



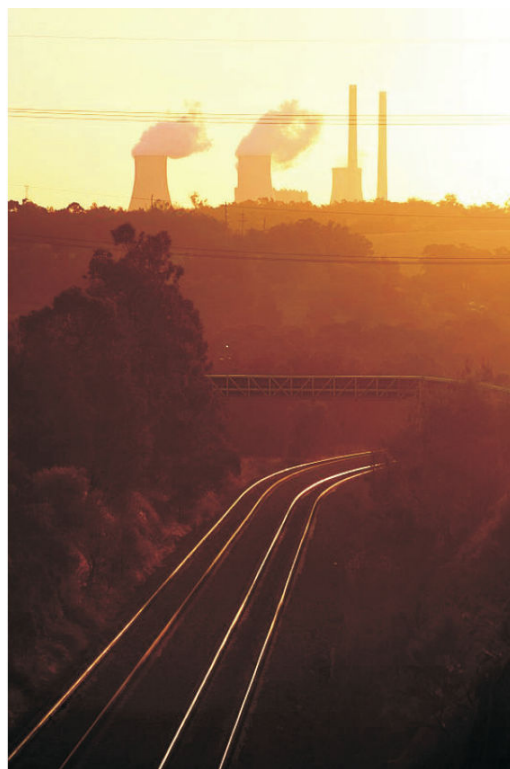
AUSTRALIAN RAIL TRACK CORPORATION LTD

2009-2018 Hunter Valley Corridor Capacity Strategy Consultation Document

June 2009



AUSTRALIAN RAIL TRACK CORPORATION LTD



2009-2018 Hunter Valley Corridor Capacity Strategy Consultation Document

June 2009



Contents

1	Introduction	-	3
2	What has changed between the last strategy and this one	-	10
3	Starting network performance	-	12
4	Reducing headways on the Minimbah, Nundah and Allandale Banks	-	13
5	Reducing junction conflicts	-	16
6	Increasing capacity between Antiene and Muswellbrook	-	20
7	Increasing capacity between Muswellbrook and Ulan	-	21
8	Increasing capacity between Muswellbrook and Narrabri	-	23
9	Reducing maintenance impacts and increasing operational flexibility	-	28
10	Terminals	-	30
11	Network performance with revised project scope and timing	-	33
12	Overview of the recommended projects	-	37
A1	Appendix 1 - Modelling Methodology	-	40

Introduction

On 5 September 2004, the Australian Rail Track Corporation (ARTC) commenced a 60-year lease of the interstate and Hunter Valley rail lines in New South Wales.

In early 2005, ARTC began to release annual Hunter Valley infrastructure enhancement strategies setting out how ARTC planned to ensure that rail corridor capacity in the Hunter Valley would stay ahead of coal demand.

This Hunter Valley Corridor 2009 - 2018 Capacity Strategy is the fourth of these annual strategies. It updates the 2007 - 2012 Strategy using revised forecasts of coal demand and the results of further analyses during the past year. For the first time this Strategy covers a 10-year time horizon, with the intention of providing better visibility of the longer-term solutions, given the long lead times of many projects.

In common with the earlier strategies, it identifies the constraints on the coal network's capacity in the Hunter Valley, the options to resolve these constraints and a proposed course of action to achieve increased coal throughput.

The fundamental approach of ARTC in developing this Strategy has been to increase capacity (with a reserve surge capability) to levels sufficient to meet anticipated demand for export and domestic coal transport, while having regard to the constraints imposed by the capacity of the Newcastle port.

The Strategy also looks at levels of operational delay on the network, and the operational robustness of the network, to highlight opportunities for improved operational performance on top of the provision of sufficient capacity.

It is important to note that the whole Hunter Valley coal supply chain is inter-related. The stockpiling and loading capability of the mines affects the trains required, the trains affect the rail infrastructure and so on. The capacity and performance of the system is entirely inter-related and the capacity of the rail network needs to be considered in this context.

Volume Forecasts

Industry forecasts indicate demand for export coal capacity from the Hunter Valley of about 113 mtpa in 2009. This is projected to increase to around 127 mtpa in 2010, 159 mtpa in 2011, 190 mtpa in 2012 and 226 mtpa in 2013. Growth is then predicted to continue but at a slower rate, reaching around 265 mtpa in 2018. Obviously these volumes become increasingly uncertain in later years.

It is of particular note in the volume forecasts that the short-term volumes are considerably below those provided by producers for the 2007 - 2012 Strategy. Specifically, 2009 volume is down by 22 million tonnes, while 2010

volume is reduced by 26 million tonnes. Volume is down by 9 million tonnes in 2011 but then up by 11 million tonnes in 2012. These variations to the volume forecasts suggest that producers have adjusted their expectations in the earlier years to reflect expected port capacity allocations.

Traffic Patterns

All but a very small proportion of the export coal shipped through Newcastle is transported by rail for shipping from either Kooragang Island or Carrington (Port Waratah).

Most of this coal comes from a series of mines and coal loaders strung out along the Hunter Valley, conveyed to the ports on the railway that runs between Muswellbrook and Newcastle. Coal also feeds onto this line from Ulan and Boggabri, west and northwest of Muswellbrook respectively, and, much closer to the port, from Stratford, Pelton and the southern suburbs of Newcastle (Figure 1).

Domestic coal is also transported over the same network. This sector is comparatively small, but is growing rapidly. Demand is anticipated to grow substantially over the next five years, especially on the Ulan and Upper Hunter lines. The largest volume will be for Macquarie Generation at Drayton, which will receive substantial volumes of coal originating from mines on the Ulan line.

Export coal also arrives at the port from the Newstan and Teralba mines to the south of Newcastle. This traffic operates on the RailCorp network as far as Broadmeadow. There are no capacity issues for this coal on the short section of the ARTC network which it traverses and accordingly this strategy does not specifically discuss these volumes.

The Hunter Valley coal network consists of a dedicated double track 'coal line' between Port Waratah and Maitland, a shared double track line from Maitland to Muswellbrook and a shared single track with passing loops from that point north and west.

The heaviest coal volumes are at the lower end of the Hunter Valley, but the expected growth in coal mining along the Ulan line and in the Gunnedah basin is likely to produce significant changes in coal demand and traffic patterns over the next few years (Figure 2 and Figure 3¹), necessitating a strong focus in this Strategy on the single track sections of the network north of Muswellbrook.

Operations

At present the theoretical export coal capacity of the Hunter Valley rail network is estimated at around 189 million tonnes per annum (mtpa). This then needs to be reduced to reflect capacity losses due to factors such as

1. Figure 3 is calculated as trains from each of the three zones as a proportion of all trains arriving at the port. The total number of trains exceeds 100% due to domestic coal.



Figure 1 - The general location of the Hunter Valley network on the east coast of Australia.

maintenance, surge volume, and system reliability. Practical deliverable capacity is significantly less than this. It is important to note that in calculating practical capacity it is necessary to make assumptions about average train sizes, the disposition of volume from load points and the ability of participants in the coal chain to maintain constant throughput at high levels of reliability. The theoretical ca-

capacity can vary significantly depending on these assumptions.

The Hunter Valley Coal Chain Logistics Team (HVCCLT) declared capacity for 2009, which represents the capacity of the chain as an integrated operation, to be 94.5 million tonnes.

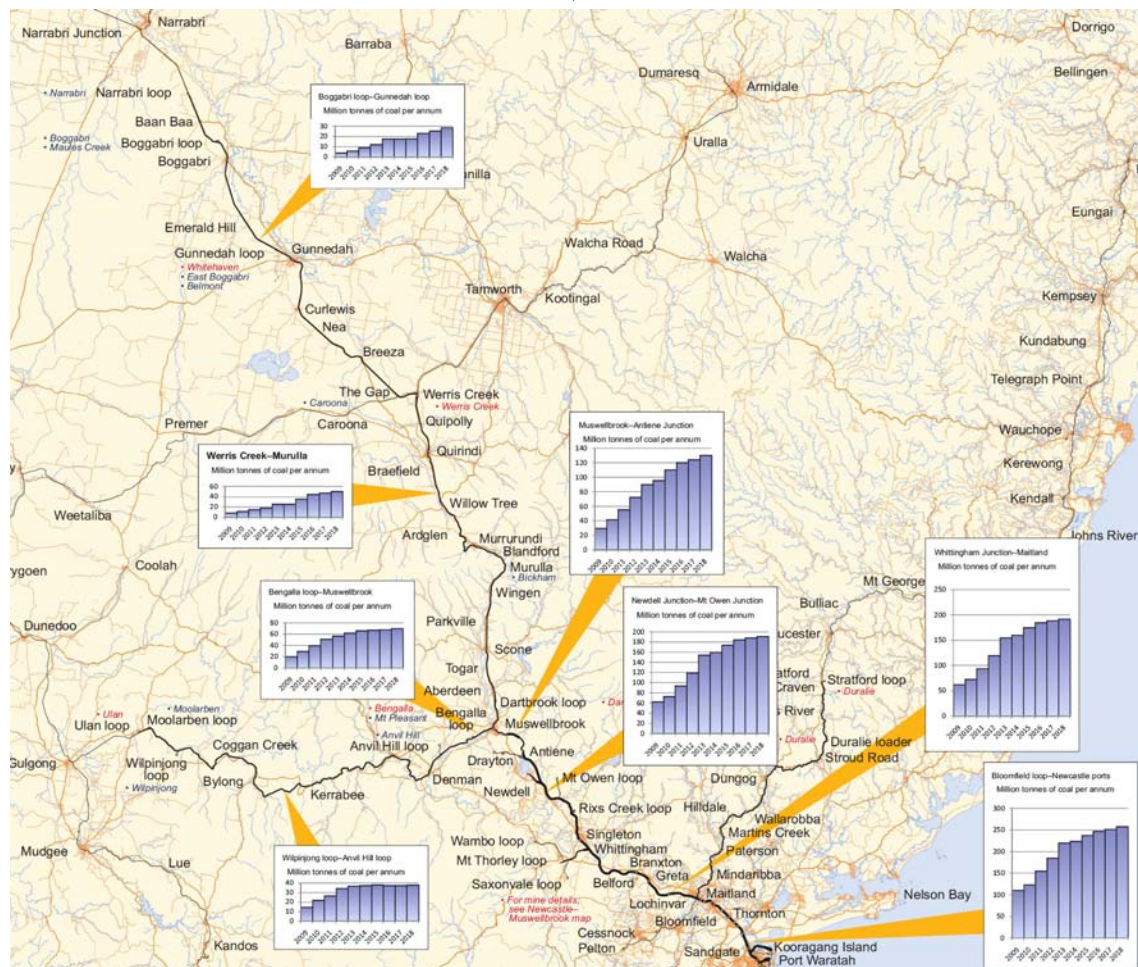


Figure 2 - Volume forecasts by line sector.

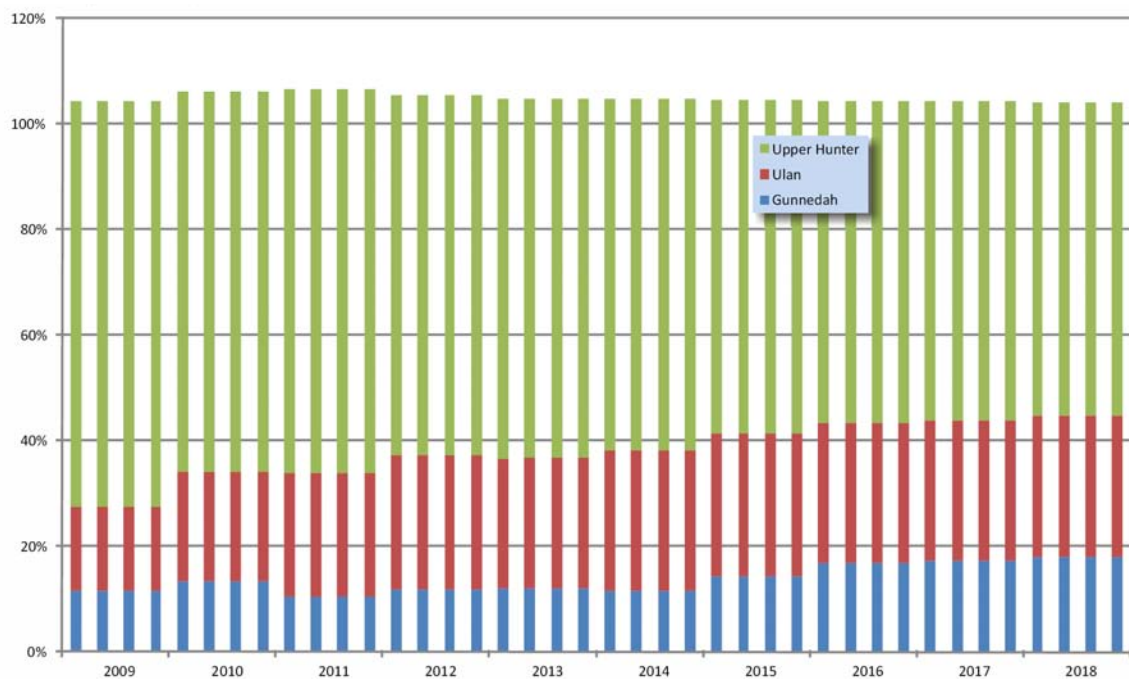


Figure 3 - Percentage of Trains by Sub-Network, by Year. (Note: Numbers do not sum to 100% due to domestic coal.)

Most of the Hunter Valley coal network is capable of handling rolling stock with 30 tonne axle loadings (i.e. 120 gross tonne wagons), but the corridor from Dartbrook Junction (near Muswellbrook) to the Gunnedah Basin, is only rated for 25 tonne axle loads (100 tonne wagons).

As at the time of finalising this Strategy, the Hunter Valley was serviced by:

- 17 trains of 91 x 120 tonne wagons
- 4 trains of 74 x 120 tonne wagons
- 3 trains of 72 x 100 tonne wagons
- 5 trains of 42 x 100 tonne wagons

This 207,035 tonnes of coal train capacity compares to the 18 trains of 120 tonne wagons and 12 trains of 100 tonne wagons at the time of the 2007-2012 Strategy, which provided 180,365 tonnes of capacity.

More importantly, the average train size continues to increase. Weighted average coal capacity per train is now around 7,200 tonnes². This compares to an average of 5,900 tonnes at the time of the 2007 - 2012 Strategy. This continuing increase in the average train size has important implications as it materially increases track capacity.

Coal volumes are currently constrained by train capacity. At the existing constrained coal volumes, an average of around 42 to 43 loaded trains need to be planned each day, or one every 33 minutes. Allowing for cancellations, this equates to approximately 38 actual trains per day, or one train every 38 minutes. This is a small increase on the 2007-2012 Strategy average of 36 minutes, reflecting the continuing increase in train size.

Train lengths vary from around 1,000 metres to 1,550 metres, apart from the small group of trains servicing the Stratford and Austar mines.

