, and the proportion of this freight that is suitable for double stacking to determine the overall cost saving for each origin-destination.

The second train operating cost that is relevant is the line haul cost of additional distance or distance savings. Evidence indicates that this varies between approximately 2.0 cents/NTK and 3.5 cents/NTK depending on the corridor and distance. A cost of $0.30 per TEU-km was assumed for this analysis which equates to approximately 2.8 cents/NTK. This cost applies to the additional or reduced distance travelled by base case (not diverted) freight in the double stack cases.

Because the analysis is attempting to identify differences between the double stack cases and the base case it is not necessary to include the line haul cost for the base case freight if there is no change in distance. All that is relevant is the saving in cost between double and single stack operation.

There are additional terminal operating costs involved with double stack operations and the operational analysis in Section 6 determined that these additional terminal costs equate to $3.03 per TEU. This is multiplied by the total freight volume and the proportion of this freight that is suitable for double stacking to determine the overall increase in terminal operating cost.

There is a breakeven distance for double stacking below which increased terminal costs are likely to exceed line haul cost savings. Based on the above estimates that have been used in the analysis this breakeven distance is about 225km. Therefore the analysis assumes that there is no cost reduction and no ability to offer a rate decrease and hence no diversion of freight from road to rail between origins and destinations that are closer than 225km (this was relevant for intrastate routes and port shuttle trains).

The preliminary analysis has assumed 66% double stackable containers on all routes at this stage consistent with current Adelaide Perth loadings. This will result in upper bound estimates of benefits in most cases because other evidence (from operators) indicates that for most corridors the proportion of containers that can be double stacked efficiently within base case axle load limits may be less than 66%.

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In order to take advantage of double stack access rail operators may also need to make some capital investment such as acquiring more powerful locomotives or higher capacity wagons to take advantage of the increased clearances. These additional costs were assumed to be negligible for the purposes of this analysis. Operators will replace locomotives and wagons in any case and it is assumed that any additional cost for equipment that is suitable for double stack operation is not significant.

The analysis assumed that all new freight attracted to rail due to double stack savings would otherwise have used road transport, i.e. it is diverted freight (rather than generated freight). The estimation of diverted freight is discussed in Section 8.

Diverting freight from road to rail generates the following categories of benefit:

- "Consumer" surplus (benefits to the freight customers)
- Producer surplus (benefits to the transport operator(s))
- Externalities (reduced emissions and accidents etc)

The proportions of each of these benefits will vary depending on the amount of the double stack cost saving that is passed on to freight customers by the rail operator(s). If the operator does not reduce prices at all there will be no diverted traffic and no benefits in any of these categories.

The consumer surplus benefit is the cost saving to freight customers who divert their freight business from road transport to rail to take advantage of the double stack cost savings. This benefit is calculated based on the rule of a half. This reflects the assumption that the demand curve is linear over the range of cost change being considered and acknowledges that some of the diverted traffic will get the full benefit of the rail cost reduction while at the other end of the range there will be diverted traffic that obtains little net benefit.

It is assumed that competition in the freight market is sufficiently strong for all cost savings from double stacking to be passed on to end customers. Accordingly the consumer surplus benefit is calculated as half of the volume of diverted freight times the cost saving per unit of existing rail freight. This was calculated separately for each origin destination pair and then summed to obtain the total consumer surplus benefit.

The producer surplus benefit is the difference between the marginal revenue from diverted freight and the marginal cost of carrying the diverted freight. In the short term, if the diverted traffic is small and can be added to existing trains without need for additional locomotives, the marginal cost of carrying additional freight is likely to be very small and hence the producer surplus could be substantial. However the Interstate Rail Network Audit notes that over longer periods (such as the 25 year evaluation period of that study) the majority of cost items would adjust to their average long run cost relatively quickly and that this position is reached sooner when the overall freight task is growing. Accordingly it is assumed that marginal revenue equals marginal cost and producer surplus from double stacking is zero.

Some of the costs of truck and rail use are not borne by operators, eg accidents, greenhouse gas emissions, air pollution and noise. The economic analysis determines the net reduction in externality costs due to diverted freight. Reductions in road externality costs are partially offset by increased rail externalities. The analysis used the externality values that were adopted in the Interstate Rail Network Audit Evaluation conducted for ARTC. These values are shown in Table 7.

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Table 7: Externality values (cents/net tonne km)

	Truck		Train	
	Rural	Urban	Rural	Urban
Road wear	0.64	0.64		
Congestion costs	0.00	0.09		
Truck crash costs	0.32	0.32		
Rail freight crash costs			0.03	0.03
Greenhouse gas emissions	0.16	0.16	0.01	0.01
Air pollution	0.00	0.11	0.00	0.03
Noise	0.003	0.006	0.00	0.004

Based on advice from Pacific National and ARTC the economic analysis assumes that approximately 15% of Sydney – Adelaide and Brisbane – Adelaide rail freight travels via Parkes and Crystal Brook and the rest via Victoria. For Perth traffic this split is reversed. Approximately 15% of Sydney – Perth and Brisbane – Perth rail freight is assumed to travel via Victoria and he rest via Parkes and Crystal Brook. Trains to/from Perth via Parkes tend not to stop in Adelaide but rather run straight through at Crystal Brook.

10 Analysis results

Table 8 shows the results of the economic analysis for the interstate corridors.