Trains made up of '120 tonne' wagons are generally restricted to 60 km/h loaded and 80 km/h empty, while '100 tonne wagon' coal trains are allowed to travel at 80 km/h empty and loaded. Because most of the coal trains are '120 tonne wagon' trains, the coal network tends to move at 60 km/h in the loaded direction and 80 km/h in the empty direction.

How this Strategy has been developed

The development of this Hunter Valley Corridor 2009-2018 Capacity Strategy largely retains the methodology of the 2007 - 2012 Strategy.

Coal capacity is analysed using a set of principles for the practical utilisation of track. ARTC then validates the results of the theoretical calculations using a network modelling package which simulates the interactions of trains with the infrastructure and each other.

For the theoretical modelling, assumptions are made about background trains, possessions, cancellations, and surge requirements. For the simulation modelling, all train services are included, so the loss of paths for other freight and passenger services is accurately modelled. Maintenance possessions have been included in the modelling assuming four possessions per week of five hours each on the line between the port and Muswellbrook. However, no maintenance possessions have been simulated on the single track sections.

The other factors, including train failures, major shut downs and losses due to misalignment of paths, have been accounted for by scaling up the modelled number of coal trains. Coal train numbers have been scaled up to

2. Note that the average is calculated on trains arriving at the Port. As the 100 tonne wagons generally travel further, they make fewer cycles and hence have a lower weighting in the calculation of the average than if a straight arithmetic average of train size was calculated.

cover a surge capability of 15%, and a cancellation rate of 9%.

It is important to note that capacity is (up to a point) not an absolute constraint. Rather, the modelling is based on assessing system performance at a given volume. Hence, surge capacity is potentially greater than the 15% allowed, though it will always be accompanied by a deterioration in performance. Conversely, to the extent that the surge capacity is not used, system performance will improve.

The modelling methodology is discussed in detail in Appendix 1.

Port Capacity

For the purpose of this strategy ARTC has taken current (Q4 2008) port capacity as 97 mtpa. Additional port capacity is assumed to be brought on-line as follows based on advice from the HVCCLT:

- Q1 2009 – KCT Dump Station 2 upgrade, lifting capacity by 2.5 mtpa, from 97 mtpa to 99.5 mtpa.
- Q2 2009 – KCT Project 3Exp, lifting capacity by 13.5 mtpa from 99.5 mtpa to 113 mtpa.
- Q1 2010 – Start-up of NCIG stage 1 with 2 mtpa moved in the quarter. Throughput is assumed to ramp up progressively with 10 mtpa moved in Q2, 20 mtpa in Q3 and 30 mtpa in Q4.
- Q4 2010 – KCT Dump Station 1 upgrade, Full Pads C & D and K7 berth – Lifts capacity at PWCS progressively over 9 months from 113 mtpa to 128 mtpa. Ramp up is assumed to be 4 mtpa in Q4 2010, 10 mtpa in Q1 2011 and 15 mtpa in Q2 2011.
- The combination of the NCIG and PWCS works gives total port capacity of 115 mtpa in Q1 2010, 123 mtpa in Q2 2010, 133 mtpa in Q3 2010, 147 mtpa in Q4 2010, 153 mtpa in Q1 2011 and 158 mtpa in Q2 2011.
- Q3 2012 – NCIG Stage 2 assumed to lift capacity by a further 15 mtpa in a single step, bringing NCIG to 45 mtpa and total port capacity to 173 mtpa.
- Q4 2012 – KCT 4th dump station and 4th ship loader. This is assumed to lift PWCS capacity by 12 mtpa, from 128 mtpa to 140 mtpa, for a total port capacity of 185 mtpa.
- Q3 2013 – NCIG Stage 3 assumed to lift capacity by a further 15 mtpa in a single step, bringing NCIG to 60 mtpa and total port capacity to 200 mtpa.

Table 1 shows the Quarter by Quarter assumed volume.

Year	Q1	Q2	Q3	Q4
2009	99.5	113	(113)	(113)
2010	115	123	133	147
2011	153	158	(158)	(158)
2012	(158)	(158)	173	185
2013	(185)	(185)	200	(200)

Table 1 - Port capacity assumptions

Producer forecasts provided to ARTC now show planned production to be relatively closely aligned to port capacity until Q1 2012. However, despite the rapid growth in port capacity, aspirational demand again moves well

ahead of capacity from 2012. The extent of the port capacity constraint is shown in figure 4.

Clearly total volume at the port will not exceed the available capacity. However, as ARTC does not know which producers will fail to obtain port capacity it is not possible to adjust ARTC's sector-by-sector forecasts to reflect the achievable volumes.

To effectively address this issue in the 2007 – 2012 Strategy, ARTC adopted a “hybrid” approach as follows:

- On the single-track sections of the network north and west of Muswellbrook, ARTC planned on the basis of producers achieving their full forecast volumes.
- South of Muswellbrook, where port capacity constraints will necessarily apply, throughput was constrained to port capacity.

For this 2009 – 2018 Strategy, ARTC has changed its approach and has assumed that producer forecasts will be realised. This reflects that:

- There is reasonable alignment of volume and port capacity to 2012.
- There is considerable evidence that both the market and Government have responded to the need to expand port capacity, and while current identified options still fall short of demand from 2012, this is sufficient lead time to develop further solutions for port development.

For 2009, above rail capacity will be a constraint on total system capacity. For the purposes of this strategy ARTC has assumed that in future years above-rail capacity will align with demand.

However, it is important to note that if rolling stock is not delivered into the system, track capacity cannot be realised.

ARTC will continue to closely monitor coal volume expectations and port capacity growth. The various capacity enhancement projects identified in this Strategy can then be implemented more quickly or more slowly as required.

Continuous Review

ARTC is continuously analysing and reviewing the available options to ensure that the value for money of projects is optimised. This process will continue right up to the commencement of construction.

As such, this strategy only represents a snapshot in time. Although the formal written strategy is only produced annually, in practice it is regularly reviewed internally to reflect the best available information and analysis.

Project Costs

This document is a strategy document and the indicative project costs are generally orders of magnitude only unless a project is in or close to construction. Costs are not ARTC's anticipated outturn costs as there are too many unknowns at the strategy phase to attach any reliability to the estimates. Scope and construction conditions are progressively better defined until a project cost is established for approval by the industry in accordance with ARTC's access undertaking.

HVCCLT Master Planning

The Hunter Valley Coal Chain Logistics Team is responsible for the co-ordination of coal chain planning on both a day-to-day and long term basis. It is developing a Hunter Valley Master Plan that deals with the optimisation of capacity enhancements across all elements of the coal chain with a view to providing an integrated planning road map for all elements of the logistics chain.

ARTC is strongly supportive of this master planning process. It sees this Hunter Valley Strategy as both needing to provide the supporting rail infrastructure analysis for the master planning process, and to respond to the investment options identified in the master plan

Other Assumptions and Qualifications

The following additional qualifications apply to the analysis and proposals in this Strategy:

- The capacity gains referred to in this Strategy take no account of the capabilities of loading and unloading interfaces, including the capabilities of private

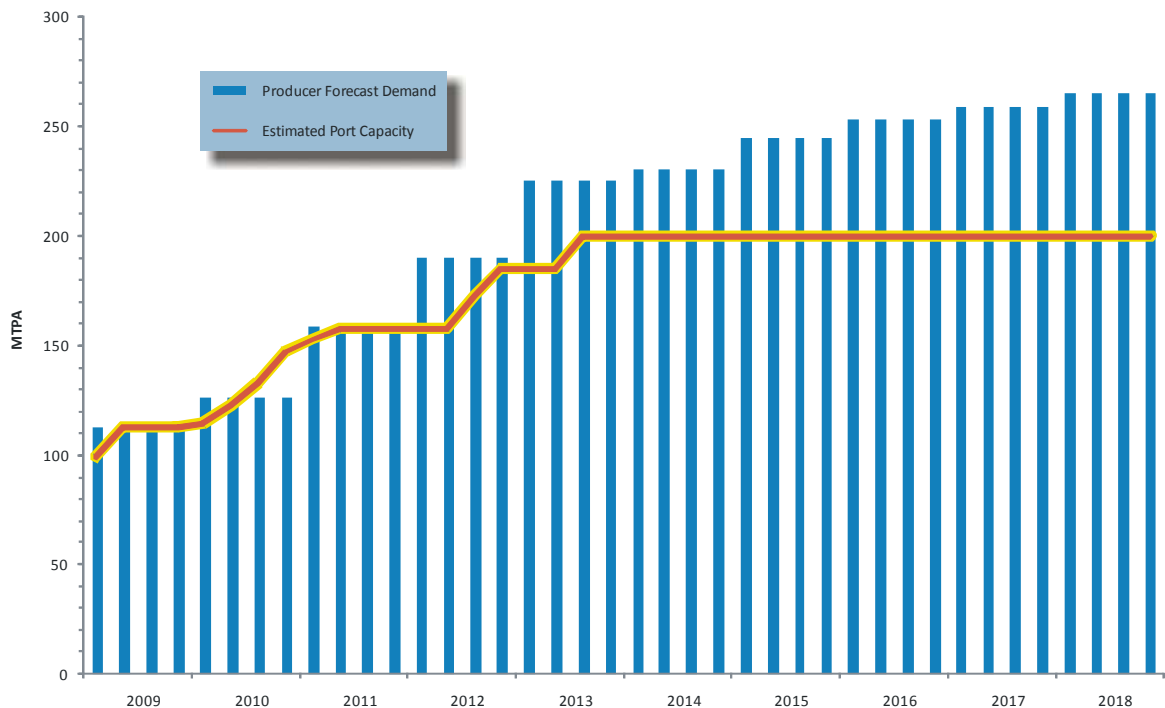


Figure 4 - Forecast volume at Newcastle Port compared to estimated port capacity.

rail sidings and loops. In other words, at the conclusion of each project the identified rail capacity will be available, but this does not necessarily mean the coal supply chain will be able to make use of this capacity at that stage.

- Estimates of the numbers of trains required to carry the forecast coal tonnages are based on the following (Assumed average payload per train is shown in figure 5):
 - On the 30 tonne axle load network Pacific National operates a mix of 91 wagon trains hauled by 3 x 90 class (8,645 net tonne) and 80 wagon trains hauled by 2 x 90 class and 1 x 82 class (7,600 net tonnes). It is assumed that trains on the Ulan line, including Macquarie Generation trains, are 80% serviced by 91 wagon trains and 20% by 80 wagon trains, while all mines between Whittingham and Muswellbrook receive a 50% / 50% split of 91 and 80 wagon trains. Between the completion of the modelling and finalisation of the strategy PN has moved to an all 91 wagon fleet. This will increase track capacity slightly and will be reflected in the next version of the strategy.
 - Mount Arthur is serviced by QRNational's 74 wagon (7,400 net tonne) trains.
 - 72 x '100 tonne wagon' trains (5,400 net tonnes) were introduced on the 25-tonne axle loading sections of the network north of Dartbrook Junction in May 2008, though some 42 wagon trains continue to operate. For the purposes of the Strategy it is assumed that all trains will be reconfigured to 72 wagons.
 - 30 tonne axle load trains are introduced to the Gunnedah Basin in Q1 2011 using a similar configuration to the QR National 74 wagon (7,030 net tonne) trains. This is an important assumption and is discussed in detail in Section 8.
 - An assumption that trains are, on average, loaded to 95% of their theoretical capacity.
- Infrastructure is treated as being available for a quarter (or year) if it is projected to be available by the end of the first month of the quarter (or year). If it is not expected to be available until later than the first month of the quarter it is treated as being available in the following quarter. For example, if a project is projected to be completed by 30 April, it is treated as being available for the second quarter. If it will not be completed until 1 May it would be treated as being available for the third quarter.

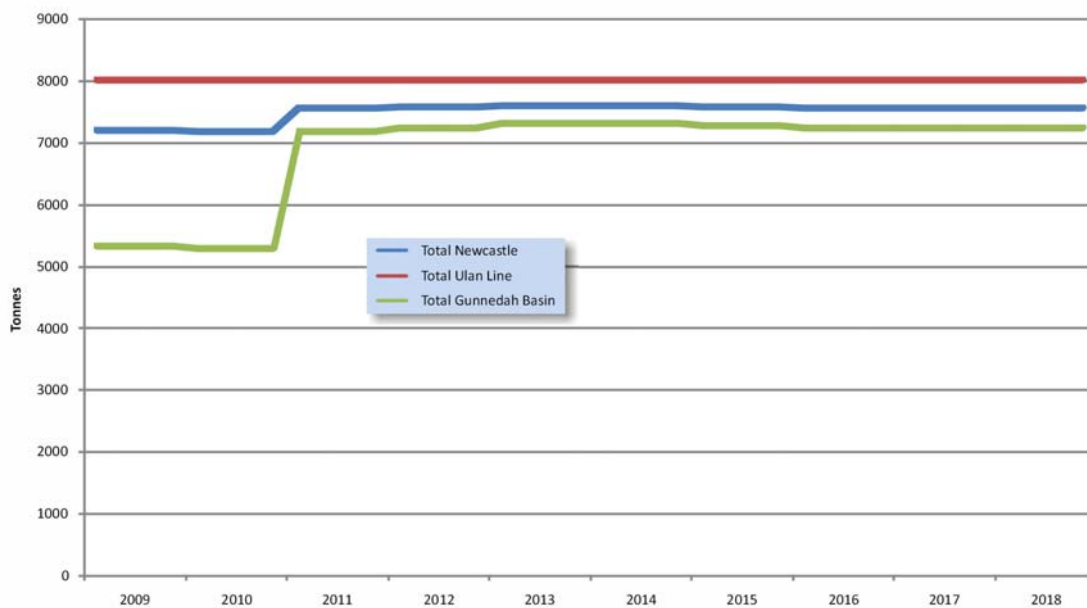


Figure 5 - Assumed Average Train Payload.



New Gunnedah loop: track in position, with ballast and tamping operations ongoing.

What has changed between the last strategy and this one

This section summarises the key methodology, assumption and outcome changes between the 2007 – 2012 Strategy and this 2009 – 2018 Strategy to allow ready comparison between the two.

Timeframe

It has become apparent to ARTC that the industry is keen to understand the development of the coal chain across a longer time horizon than has previously been the case. Accordingly ARTC has now extended its analysis timeframe to 10 years. Most producers have been able to provide indicative forecasts for this time period.

Volume forecasts

Volume forecasts have been updated and extended to match the new 10-year timeframe of the Strategy. Figure 6 compares the forecast volumes from the 2007 – 2012 Strategy with the forecasts used for this Strategy. A comparison is made at both the port and at Muswellbrook. Muswellbrook provides an indication of the contribution traffic on the Ulan Line and from the Gunnedah basin make to total growth.

Short-term projections are now closely aligned to port capacity, providing a more realistic basis for capacity planning. Beyond 2012 the key message remains that dramatic growth can be expected.

It is worth noting that the short-term volumes reflect realism on the part of producers about their capacity allocations at the port. ARTC understands that in the absence of port capacity constraints producers would choose to increase throughput substantially.

Port capacity constraint

The last version of the Strategy treated port capacity largely as a given. Since that time the industry has increased its focus on the port issue and adopted a starting position that port capacity should be ramped-up to meet the industry's aspirational volumes.

Given the better alignment of volume to port capacity in the short-term, and the prospects for port capacity enhancement in the longer-term, this Strategy has done all modelling on actual forecast volumes rather than the hybrid constrained approach used in the 2007 – 2012 version.



The completed Sandgate grade separation project.

Completed Projects

The following projects have been completed since the release of the 2007-2012 Strategy:

- Ulan line CTC.
- Wollar, Mangoola and Bylong loops on the Ulan line.
- Extension of loops at Ardglen, Willow Tree, Breeza, Curlewis, Emerald Hill, and Boggabri, and a new loop at Gunnedah, on the Gunnedah basin line.
- Werris Creek resignalling.

- Antiene—Muswellbrook duplication including bi-directional signalling.
- Gap – Turrawan CTC.
- Maitland-Branxton bi-directional signalling.

Recommended projects, timing and cost

A summary of the recommended projects comparing previous and new proposed delivery timeframes is shown in Table 2.

Forecast volume at Newcastle Port and Muswellbrook - 2007 Forecast v 2009 Forecast

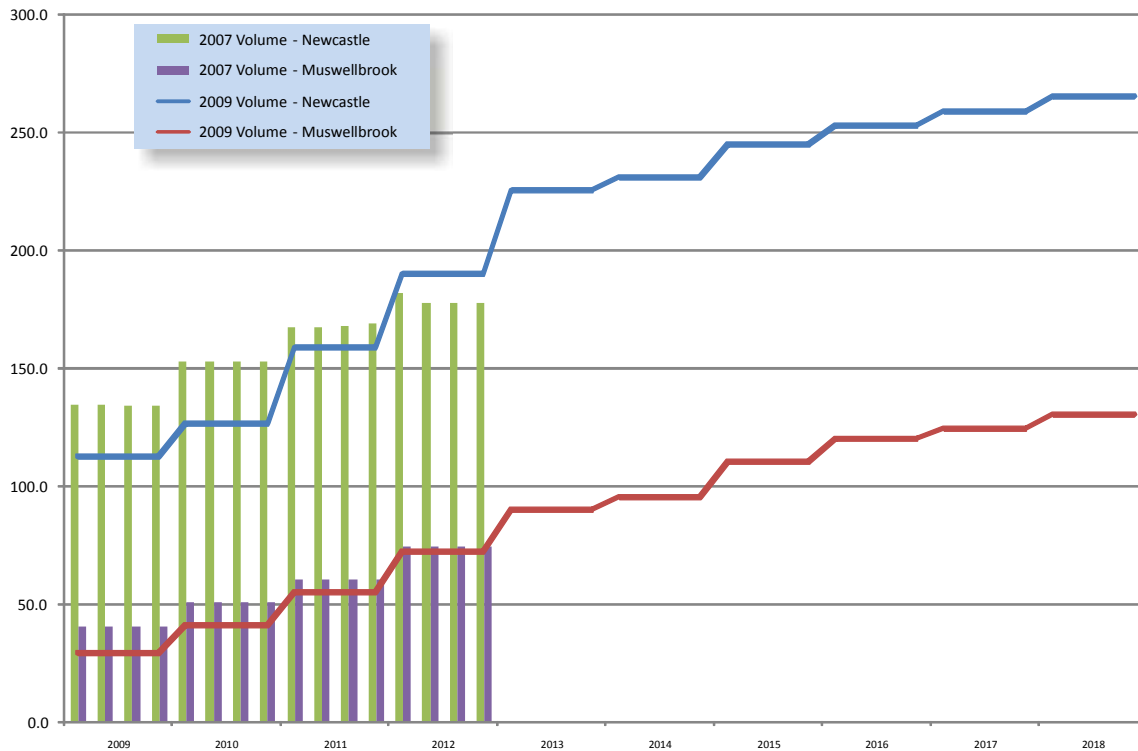


Figure 6 - Forecast volume at Newcastle Port and at Muswellbrook - 2007 Forecast vs. 2009 Forecast.



Loaded coal train speeding up on approach to the Main Line from the completed Muswellbrook Loop Extension.

	2007-2012 Strategy Timing	2009 - 2018 Strategy Timing	Comment
Newcastle - Muswellbrook			
St Heliers - Muswellbrook duplication	Q3 2009	Completed	
Bidirectional signalling Grasstree - St Heliers	Q3 2009	Completed	
Antiene to Grasstree duplication	Q1 2009	Completed	
Bidirectional signalling Maitland to Branxton	Q3 2009	Completed	
Allandale resignalling for 8-minute headways	Q3 2009	Completed	
Newdell Junction Upgrade	Q1 2010	Q1 2010	No change
Minimbah Bank 3rd road - 8 min headway	Q4 2009	Q2 2010	Adjusted back 2 quarters
Drayton Junction upgrade	2011	2011	No change
Minimbah - Maitland 3rd road	2012	2012	No change
Provisioning Centre		2012	New
2 Export Terminal Arrival Tracks		2012	New
Nundah Bank 3rd road - 8 min headway		2013	New
Muswellbrook Junction reconfiguration		2015	New
Camberwell - Whittingham 3rd Road		2016	New
Muswellbrook - Ulan			
Muswellbrook - Ulan CTC	Q1 2008	completed	
Mangoola (304 km) loop	Q4 2008	completed	
Bylong (381 km) loop	Q4 2008	completed	
Wollar (410 km) loop	Q4 2008	completed	
Aerosol Valley (372 km) loop	2010	Q1 2010	No change
Worondi (345 km) loop	2010	Q1 2010	No change
Radio Hut (317 km) loop	2012	Q1 2010	Brought forward 2 years
Bylong Tunnel Ventilation		Q1 2010	New
Bengalla Loop	2012	2012	No change (Replaces Duplication)
Wilpingong (422 km) loop		2012	New
337 km loop		2012	New
378 km loop		2012	New
353 km loop		2013	New
390 km loop		2013	New
Mt. Pleasant loop		2014	New
404 km loop		2014	New
Muswellbrook - Gap			
Willow Tree loop extension	Q1 2008	completed	
Ardglen loop extension	Q2 2008	completed	
Braefield loop	2010	Q1 2010	No change
Quipolly loop	2011	2011	No change
Parkville loop extension	2011	2011	No change
Murrurundi loop extension	2011	2011	No change
Scone reconfiguration	2011	2011	No change
Werris Creek Bypass	2011	2011	No change
Koolbury loop	2011	2011	No change (replaces duplication)
Quirindi loop extension		2012	New
New Liverpool Range alignment and duplication	2012	2013	Adjusted back 1 year
Wingen loop	2012	2012	No change
Scone - Parkville Duplication		2014	New
Koolbury - Aberdeen duplication		2014	New
Parkville - Wingen Duplication		2015	New
Togar - Scone duplication		2015	New
Quirindi - Werris Creek duplication		2015	New
Willow Tree - Braefield Duplication		2015	New
Wingen - Murulla duplication		2016	New
Braefield - Quirindi duplication		2016	New
Aberdeen - Togar duplication		2016	New
Murulla - Murrurundi Duplication		2017	New
Gap - Narrabri (RIC)			
Gunnedah loop	Q1 2008	completed	
Breeza loop extension	Q3 2008	completed	
Curlewis loop extension	Q3 2008	completed	
Werris Creek to Turrawan CTC	2010	completed	
Emerald Hill loop extension	2010	completed	
Boggabri loop extension	2010	completed	
Watermark passing loop	2011	2011	No change
Burilda loop	2012	2012	No change
South Gunnedah loop	2012	2012	No change
504 km loop		2015	New
Werris Creek - Gunnedah duplication		2017	New

Table 2 - Comparison of project timings between the 2007-2012 and 2009-2018 Hunter Valley Capacity Strategies.



3

Starting network performance

As already noted, this Strategy has taken the 2007 – 2012 Strategy as its starting point. Figure 7 graphically illustrates this starting point. The graph shows simulated network performance assuming the infrastructure enhancements set out in the 2007 – 2012 Strategy, and the volume forecasts developed for this Strategy. Performance is expressed as minutes of delay per 100 km for groups of trains. This allows normalisation across sub-groups and mitigates the effect of changes in the mix of destinations over time.

The graph shows performance separately for Hunter Valley, Ulan Line and Gunnedah Basin trains, as well as for

All Trains. The sub-groups refer to coal trains only, where the All Trains includes passenger and general freight as well as coal. Hunter Valley includes trains servicing load points as far north as the Drayton Branch. All trains from the Ulan line, including Bengalla, Mangoola and Mt Pleasant trains, are included in the Ulan line category.

The key point of this analysis is that the infrastructure solutions recommended in the 2007 – 2012 Strategy continue to be appropriate up to 2012. In 2013 delay starts to accelerate, and no simulations were able to resolve for 2014 onwards.

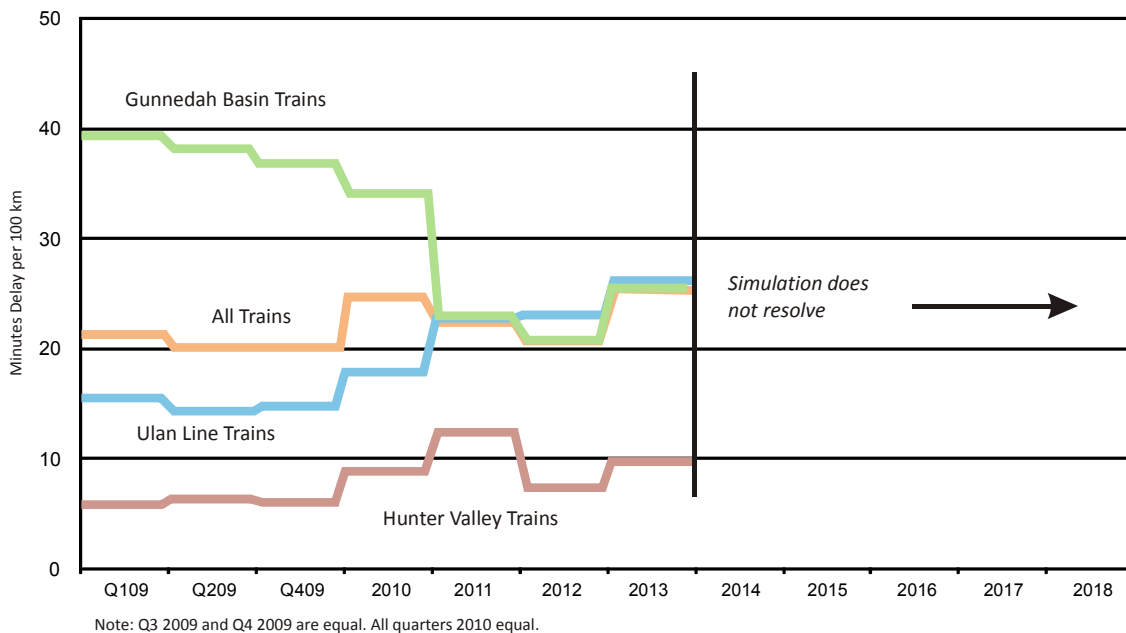


Figure 7 - Quarter By Quarter Performance of the Hunter Valley Network, 2009 Strategy Train numbers, Infrastructure as per 2007-2012 strategy.

Reducing headways on the Minimbah, Nundah and Allandale Banks

The issues

Between the ports and Muswellbrook there are only two 'plain track' sections of the coal rail network – as distinct from the junctions considered in Chapter 5 of this Strategy – for which the minimum headway between loaded coal trains is more than eight minutes:

- The 'Minimbah Bank', which climbs from just south of Muddies Creek to a crest just south of Minimbah (figure 8).
- The 'Nundah Bank', from Glennies Creek to a crest on the line just south of Camberwell Junction (figure 8).

Headways on Allandale Bank (see figure 8) were previously 10 minutes but were reduced to 8 minutes in conjunction with the Minimbah-Maitland bi-directional signalling project. At this headway, capacity will not become constrained until 2015. For the reasons discussed in Section 9 the Minimbah-Maitland Third Road will be completed by then, avoiding any capacity constraint.

The minimum headways for loaded coal trains on the Minimbah and Nundah banks were originally around 17 and 20 minutes, respectively. These headways were reduced to approximately 14 and 16.5 minutes with the introduction of 80 km/h approach speeds to the two banks in January 2007.

Minimbah Bank

Although Minimbah bank has shorter headways than Nundah bank, and hence greater nominal capacity, its true capacity will inevitably be constrained by the Nundah bank configuration. Trains that operate over Nundah bank can be no closer than 16.5 minutes apart. Trains exiting the Mt Thorley branch are not at the full 80 km/h speed and hence their transit time up the Minimbah bank is slower than mainline trains, also increasing the headway. Consequently, the effective headway on Minimbah bank is also around 16.5 minutes.

The current configuration on the three banks provides sufficient theoretical capacity to last until NCIG Stage 1 ramps-up to around 10 mtpa, which is assumed to be in Q2 2010. At this time the capacity of Minimbah bank will be reached. The 2007 – 2012 Strategy recommended that a third road be constructed on Minimbah bank with completion in late 2009. ARTC has now secured industry support to proceed to construction of a new track in the loaded (Up) direction in the existing corridor on a reduced (1 in 100) grade. The current expectation is that this third road will be available in Q2 2010. As the timing of the ramp up of NCIG Stage 1 has moved back since the 2007 – 2012 Strategy. The revised Minimbah Bank Third Road timing will still ensure adequate capacity.

Minimbah bank is not expected to become capacity constrained again in the loaded direction before 2018. The empty (down) direction reaches capacity in 2015. However, it is expected that there will be sufficient spare capacity in the up direction to accommodate the overflow of down direction trains using the existing bi-directional capability of what will become the centre road.

The primary benefit of a reduced grade is that the track would climb to a lower maximum elevation. Transit time and fuel consumption are both a function of the amount of energy required to lift a given mass to a given elevation. Accordingly, a reduced gradient does not in itself have much effect on operational performance if the train configuration remains the same, but a lower maximum elevation will both improve transit time and reduce fuel consumption.

In addition, the reduced grade of 1 in 100 means that trains can be brought to a stand on the new track with minimal risk of them not being able to restart. Accordingly it is intended that up to three trains will be able to be held on the third road while a passenger service overtakes.

Nundah Bank

The capacity of Nundah bank is reached in Q1 2012 if there is no port capacity constraint and Q3 2012 under the assumed port capacity expansion program. However, demand is very close to capacity for 2011.

Two options are available to increase capacity on Nundah bank:

- Re-signalling of the current track to further reduce headways for loaded coal trains.
- An additional track (third road).

Reducing headways would be achieved by reducing the distance between signals and providing additional signal indications. This allows coal trains to be more closely spaced while ensuring that fast passenger trains and other freight trains continue to have adequate braking distances.

Fundamental to this option is that the signal spacing will allow two coal trains to be on a bank at the same time, thereby increasing the capacity of the bank.

However, if a train is required to come to stand on the bank for any reason there is a risk that it might not be able to resume its climb from a standing start, with the consequence of significant operational delays. While in theory all the train types using the Nundah bank are capable of restarting, there are divergent views about the level of risk that this type of operation creates.