Table 8: Preliminary economic analysis results

Case	PV of costs ($M)	PV of benefits ($M)	NPV ($M)	BCR
1 Melbourne – Adelaide direct, and Melbourne – Sydney	489.3	103.7	-385.6	0.21
2 Melbourne – Adelaide both direct and via Parkes, and Melbourne – Sydney	496.9	157.2	-339.8	0.32
3 Melbourne – Adelaide via Parkes, and Melbourne – Sydney	353.1	130.6	-222.5	0.37
4 Melbourne – Adelaide via reopened Tocumwal – Roto line, and Melbourne - Sydney	383.6	38.7	-344.9	0.10
5 Melbourne – Adelaide via Parkes, Melbourne – Brisbane via inland route, and Melbourne - Sydney	639.2	156.8	-482.4	0.25
6 Melbourne – Adelaide via Parkes, Melbourne – Brisbane via inland route, and Melbourne - Sydney	924.4	166.5	-757.9	0.18

Table 8 shows the analysis results if double stack clearances are provided directly to and from the Port and Dynon precincts at Melbourne. An alternative analysis was also undertaken in which double stack clearances are not provided between the Port/Dynon precinct and the outskirts of Melbourne. This avoided the costs of providing double stack access through the Bunbury Street tunnel and Maribyrnong River Bridge, however the additional costs of double handling containers at external terminals to/from double-stacked interstate trains more than outweighed this saving making this a less satisfactory option.

Table 8 shows that none of the cases are economically viable at present and in fact they all involve a high cost to achieve relatively small benefits.

11 Other findings

A change to double stack operation could initially result in shorter trains. Based on the preliminary analysis, diverted freight from road will only fill some of the reduced length. The remaining saved train length will gradually be filled again as freight volumes grow. In the meantime it will enable passing loop extension projects to be deferred.

Based on the forecast freight growth rates in Section 8 and assuming that 66% of containers on average are suitable for double stacking, the introduction of double stacking could reduce train length by approximately one third. This means that freight could grow by another 50% before trains would have returned to their previous length. Assuming that they were previously at the maximum possible length and investment would have been required in longer loops to allow longer trains, or capacity improvements to allow more trains, double stacking would enable these investments to be deferred. Based on a weighted average forecast freight growth rate of 3.81% per annum this would enable investments to be deferred by approximately 10 years providing that capacity constraints (rather than safety, reliability, transit times etc) were the only reasons for doing them.

The deferral period and economic benefit depends on the proportion of freight that is suitable for double stacking, and will be less if the proportion is less than the assumed 66%.

In the consultation for this project a number of operators commented that the main benefit of double stacking would be to overcome capacity constraints and that they did not expect cost reduction to be a major driver. The analysis undertaken in this study tends to support the view that direct operating costs savings are not a major benefit in most of the east coast rail corridors where distances are relatively short.

Even if the benefits from deferring capital expenditure on capacity improvements such as passing loop extensions are significant, they may not be realised if operators choose not to adopt double stack operations on shorter routes due to the small operating cost savings. Track owners may need to consider incentives to encourage greater adoption of double stacking if they wish to realise the benefits of deferring capital expenditure.

The reduction in train length from double stacking can also have a short term benefit if the saved train length is used to carry additional freight during periods of high demand that would otherwise go by road. One freight forwarder advised that they have difficulty obtaining space on trains at particular times of year such as the two months leading up to Christmas.

The ability to accommodate additional freight at peak times will gradually reduce each year as the underlying freight growth gradually fills the train back to original single stack length. This benefit is more of a service level issue and was not quantified in this study.

In accordance with Victorian appraisal guidelines this analysis used a 30-year evaluation period. Most structures over rail lines are built to last considerably longer than 30 years. Also rail freight volumes may be expected to continue growing, leading to increasing benefits beyond the 30-year evaluation period. It could be considered that a longer evaluation period than 30 years may be appropriate for a study of this type. However, discounting results in benefits and costs that occur more than 30 years in the future having little effect on the results.

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12 Conclusions

All of the double stack cases specified for evaluation have a benefit cost ratio significantly less than one and a negative Net Present Value.

Case 3, Melbourne to Crystal Brook via Parkes, and Melbourne to Sydney gives the best results in economic terms with a BCR of 0.37 and NPV of -$223 million.

Although this was a pre-feasibility analysis, the results are considered to establish fairly conclusively that providing double stack access on the corridors that were analysed is unlikely to be economic in the short to medium term. This finding is considered robust because inputs and other assumptions were selected to be favourable for double stacking yet the cases all proved to be clearly uneconomic.

Double stacking provides the most benefit on long distance corridors with large freight volumes and few infrastructure constraints. All of the cases that have been evaluated become uneconomic due to the inclusion of relatively short distance routes (less than 1,000 km) where operational cost and the higher infrastructure costs on the approaches to the cities (not just within metropolitan areas but for up to 100 km out) outweigh the benefits.

Alternative options that were suggested for subsequent further consideration were:

- Double stacking only as far as Somerton (Melbourne), Goulburn (NSW) and North Star in Queensland, and use single stacking or road transport through to the capital city terminals. This would have the advantage of combining relatively long haul distances for double stacking while avoiding the line sections where costs of providing double stack clearances are high.
- Examining the option of loading trucks on rail wagons on the high volume freight route between the outskirts of Melbourne and Sydney, which would require lower vertical clearances than double stacking and thus lower infrastructure costs.
- Defining corridors where some additional clearance could be achieved at little cost (although not necessarily double stack clearance), and allowing innovative freight forwarders to develop rolling stock and operational practices to take advantage of the additional clearance.

This investigation found that it is not economic to undertake a proactive upgrading programme to provide double stack clearances on the routes investigated in the short to medium term. However in order to avoid making the achievement of double stack clearances even more difficult in the longer term it is appropriate for new and replacement structures over relevant rail lines to be constructed with double stack clearances where the incremental costs of this are small and agencies are willing to make this investment such that over time the objective of double stack clearances may be achieved. It is understood that the Code of Practice for Australian rail operations requires new structures over interstate rail corridors to provide double stack clearances.

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