Provision of a third road allows alternate trains to be directed to opposite tracks, effectively doubling the capac-

ity. This option would also:

- Allow two trains to be on the grade without the risk of the second train needing to come to a stand.
- Provide greater recovery flexibility if a train stalls on the grade.
- Reduce the impact of the capacity “shadow” caused by passenger trains, by allowing passenger services to overtake coal trains on the grade, where the speed differential is greatest.
- Permit re-sequencing of coal trains if this is required.

10-minute headways on Nundah bank would provide adequate capacity through to 2015.

However, the 10-minute headway option is a less than ideal solution with some risk attached. Given the additional benefits of a third road this is considered the first best option and is therefore recommended. It is also recommended that it be pursued with a view to completion by Q3 2012.

Nundah - Whittingham

Simulation modelling has also identified that the remaining double track section, between the top of Nundah bank and Whittingham Junction, becomes a bottleneck as volume increases. While it does not constrain capacity, it does impose material additional delay. This Strategy therefore flags potential infilling of this section by 2016. Completion of this section of third road would then provide a continuous three tracks from the foot of Nundah bank to Maitland. This would provide excellent levels of capacity and robustness and keep operational delay to a minimum.

Proposal

It is proposed that a third road be constructed on Nundah bank. It is desirable that this be completed by Q3 2012. A third road in the vicinity of Allandale bank is required around 2016 though the Minimbah – Maitland third road discussed in section 9 will address this constraint and is proposed for completion by early 2012 for reasons other than pure capacity. Infill with a third road on the remaining double track section between the crest of Nundah bank and Whittingham Junction is desirable by 2016.

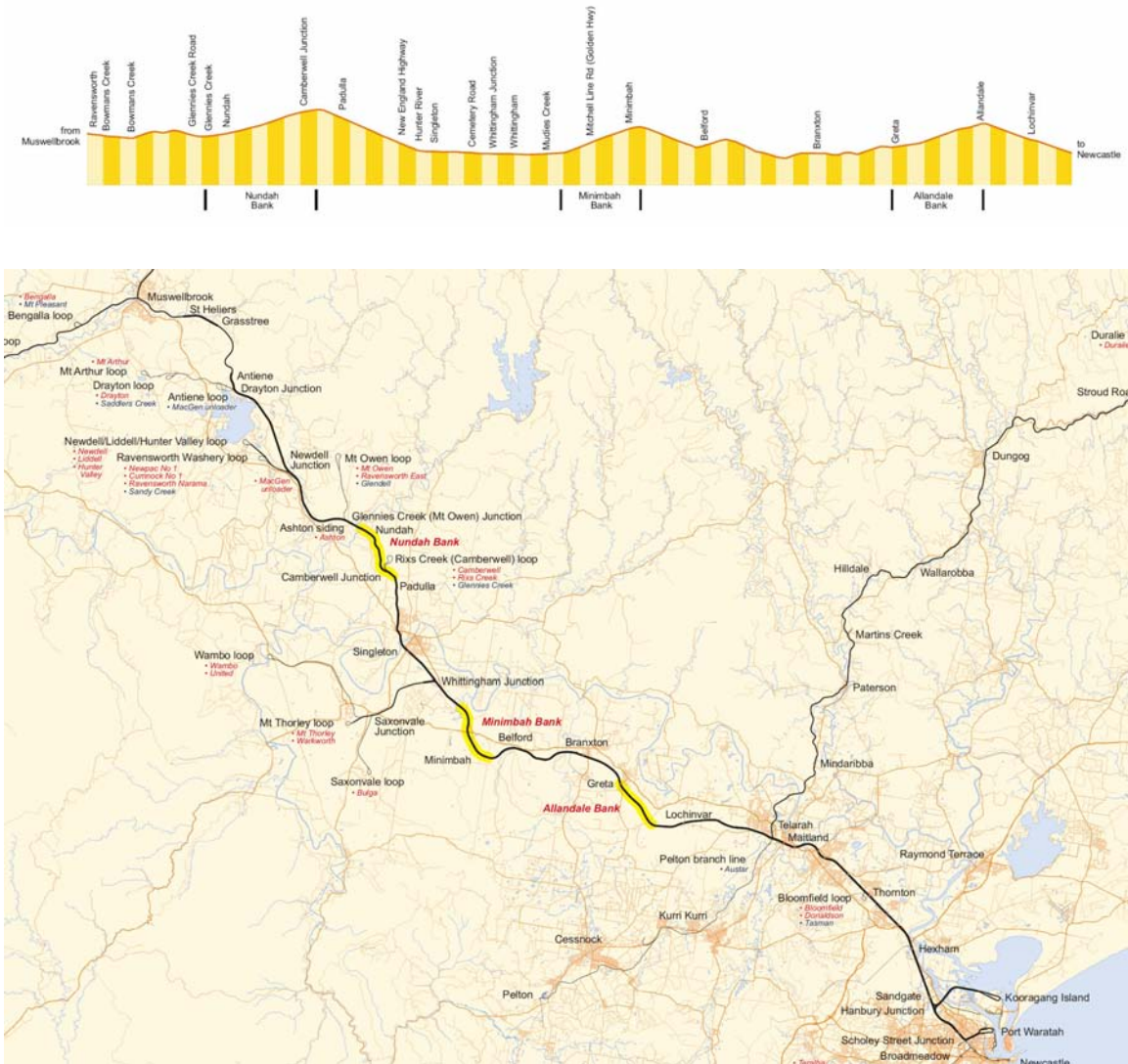


Figure 8 - The Nundah, Minimbah and Allandale Banks.



Existing Minimbah Bank, looking up the Bank, at approximate chainage 230km.



A southbound coal train climbing the Minimbah Bank.

Reducing junction conflicts

The constraints

There are numerous junctions on the Hunter Valley rail network where trains travelling from coal-loading branch lines conflict with empty trains travelling in the opposite direction on the main line, or vice versa.

The effects of these conflicts on rail capacity are particularly acute at three junctions that have slow junction speeds and/or high frequencies of train movements: Whittingham, Newdell and Drayton (figure 9).

Newdell and Drayton Junctions also have high maintenance turnouts, necessitating excessive track maintenance and producing additional train delays.

With the strong growth of coal volume from the Ulan and Gunnedah basin lines, the junction of these two lines at Muswellbrook will also come under increasing pressure as will the junction at Maitland, where passenger and general freight services merge and diverge with coal traffic.

The options

The options identified to address junction constraints are:

- Relay junctions with new high-speed, low-maintenance turnouts.
- Separate entry and exit tracks (or in the case of Muswellbrook, double track on both branches).
- A three-track mainline configuration.
- 8-minute headways in the down direction.
- Grade separation.

Relaying with high speed turnouts is an obvious and simple option. It reduces junction occupancy times and ongoing maintenance costs, and in some circumstances the faster speeds through the junctions may also allow a simplification of the junction arrangements, further reducing the up-front cost, installation time and ongoing maintenance.

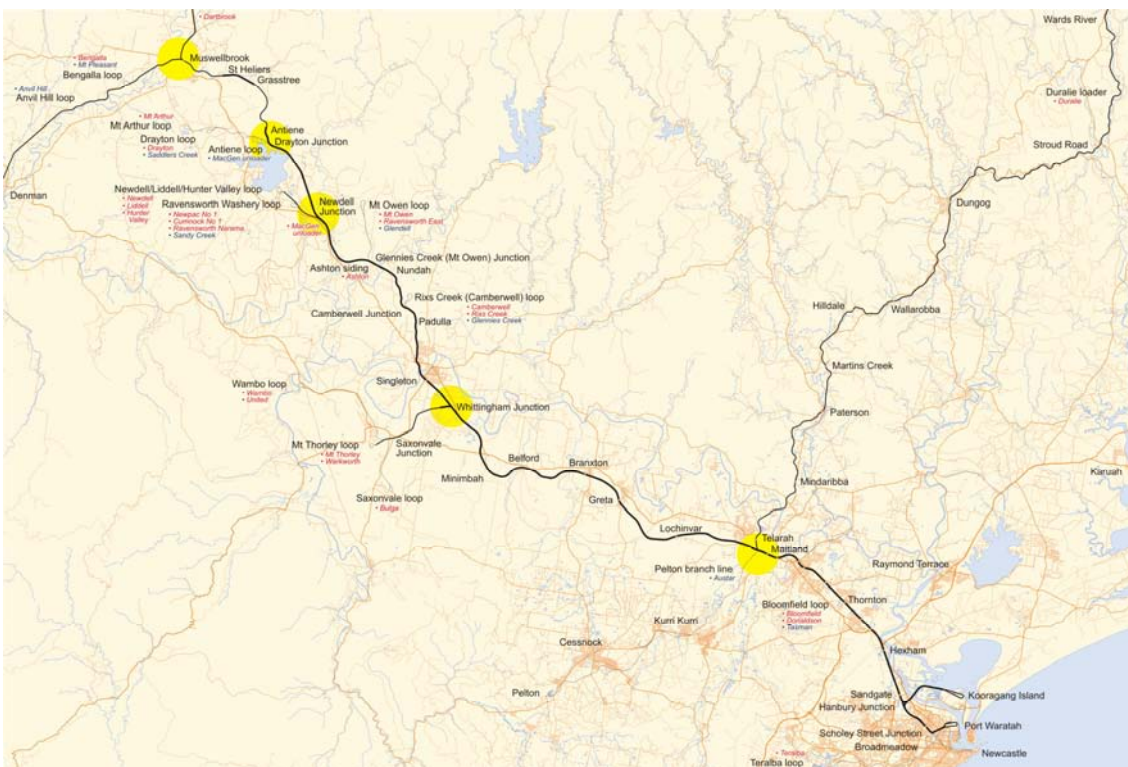


Figure 9 - The Maitland, Whittingham, Newdell, Drayton, and Muswellbrook Junctions.

nance.

The separation of entry and exit tracks may be justified if it is desirable to be able to hold an arriving empty train clear of the main line, although the need for this may be partly offset by higher junction speeds. This option would generally have higher costs and in some cases it might be complicated by track ownership issues.

In the case of Muswellbrook, a double track configuration on both branches would minimise delays at the junction by avoiding the situation where a northbound train needs to be held at Muswellbrook awaiting a southbound train off the same line, and in turn delaying a following northbound train with a destination on the other line.

A three-track mainline configuration allows up direction and down direction conflicts to be managed separately. At present, a departing up train off the Mount Thorley, Newdell and Drayton branches needs to cross the down line and slot in between up direction trains, meaning that there is a high probability of a conflict in one or other direction. A third track at the junction permits a departing up train to proceed across the down line during a gap and then be held on the centre track until a suitable gap in the up direction is available.

Consistent eight-minute headways on the main line in the 'down' direction would compensate for the fact that, at present, the conflict between 'up' trains exiting the branch lines and 'down' through services, reduces the main line's capacity in the 'down' direction even though it does not produce a corresponding reduction in 'up' direction capacity. Sustaining a consistent 8-minute headway in the 'down' direction is easier than in the 'up' direction due to the faster average speeds of empty 'down' direction trains.

Grade separation is a high cost option, but if train frequency is high it may be the best way to reduce conflicting train movements and reduce the wear from loaded coal trains on main line turnouts and crossovers.

Discussion

ARTC investigations suggest the first option would be the best for Newdell and Drayton Junctions, both of which have slow-speed, high-maintenance turnouts.

Although the existing junctions have adequate capacity for the immediate future, renewal of the junctions is highly desirable as a way of reducing the impacts of infrastructure maintenance and reliability downtimes. Accordingly, ARTC has now commenced design work on these renewals.

It is proposed that both Junctions should be renewed with 1:18 turnouts, raising the junction speeds for trains moving onto and off the branch line from 25 km/h to 60 km/h. This will approximately halve the junction occupation time, ensuring that interference between trains and hence delays, are minimised in the short term and ensuring adequate capacity in the longer term.

Train numbers on the Mt Thorley line are expected to jump significantly, from 13 each way per day in 2010 to 22 trains each way per day in 2012. As already noted, industry has agreed to support the construction of a third road on Minimbah bank. This project has been configured such that the new third track extends to the north of Whittingham Junction (figure 10). This will allow loaded trains to cross the down track largely independent of the flow of up trains, reducing conflicts and hence increasing the capacity of the junction. This configuration should be sufficient to accommodate this projected growth in trains off the branch.

In the medium term the continuing growth from both the Ulan and Gunnedah basin lines means that the capacity of the at-grade junction at Muswellbrook will become stretched. This issue requires further detailed modelling, but it is expected that a comprehensive solution will be

required as volumes exceed 100 mtpa at the junction, currently forecast for 2015. An indicative configuration for a future Muswellbrook Junction grade separation is shown in figure 11 - option 1. Alternatively, a three track configuration (figure 11 - option 2) may be adequate for the medium term.

Similarly, the junction arrangements at Maitland will become increasingly tested as volumes grow. With the proposed Minimbah – Maitland third road it is intended in the first instance to provide only for a simple connection with a short section of double track between the third road junction and the junction for the main lines at Maitland. This is illustrated as Maitland Option 1 in figure 12.

The operational flexibility of the Maitland area could be enhanced by reducing the length of the residual double track and a solution for doing this is shown as Maitland Option 2.

For a number of reasons it is intended that up direction passenger and general freight services will use the centre road on the Whittingham – Maitland section once the third track is complete. Consequently they will necessarily conflict with up direction coal trains at Maitland and there is therefore only small benefit in adopting a three track configuration solution as proposed at Whittingham.

The only mechanism to fully address the conflicts is a grade separation. Options for such a solution are shown in Maitland Options 3a and 3b at figure 13. Current preliminary design work on the Minimbah – Maitland third road is having regard to these concepts. ARTC is not at this stage advocating adoption of the grade separation solution. However, this will be further assessed in future Strategies.

Finally, the efforts to increase network capacity on heavily trafficked lines are adversely impacted when a train departing the network to a siding or loading balloon loop delays the following train. This is particularly so when this is a shunt signalled move over a 25 kph turnout to the (private) facility. Generally ARTC have discontinued the practice of shunting wagons from the mainline to sidings. The movement of full trains to these sidings should as a general rule be via a running signal with a high speed turnout. This would typically achieve a speed of 50 kph for the train exiting the network.

It is recognised that in some cases the high speed configuration is unachievable due to the distance between the junction and the point at which the train needs to come to a stand. While ARTC is prepared to review projects on a case-by-case basis and to be flexible recognising the specific circumstances of the project, as a general principle it will be moving to secure higher junction speeds at the new construction stage or the traffic upgrade stage.

Proposal

ARTC proposes that both the Newdell and Drayton junctions be upgraded with high-speed swing-nose turnouts.

Whittingham Junction will be effectively addressed by the Minimbah bank third road project.

By 2015 it is anticipated that a solution will be required for Muswellbrook Junction. Grade separation and 3 track solutions will be further analysed.

This Strategy does not propose any change to the arrangements at Maitland, but the issue of the junctions in this area will be subjected to further analysis.

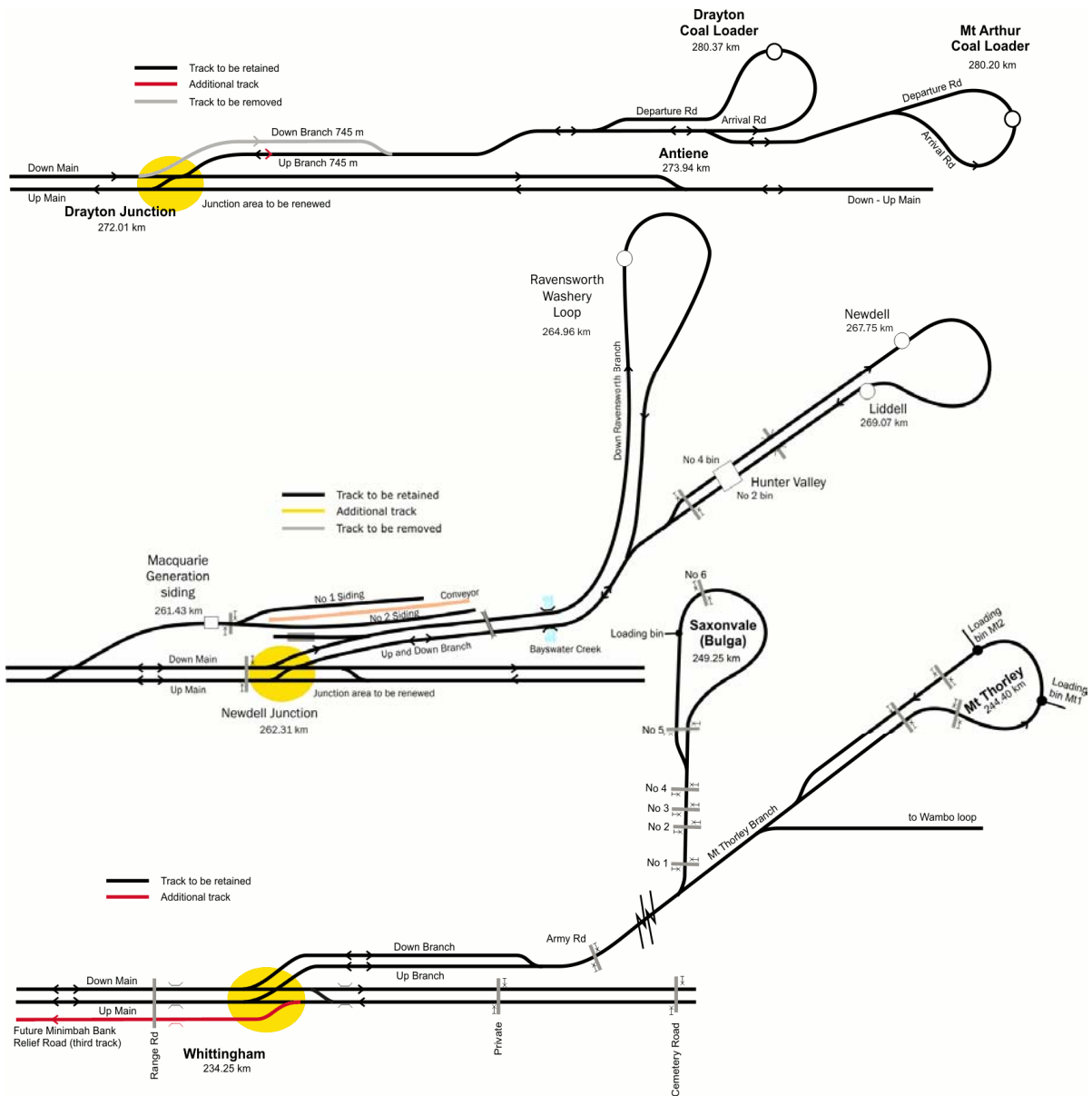


Figure 10 - Drayton, Newdell, and Whittingham junction configurations.

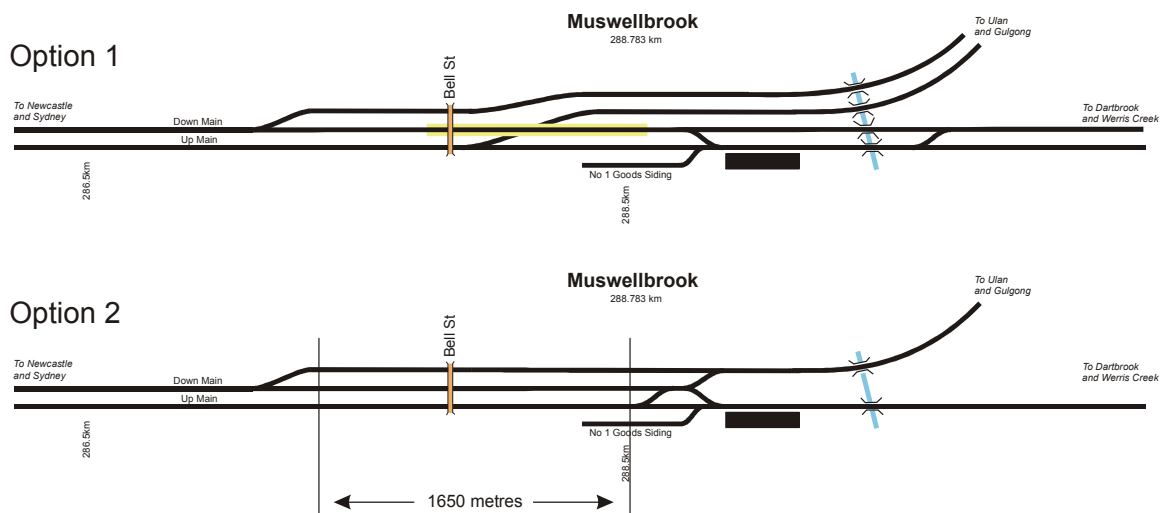


Figure 11 - Muswellbrook junction reconfiguration illustrative option.

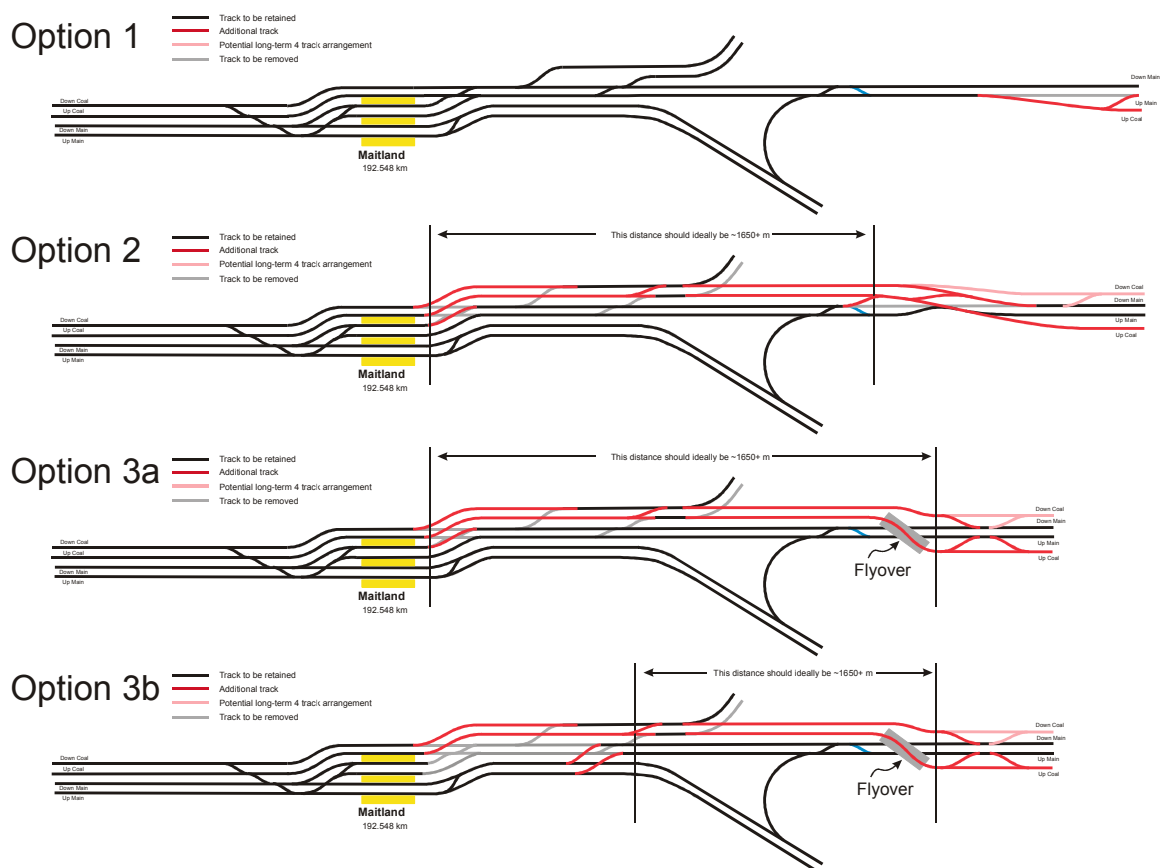


Figure 12 - Maitland Junction Concept Options.

Increasing capacity between Antiene and Muswellbrook

There were two single track sections of the Main North line between Antiene and Muswellbrook, the first of them being a 7 km section between Antiene and Grasstree, and the second a 2 km section between St Heliers and Muswellbrook Yard (Figure 13).

The capacity of these single track sections was significantly lower than the capacity of the rest of the Newcastle–Muswellbrook line, and well below the demands forecast within the next five years as a result of new mine developments along the Ulan line (see Chapter 7) and the Muswellbrook–Werris Creek–Narrabri lines (see Chapter 8).

Train numbers between Antiene and Muswellbrook were restricted by these single track sections to around 70 trains per day in total.

ARTC has now completed duplication of the Antiene – Muswellbrook section, including bi-directional signalling. These works provide a comprehensive solution to this section of the network, and no further works are expected to be required on this section for the foreseeable future.

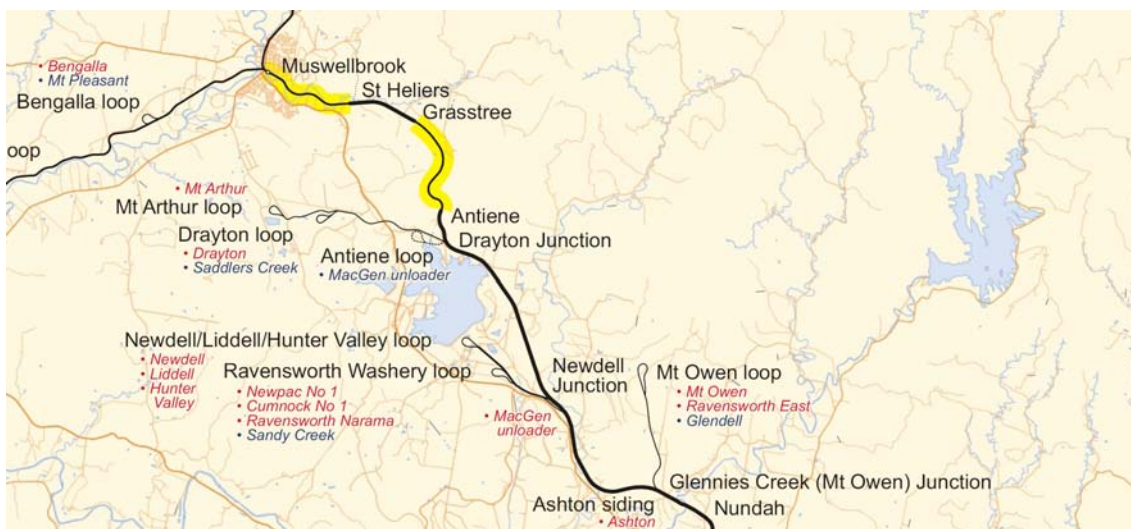
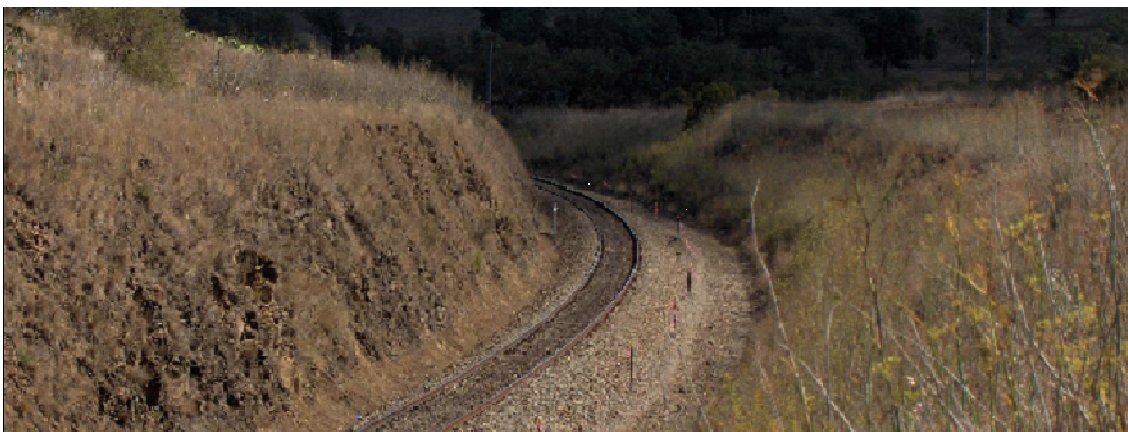


Figure 13 - The two single track sections of the Main North line south of Muswellbrook (Antiene–Grasstree and St Heliers–Muswellbrook).



Typical track section prior to duplication.

Increasing capacity between Muswellbrook and Ulan

The constraints

The Ulan line extends approximately 170 km, between Muswellbrook in the upper Hunter Valley, and Gulgong, west of the Dividing Range.

It is a single track line, with passing loops at Mangoola, Sandy Hollow, Kerrabee, Bylong, Coggan Creek, Wollar and Ulan. The line was upgraded from electric staff working to CTC during 2007/08.

Although the line is used mainly by coal trains, it is also used by one or two country ore and grain trains per day and occasionally by interstate freight trains that are bypassing Sydney during possessions. The line services long-standing mines at Bengalla and Ulan. The Wilpingong mine has recently commenced operation. Two new mines, Moolarben and Mangoola, have been granted development approval. There is also a prospect at Bylong, though this is not under active development.

Coal demand on the line is forecast to increase rapidly for both export coal and for domestic coal to Hunter Valley power stations, in particular the new Antiene unloading loop.

The completion of Muswellbrook, Mangoola, Wollar and Bylong loops, and CTC, places the line in a good position to meet demand to Q1 2010, but continued rapid growth will require further capacity enhancement.

An unusual capacity constraint is posed by the ventilation in the tunnels on the Ulan line, in particular the Bylong tunnel. Although the line only opened in 1982, the four tunnels were built as part of the original uncompleted construction of the line which commenced in 1915. Accordingly the tunnels were built to a relatively small outline and ventilation in the tunnels is a problem. Train spacing and track maintenance are limited by the 'purge times' for air in the tunnel. Current loop spacing limits following loaded trains to operating at around 45 minutes apart and opposing loaded and empty trains to around 24 minutes apart. As new loops are built closer to the tunnels, thereby reducing these inherent train separation times, it will be necessary to address the ventilation issue.

The options

The options identified to provide capacity beyond Q4 2008 are:

- Increased train speeds.
- Additional passing loops.
- Double track / passing lanes.
- Tunnel ventilation works.

A 33% increase in coal train speeds on the Ulan line

from 60 km/h to 80 km/h would give a transit time reduction of only around 15 minutes, or 8%, as the tight curves and significant gradients on much of the line limit the ability of trains to make use of the increase in the maximum speed. Average section times would reduce by about 1.5 minutes and allow a small deferral of the loop projects, though this would be offset by an increase in track maintenance cost and possessions time.

An increase in track speeds through Muswellbrook would, however, have a significant benefit. This project requires the removal of the current 25 km/h junction at the northwestern end, permitting trains to run at 50 km/h instead. This project represents stage 2 of the Muswellbrook loop works and will improve train speeds and capacity not only on the Ulan line, but also on the Werris Creek / Gunnedah line (see Chapter 8). This stage 2 project is scheduled to be completed in conjunction with the St Heliers – Muswellbrook duplication.

Additional passing loops represent the main mechanism to deliver further incremental increases in capacity on the line.

Double track may become desirable once passing loops start to be required at intervals of around 8 kilometres or less. While further passing loops can be interspersed, double track becomes increasingly attractive due to lower signalling costs, simplified train control and reduced delay due to stopping / starting and signal clearance times. The choice between double-track and passing loops depends mainly on site specific costs.

The Ulan line also has quite difficult terrain, offering relatively few locations that are desirable for new passing loops due to train handling issues. This will also become an important consideration in choosing between loops and double track as volumes grow.

Ventilation options for the tunnels have now been assessed in detail. The study identified five options as follows:

- Tunnel portal door.
- Portal fan stations.
- Portal fan station with tunnel portal door.
- Longitudinal jet fans.
- Vent shaft and above ground fan station.

Discussion

The 2007 – 2012 Strategy identified a requirement for up to 6 additional loops on the Ulan line. Three of these were constructed during 2008. With the extended time-frame of this Strategy and the continuing strong growth in volumes, a need for up to 9 additional loops has now been

forecast.

The three remaining loops identified in the previous Strategy are now all proposed for completion by Q1 2010. This does not represent a change for the Aerosol Valley and Worondi loops, but involves bringing the Radio Hut loop timing forward by 2 years.

It should be noted that the original names given to these loops were provisional and it is proposed to better reflect the local names of the sites in the loop names. The local names are Murrumbo for Aerosol Valley, Baerami for Worondi and Yarrawa for Radio Hut.

The 6 new proposed loop locations are at 337 km, 353 km, 378 km, 390 km, 404 km and adjacent to the Wilpingjong mine junction at 422 km. These 6 loops will split each of the sections as they stand at 2010, with the exception of Kerrabee – Aerosol Valley which will already be a relatively short section. The 6 loops are proposed to be constructed over the 2012 – 2014 period and will reduce all sections on the Ulan line to between 8 and 11 minutes running time.

The proposed locations are based on optimisation of section running times and are only nominal at this stage as no site investigations have been undertaken. The Ulan line has some difficult geography which constrains the location of loops. As sections become shorter, the scope to adjust the location of the loop declines. Accordingly, as investigation of sites proceeds it may become necessary to adopt alternative solutions. Specifically, it may be necessary to construct “passing lanes”, which are effectively short sections of double track. The 378km proposed loop for instance coincides with the location of the Bylong Tunnel, and it may instead be necessary to extend both adjacent loops instead. Such solutions will necessarily be materially more expensive than straightforward loops.

At the Muswellbrook end of the line there is expected to be large growth with the Bengalla mine being joined by Mount Pleasant and Mangoola (formerly Anvil Hill). By 2011 there will be a requirement to provide additional capacity between Muswellbrook and Bengalla. This section is only 7 km long and would most logically be enhanced by double tracking rather than by splitting the section with a loop. However initial project cost estimates indicate that

duplication will be a high cost solution, with relatively little advantage over a loop on a cost per km basis. Accordingly, the strategy is now leaning toward a loop rather than double track as the preferred solution.

By 2012 there is a similar requirement for additional capacity between Bengalla junction and the junction for the Mangoola mine. Again, this section at around 11 km lends itself to double-tracking, but the initial cost estimates suggest that this would represent poor value for money and a loop solution is therefore preferred.

The first loop, between Bengalla and Muswellbrook is proposed for 2012. The second loop, in the vicinity of Mt Pleasant Junction, is proposed for 2014.

The tunnel ventilation analysis has recommended the portal fan station with tunnel portal door as the most cost effective solution. However, it has identified that a tunnel portal door may, in the first instance, provide a sufficient interim solution at lower cost. It has therefore been recommended that this be pursued as a first stage. This work will need to be timed to align with the Aerosol Valley loop, which when completed will allow a significant reduction in the time between trains.

All of the proposed works on the Ulan line assume that there is no change to the current pattern of limited background (non-coal) trains on this line.

Proposal

The proposed sequence of projects is:

- New loops at Worondi (345 km), Aerosol Valley (371 km) and Radio Hut (317 km) and a tunnel portal door on the Bylong tunnel by Q1 2010.
- New loops at Bengalla 422 km (Wilpingjong), 378 km and 337 km by 2012.
- New loops at 390 km and 353 km by 2013.
- New loops at 404 km and Mt Pleasant by 2014.

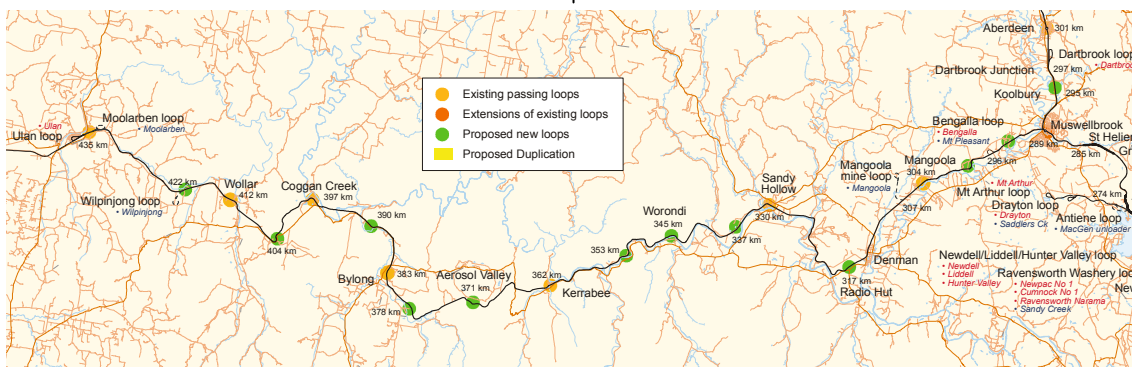


Figure 14 - Locations of proposed additional loops on the Ulan line.



St Heliers looking north pre-duplication works commencement.

Increasing capacity between Muswellbrook and Narrabri

The constraints

The single-track Muswellbrook–Werris Creek–Narrabri line is highly complex.

In addition to its coal traffic, it carries passenger trains (CityRail services to and from Scone and CountryLink services to and from Moree and Armidale) and a proportionately high level of grain, fuel, cotton and flour train activity. This ‘background’ traffic is up to 12 trains each way per day as far as Scone, then up to nine each way to Werris Creek, seven each way to Gunnedah and six each way to Narrabri.

Coal demand on the line has already increased significantly and is forecast to continue to increase very rapidly. Considerable increases in capacity will be needed to accommodate this growth.

There are currently three coal train origins and destinations along the route, at Werris Creek, Gunnedah and Boggabri⁵, but in the future these are expected to be joined by new coal loader loops at Murulla, Caroona⁶, Watermark⁶ and the proposed Narrabri colliery.

The Ardglenn bank, crossing the Liverpool Range, is a particular impediment. The severe grades on the short section between Willow Tree and Murrurundi dictate limits for train operations on the whole Werris Creek to Newcastle route. The need to use ‘banker’ locomotives for loaded coal and grain trains on this section means it will reach its capacity limits earlier than the rest of the line, because the return of the ‘banker’ locomotives adds a northbound train path for each southbound coal or grain train, though this is mitigated to some extent by the ability of bank engines to use the short loop at Kankool.

The existing passing loops on the Muswellbrook–Narrabri route (figure 15) have highly variable lengths. Many are around 650–750 m, some are as short as 400 metres and there is now a number of 1350 m – 1450 m loops developed to accommodate the recent increase in train length to 1250 metres.

The track north of Dartbrook is only rated for 25 tonne axle loads (i.e. ‘100 tonne’ wagons).

All of the network currently carrying coal is now CTC with the recent conversion of The Gap – Turrawan from electric staff working.

The Gap – Narrabri section of the route is managed by ARTC on behalf of the NSW Rail Infrastructure Corporation (RIC), and decisions on investments in this section are a matter for RIC. ARTC is working closely with RIC to facilitate an integrated approach to investments across the entire corridor.

5. The Dartbrook mine closed two years ago.

6. On the line between Werris Creek and Gunnedah.

Four major new mines are proposed for the Gunnedah basin: Narrabri; Caroona; Watermark, and; Maules Creek. For the purposes of the Strategy, it has been assumed that Caroona and Watermark will load from new load points close to Werris Creek, Narrabri will load from a new loop to the north of Boggabri at 540 km, and Maules Creek will load at the existing Boggabri loader. To the extent that the actual load points vary it may require some adjustment to the extension of loops in the immediate vicinity.

The options

The options identified to address capacity constraints between Muswellbrook and Narrabri are:

- A new alignment over the Liverpool Range.
- The progressive lengthening of existing passing loops, and construction of additional long loops.
- Reopening and reconfiguration of the former Gap – Werris Creek alternative route to create a Werris Creek bypass.
- Track duplication (passing lanes) on sections where desirable loop spacing falls below around 8 km.
- The upgrading of structures and track to accommodate trains with 30-tonne axle loads.
- A further increase in train length.
- Reconfiguration of the asymmetrical loop arrangement at Scone.

Discussion

During the past year ARTC and RIC have delivered the planned capacity enhancement projects on the Gunnedah Basin line. This allowed 72 wagon trains to be introduced in May 2008 and ARTC has now provided 7 paths per day for 72 wagon trains as intended.

The previous strategy had provided for CTC between Werris Creek and Narrabri to be introduced progressively, with loop extensions following as required. During the year RIC took the tactical decision to complete the CTC as essentially a single project and to undertake the loop extensions as part of the works, allowing total costs to be minimised. As a result, capacity to the Gunnedah basin, particularly north of Werris Creek, is now well ahead of demand.

The maximum practical length of trains on the line is likely to remain at about 1,300 m until a new alignment is constructed across the Liverpool Range, because of in-train forces on grades. The option of using ‘distributed’ power to permit even longer trains on the existing grades,

with one or more locomotives in the middle of each train rather than at the front, would present technical complexities and is regarded by ARTC as unlikely.

In 2007 ARTC completed a study on options for a new alignment across the Liverpool Range in the vicinity of Ardglen. This report assessed four tunnel options and two new surface alignment options, as well as duplication of the existing alignment (figure 16). All of the new alignments have a maximum grade of 1 in 80 or less, compared to the existing 1 in 40 grade. Adoption of a new alignment would allow the elimination of 'banker' locomotives currently required to assist trains on the long climb.

The tunnel alignments connect Willow Tree to Murrurundi

while the surface alignments would connect Willow Tree to Ardglen. If a surface alignment was adopted, coal trains would use the existing alignment to descend from Ardglen to Murrurundi. An information sheet on the Liverpool Range New Alignment Study is available on the ARTC website under 'Infrastructure Strategies'.

The report concluded that under any option for a new alignment the existing track should be retained for all northbound trains, and southbound trains other than coal and grain. This effectively duplicates the line from Willow Tree to Murrurundi, or in the case of the surface alignments, Willow Tree to Ardglen.

ARTC is continuing to discuss with the relevant coal

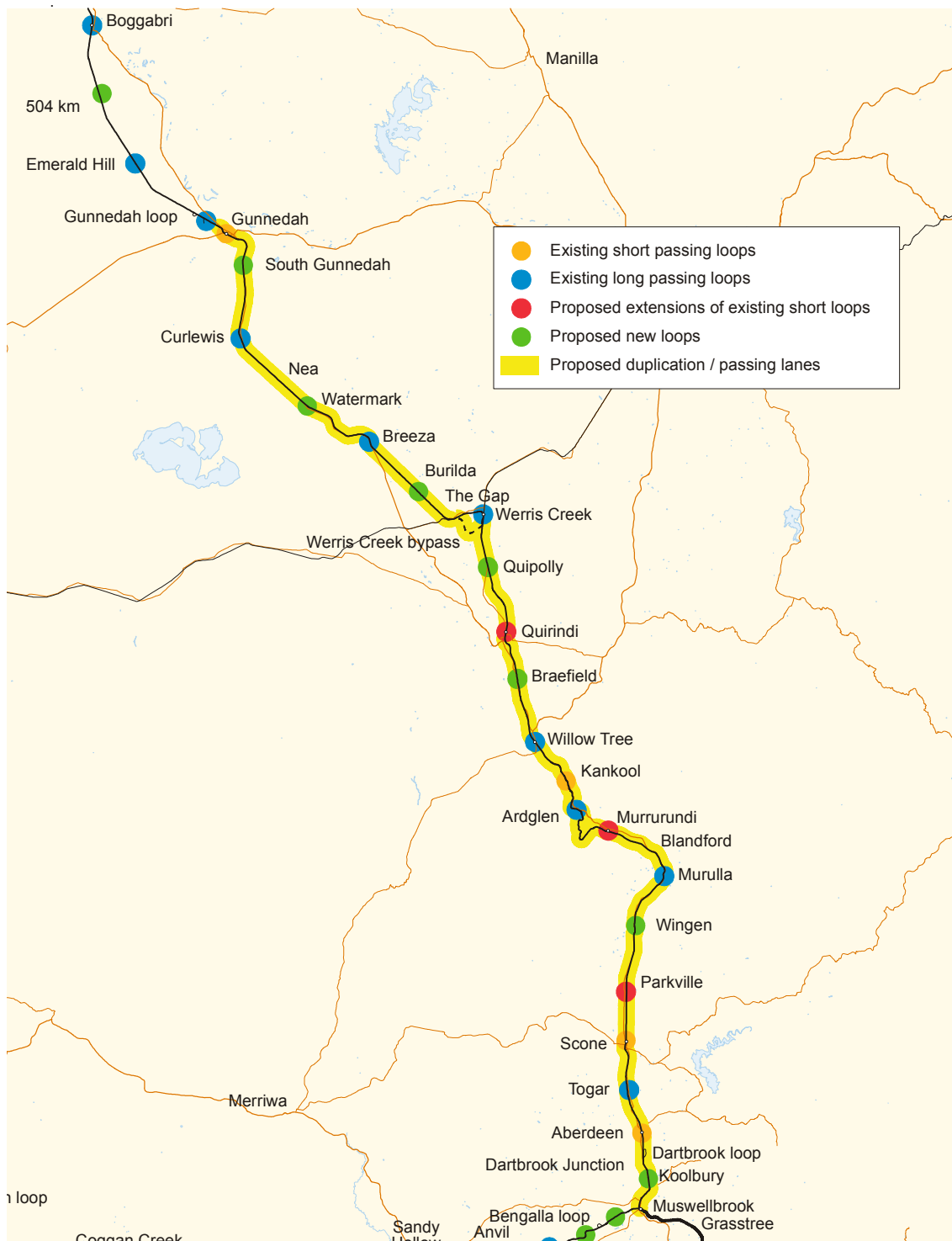


Figure 15 - Proposed new and extended loops, and duplication, on the Gunnedah Basin line.

producers the way forward for this project.

Duplication across the Liverpool Range, whether on a new alignment or not, is an expensive project. Also, there is a risk of creating redundant assets if smaller projects are pursued on the Willow Tree – Murrurundi section and these are subsequently superseded by a new alignment. Accordingly, for the purposes of this Strategy ARTC has sought to delay the need for any duplication until as late as possible, while at the same time avoiding any further works on the Willow Tree – Murrurundi section.

On the Strategy volume forecasts, 2012 is the year in which the project becomes necessary using the theoretical capacity calculations. However, as discussed in Appendix 1 the theoretical model only provides a generalised view of approximate capacity. Accordingly, the need for the project in 2012 has been tested using simulation software and this shows that deferral of the project to 2013 is feasible, though capacity will be tight. This is one year later than proposed in the 2007 – 2012 Strategy and has come about as a result of the firming of the intention to go to 30 tonne axle loads.

It also appears highly desirable to duplicate the Ardlen – Murrurundi section by 2013 given current volume forecasts. ARTC remains neutral between surface and tunnel options. As a tunnel option would achieve duplication between Willow Tree and Murrurundi this Strategy has assumed that the full section is duplicated as part of the new alignment project.

However, it should be noted that ARTC will only be pursuing the new Liverpool Ranges alignment if it is strongly supported, and fully underwritten, by the coal industry.

Progressive lengthening of selected existing passing loops and constructing additional passing loops will be necessary for the projected volumes to be accommodated. This process is already underway with a number of loops already extended to a standard length of 1350 metres.

Previous strategies have raised the prospect of extending grain trains to a similar length as the 72 wagon coal trains so as to free up additional paths for coal services. There are a number of complexities associated with this, in particular constraints at the Port Waratah grain loader. Accordingly, modelling for this strategy has assumed a continuation of the current grain arrangements.

There is a view that as volumes grow 72 wagon coal trains standing in Werris Creek loop may create operational inefficiencies. A large proportion of non-coal trains need to access the yard, which is blocked by a coal train in the loop. While this can be mitigated by standing the coal train on the mainline, a longer term solution is desirable.

An opportunity under consideration to resolve this problem and achieve a number of other desirable operational outcomes is the reopening and reconfiguration of the alternative Gap – Werris Creek line (figure 17). This line is understood to have been constructed in the 1940's to allow trains from the cross-country line from Dubbo to proceed toward Tamworth (and ultimately Brisbane) without reversing. It fell into disuse during the 1980's but was partially reinstated in 2005 to provide the track for the Werris Creek mine coal loader.

If the line was reinstated the full way to Gap and a triangle connection established at the Werris Creek end, it would provide an effective bypass of Werris Creek. It would also give tremendous operational flexibility, with trains able to cross through the use of both lines. If a triangle connection was established at the Gap end it would also create a balloon loop configuration for use by Werris Creek coal trains.

This configuration would also have potential benefits for grain services, with the Werris Creek sub-terminal effectively located on a balloon loop for trains from both the north and the south.

A final enhancement would provide a second track for an appropriate distance either side of the Werris Creek mine coal loader, so that loading operations could be undertaken without interfering with the operation of through trains.

Axle loads beyond Dartbrook are currently limited to 25 tonnes. Increasing axle loads to 30 tonnes would permit the use of 120 tonne wagons and thus increase the carrying capacity of each train. This would deliver significant cost savings as well as allowing some capacity projects to be deferred. In particular, it would allow the duplication across the Liverpool Range to be deferred.

RIC has recently completed resleepering of the Gap – Gunnedah section in concrete, which was identified as the lowest cost solution for necessary resleepering. ARTC is continuing to review its sleeper replacement strategy for the Dartbrook – Werris Creek section, with a leaning toward extensive use of concrete.

These initiatives have further strengthened the case for 30 tonne axle loads and this Strategy has assumed that these are introduced by 2011. Train configuration is assumed to be equivalent to the QR 74 wagon train, which will fit in the loops at their currently extended length.

The exact scope of work to introduce 30 tonne axle loads remains unresolved. In the short term, it may be possible to upgrade only the structures and track that are structurally unable to accommodate 30 tonne axle loads. The rest of the track would be upgraded to a stronger structure, with concrete sleepers and 60 kg/m rails, as renewals were required.

This approach minimises the up-front capital costs but will increase short and medium-term maintenance and renewal costs and the amount of time taken in possessions. ARTC would need to recover the capital costs and additional maintenance cost by way of increased access charges.

A separate but related issue is the option of resleepering with concrete sleepers. Concrete sleepers are not mandatory for the introduction of 30 tonne axle loads. However their installation would contribute to a reduced maintenance task both in terms of cost and possession hours. As tonnages increase, the magnitude of the maintenance savings increase thereby making the case progressively more positive. ARTC is aware of the need to minimise maintenance possessions and adopting concrete sleepers early would allow a material decrease in possession time. The cost of installing concrete sleepers between Muswellbrook and Werris Creek is in the order of \$42m. The cost for Gunnedah to the Narrabri mine is in the order of \$23m.

Pending resolution of the strategy to facilitate increased axle loads, and the consequent scope of up front capital works, no allowance has been made for this in the expenditure forecasts. In the event that upgrade to 30 tonne axle loads does not occur, capacity will be limited to approximately 15mtpa between Willow Tree and Murrurundi until the new Liverpool Range alignment is completed.

The passing loop at Scone is short (410 m) and has an asymmetric layout, requiring all trains to negotiate a curved turnout leg and slowing speeds through the station area to 25 km/h. Level crossings and the proximity of the town make an extension of the loop unattractive.

Passenger trains are the only services that stop at Scone. It is therefore proposed that the track arrangement at Scone should be altered to give an unrestricted run for through trains. This would save approximately 4 minutes in the section between Togar and Parkville.

Capacity in this section becomes tight in 2012 and the reconfiguration of Scone together with the extension of Parkville loop is required. The strategy provides for this work to be completed for 2011 in line with the objective of allowing the construction of the new alignment between Murrurundi and Willow Tree to be deferred as long as pos-

sible.

From 2014, volume on the line to the Gunnedah basin begins to reach a level where the current loop pattern becomes insufficient. Loops are spaced at around 8 km – 10 km and at this spacing it becomes undesirable to split a section with an intermediate loop, both because of the high fixed cost of the infrastructure, and the “transaction time” at the loop. It therefore becomes preferable to move to double track, though site specific construction costs mean that the decision needs to be assessed on a case-by-case basis.

Analysis suggests that growth between 2014 and 2017 will require the entire distance between Muswellbrook and Gunnedah to be further sub-divided into shorter sections to become double track, with the priority order being largely dictated by section length (ie the longest sections will require duplication first). A hybrid option would be to extend each loop to around 4 km rather than providing full double track. Whether this is operationally or

cost effective requires further research and for the purposes of this Strategy it has been assumed that full duplication is the base case solution.

An alternative option would be a further significant increase in train length. Train length represents a trade-off between the operational and capacity efficiency of running a longer train, and the inefficiency of having wagons effectively idle while the longer train spends more time loading and unloading. The further the train needs to travel the larger the operating and capacity efficiencies are, while the inefficiency of longer loading and unloading time is essentially fixed. Hence, the greater the journey length the better the case to increase train length.

The obvious option for the Gunnedah Basin region is to go to either 111 wagons (ie a 50%, or one locomotive, increase in the standard QR train) or 121 wagons (ie a 33%, or 1 locomotive, increase in the standard PN train). Assuming a 50% / 50% split between these two train types, this change would give a 51% increase in capacity

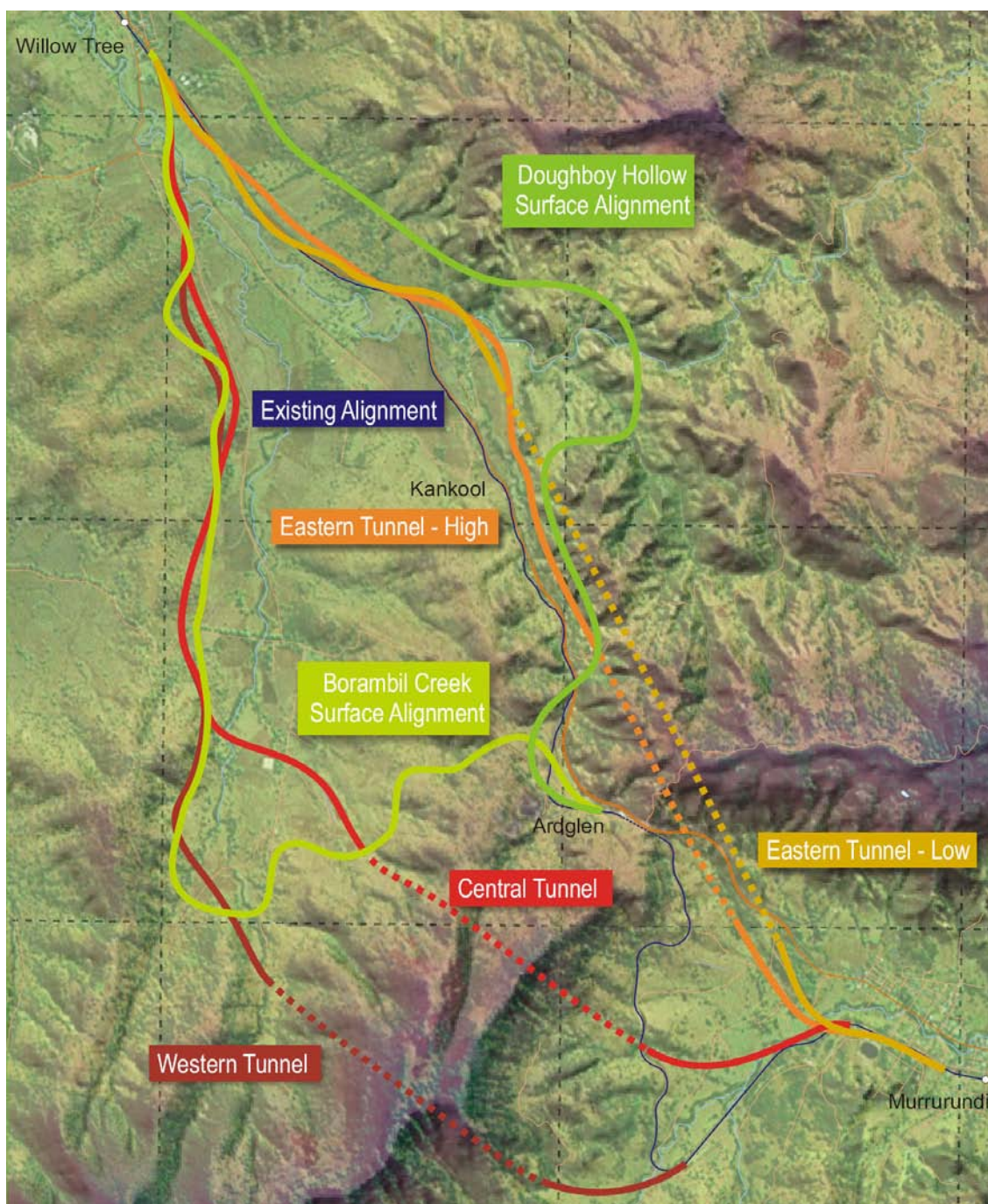


Figure 16 - Route options identified in the “Liverpool Ranges New Alignment” Study.

compared to the 74-wagon trains assumed to operate once 30 tonne axle loads are introduced. It is assumed that these longer trains would operate with distributed power to appropriately manage in-train forces.

Increasing train length has an array of implications. This includes the need to reconfigure load points and the dump station tracks at the port, increase loop length, and potentially adjust signal spacings.

Initial analysis suggests that this solution would defer the need for duplication until volumes exceeded 50 mtpa, which is speculatively forecast for 2021. This solution would require up to 20 loops to be extended to around 2,300 metres.

This is likely to be a more cost effective solution than extensive construction of double track. However, this option requires significant further technical analysis and the in-principle support of operators. Accordingly, this Strategy has taken the conservative approach and has been based on adjustments to the infrastructure.

It should be noted that the option of going to longer trains is only feasible once a new alignment across the Liverpool Ranges is completed.

Proposal

The proposed sequence of projects is:

- A new loop at Braefield by Q1 2010.
- By 2011, the extension of the loops at Parkville, Murrurundi and Quipolly, construction of new loops at Watermark and Koolbury, reconfiguration of Scone loop, and reinstatement of the Gap – Werris Creek alternative route with a triangle connection at the Werris Creek end.
- New loops at Wingen, Burilda and South Gunnedah, and extension of Quirindi loop, by 2012.
- A new alignment over the Liverpool Range in the vicinity of Ardglen by 2013, including providing

effective double track from Willow Tree to Murrurundi.

- Progressive duplication between Koolbury and Gunnedah between 2014 and 2017 with the sequencing largely determined by the need to duplicate the longest sections first.
- A new loop at 504 km (between Emerald Hill and Boggabri) by 2015.

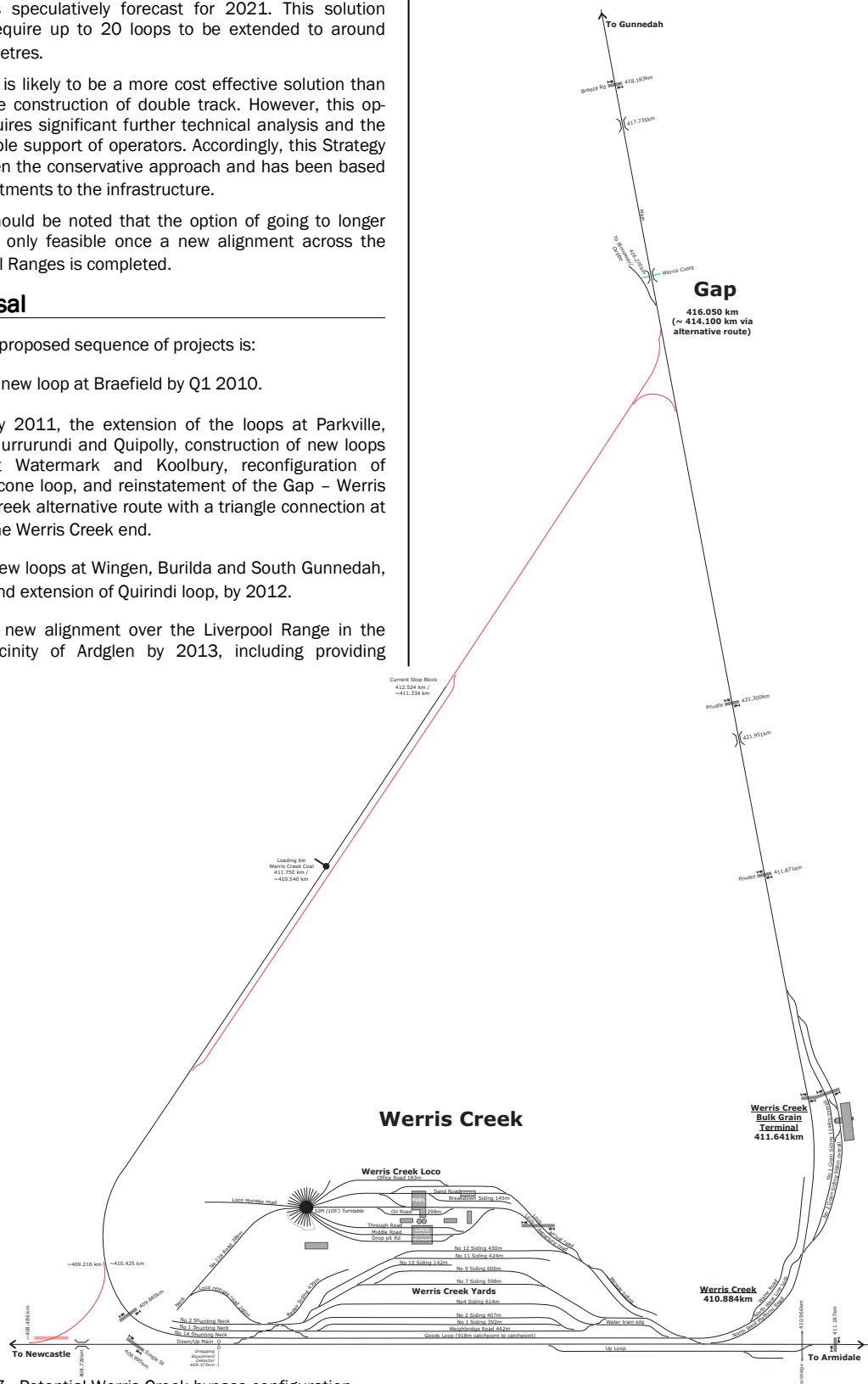


Figure 17 - Potential Werris Creek bypass configuration.



Reducing maintenance impacts and increasing operational flexibility

The constraints

The need for on-track maintenance inevitably results in some loss of capacity for coal trains.

This loss will become more significant as coal tonnages increase, because maintenance requirements will increase and there will be a greater loss of coal tonnage for any given duration of maintenance activity.

For the purposes of modelling, track closures for maintenance purposes have been assumed to require the same amount of time as at present. This generally follows a pattern of four possessions of approximately 5 hours on Monday, Tuesday, Wednesday and Thursday. Generally, only one track is closed at a time, with a heavy skewing toward possessions of the 'Up' direction track due to the much larger tonnages it carries. These routine possessions are supplemented by a small number of weekend maintenance closedowns.

In practice, the growing tonnages may result in greater impact on the track and it will be necessary to either develop strategies to achieve more maintenance in the same amount of track closure time, or provide a further small increment of capacity, for the essential maintenance activities to be done.

The options

The infrastructure options identified to reduce these constraints are:

- Additional tracks to allow more on-track time while retaining train running capacity, and
- Bi-directional signalling, allowing some train running while maintenance is being carried out.

For both of these options a secondary benefit would be the general ability to recover from train or track failures more quickly than with a single track or uni-directional tracks.

Bi-directional signalling provides a significant degree of operational flexibility without the cost of extra tracks. Bi-directional signalling is already in place between Maitland and Whittingham Junction. It was also installed between Antiene and Muswellbrook as the marginal cost of bi-directional signalling was relatively small and it will provide material benefit in dealing with domestic coal services operating from the Ulan line to the Antiene unloader.

ARTC's Advanced Train Management System (ATMS) is continuing to be developed with proving trials now underway on the section between Adelaide and Port Augusta. In the event that ATMS was installed in the Hunter Valley it would provide bi-directional functionality as an inherent feature of the technology. Further work is required before a decision is made on whether ATMS will be pursued in the

Hunter Valley.

The provision of additional tracks is a high-cost option with long lead times, and is justified only where capacity enhancements are approaching their limits with the existing number of tracks (see Chapter 4). A third road on the Whittingham to Minimbah section is already underway to address capacity constraints in this area.

Discussion

A key issue for addressing maintenance requirements is the need for the unloading facilities at the port to receive a constant flow of trains, rather than the need to increase capacity in absolute terms. To the extent that the flow of trains at the loader is interrupted, this creates a direct unrecoverable loss of coal chain capacity.

Analysis of the capacity benefits of bi-directional signalling has been undertaken by both ARTC and the Hunter Valley Coal Chain Logistics Team. The analysis suggests that bi-directional signalling of the Maitland – Branxton section will deliver at least 1.5 million tonnes of capacity that will contribute directly to increasing the capacity of the entire coal chain, as it will feed trains to the port unloaders when they would otherwise be idle. At current coal prices it is believed that this project will have a payback period of significantly less than four years, suggesting that early delivery of the project was well justified despite the potential redundancy of the works should ATMS be rolled-out in the Hunter Valley.

During possessions north of Whittingham it is still possible to achieve a flow of trains off the Mt Thorley branch. Hence, the benefit of delivering the capacity on Maitland – Branxton is significantly greater than doing so north of Whittingham. Having regard to this, and the potential roll-out of ATMS, no further bi-directional specific signalling schemes are proposed, though this will continue to be kept under review.

The marginal cost of bi-directional signalling installed in conjunction with duplication of the Antiene – Grasstree and St Heliers – Muswellbrook sections was small and these sections were being constructed as bi-directional. This also resulted in the short Grasstree – St Heliers section becoming bi-directional. In this case, the bi-directional signalling has the added benefit of increasing flexibility for domestic coal trains to the Drayton unloader.

The section between Minimbah and Maitland is built on relatively poor quality formation. There is a strong prospect that with the rapid increase in volume this formation will require a significant increase in maintenance frequency and intensity. As this section is also the most heavily trafficked of the network, the option of constructing a third road needs to be seriously considered.

The third road will also serve to further reduce the impact of maintenance on the throughput of the port

unloading facilities, as it will allow two tracks to remain open at all times. In doing so it potentially delivers benefits from a “whole-of-chain” perspective that are not immediately identifiable as track capacity benefits.

The HVCCLT has analysed this issue and suggested it would be desirable to accelerate delivery of the third road to Q1 2011. However it is not realistic to expect that construction could be completed in this timeframe due to the scope of issues involved in the project. The HVCCLT has concluded that this will not impact total capacity but may result in an increase in the vessel queue as a result of greater peaking than would be the case with a full third road. ARTC is continuing to assess options of staged delivery of the project but for the purposes of this strategy has assumed that it will open as a single stage in early 2012.

Infrastructure options may also be supported by in-

vestments in higher production rate track maintenance equipment, so maintenance tasks can be completed more quickly. ARTC is continuously reviewing its maintenance techniques to ensure that they are optimised having regard to both cost and capacity impacts.

Proposal

Work has commenced on planning and design for a Minimbah – Maitland Third Road and this Strategy has assumed that it is delivered in early 2012. There is the potential to incrementally access some of the benefits of the project earlier by pursuing a staged delivery approach and this is being further assessed.

No further bi-directional signalling will be progressed at this stage pending clarity on the potential for ATMS to be introduced to the Hunter Valley.



Bi-directional signalling on the Minimbah Bank.



High speed tamping machine.



10

Terminals

Background

The Hunter Valley coal industry is serviced by two coal loader terminals, Port Waratah and Kooragang Island. The coal loaders are owned by Port Waratah Coal Services (PWCS), but most of the track in and around the terminals is leased by ARTC and all train operations are controlled by ARTC.

The Kooragang Island facility has a nameplate capacity of 77 mtpa as at late 2008, while the older Port Waratah facility has a capacity of 25 mtpa, with no expectation of expansion. There are options to significantly increase capacity at Kooragang Island with an ultimate capacity of 115 mtpa as set out in Section 1.

A third terminal, to be located on Kooragang Island, is proposed to be developed by the Newcastle Coal Infrastructure Group (NCIG). The first stage of this terminal is proposed to have a capacity of 30 mtpa. Stage 2 would take capacity to 45 mtpa and stage 3 to 60 mtpa.

There are concept options being developed for further expansion on Kooragang Island that would take total system capacity to significantly above 200 mtpa.

The Port Waratah facility is located in a highly developed and constrained location with extensive rail facilities servicing a variety of activities. This includes steel products for One Steel, grain for the GrainCorp loader, ore for the Pasminco loader, general freight through Toll / R & H Transport and other minor customers. There are also locomotive and wagon servicing and maintenance facilities.

The Port Waratah coal facilities include 3 arrival roads and 2 unloaders. While there are nominally 10 departure roads, these range in length from 414 metres to 863 metres, all of which are shorter than all coal trains other than the short trains used for Stratford and Pelton services. Only two of the 3 arrival roads can accommodate 80 wagon and longer trains.

Kooragang Island terminal is better configured for modern rail operations. It has 3 arrival roads, with cross-overs immediately before the 3 dump stations, and 6 departure roads with reasonably flexible crossover arrangements immediately after the dump stations.

Number 3 departure road on Kooragang Island is used for provisioning of locomotives. There is a large locomotive maintenance facility connected at the entry point to the terminal.

The NCIG terminal will connect to the Kooragang Island branch not far from the Hunter River bridge. For NCIG Stage 1 this will be a simple at-grade connection leading to two arrival roads and a single dump station. For NCIG stage 2 it is intended that the junction become grade separated. A third arrival road and second dump station will be provided.

The Constraints

Terminal constraints can be meaningfully divided between arrivals and departures.

The critical issue in regard to arrivals is the requirement for “buffering” capacity between the mainline and the dump stations.

When there is a gap between trains due to a change in coal type, a train departs and, some time later (up to 40 or 50 minutes), the following train arrives and can proceed direct into the dump station following pre-dump checks.

However, when a second train is loaded with the same coal type it can be unloaded immediately following the first train. This is estimated to occur approximately 25% of the time and in this case it is essential that the second train be in a position to arrive as the first train departs. This can be achieved by:

- Having a separate arrival road, allowing the second train to arrive at any time while the first train is dumping.
- Holding the second train on the mainline until the first completes dumping and departs.
- Timing the arrival of the second train so it aligns with departure of the first, though the practicalities of this are so challenging that it can be discounted as a realistic option.

A probability based analysis of terminal throughput patterns has been undertaken, leading to the following conclusions:

- Carrington terminal has two dump stations and three arrival roads, though one arrival road is not suitable for 91 wagon trains. This amount of infrastructure is relatively generous for the capacity of the terminal and gives it a high level of flexibility.
- Stage 1 of NCIG will have two arrival roads for a single dump station, giving it complete flexibility.
- Stage 2 of NCIG is conceptually intended to provide a second dump station, but only one additional arrival road. This means that (unless planned out) 6.3% of the time a fourth train will arrive during a 2 hour window and it will need to stand on the mainline.
- Kooragang Island currently has 3 dump stations and 3 arrival roads. This means that 42% of the time a fourth train will arrive within the 2 hour period and it will need to stand on the mainline. 14.1% of the time a fifth train will arrive and will also need to stand on the mainline, and 1.6% of the time a

sixth train will do likewise. In other words, 1.6% of the time there will be three trains queuing. This inevitably creates significant congestion and sequencing issues.

- In the event that a fourth dump station was constructed on Kooragang Island with only a single additional arrival road, the proportion of time that trains were needing to be held out on the mainline would increase to a total of 68.4%, with three trains queuing 4.7% of the time.

The mainlines from Kooragang Island to west of Hexham are bi-directionally signalled and there are a number of cross-overs. This configuration is providing the required flexibility at this time, though with some compromise to efficiency.

However, when NCIG stage 1 starts-up, the queuing of trains on the mainline to access Kooragang Island is likely to have a material impact on access to NCIG. This will be exacerbated by NCIG stage 2, which with current plans will also have a small but material requirement for mainline queuing.

An alternative perspective on this issue can be provided by a simple analysis based on an assumed average queuing time. Assuming an average of one hour queuing per train, and applying this to a projected rolling stock fleet size, gives the following average number of trains in the queue at any one time:

Trains in Queue Assuming 1 Hour Queuing per Cycle

Year	Q1	Q2	Q3	Q4
2009	2.67	2.67	2.67	2.67
2010	2.67	3.33	3.33	3.33
2011	3.33	3.33	3.33	3.33
2012	3.33	3.33	4.00	4.67
2013	4.67	4.67	4.67	4.67

This reinforces the point that the growing task will result in an increase in the size of the typical queue.

While in general this can be accommodated by queuing on the mainline, the critical issue is going to be the need to correctly sequence trains into the three separate terminals. The third tracks on Minimbah and Nundah banks (and to a lesser extent the Minimbah – Maitland Third Track) are going to increase the flexibility of operations and improve sequencing ability. However, with a do nothing scenario in terms of holding / arrival roads there is a serious risk of inefficiency and loss of throughput due to congestion in and around the terminal area.

To address this risk it would be desirable to provide a small number of additional holding or arrival roads.

The key issue in regard to departing trains is that the departure roads are effectively being used as a yard.

The departure tracks are used for stabling trains while locomotives are serviced and fuelled, trains are examined, and while waiting a path. There are six departure roads, but each of the three dump station requires a departure road to be vacant for a train to feed onto as it unloads. One departure road is effectively occupied with fuelling activities.

As the throughput rate of the Kooragang Island facility has progressively increased, so to has the scale of occupation of the departure tracks, leading to congestion and the potential for unloading activities to be compromised by the lack of a suitable departure track to feed onto.

There are also environmental contamination concerns with the current fuelling arrangements.

Options

With regard to the provision of buffering capacity for arriving trains, it would be desirable to provide two tracks by the time volume reaches 173 mtpa in 2013. Depending on the final design of NCIG Stage 2/3 and a fourth dump station at PWCS Kooragang or a fourth terminal, it may be desirable to provide up to a further 2 holding/arrival tracks.

There are essentially two options for how additional tracks could be configured:

- Provide arrival road capacity at or immediately adjacent to the terminals, with PWCS Kooragang Island the primary candidate for such tracks.
- Provide a single multiple-track holding facility that is remote from, but able to service, all three terminals.

The options with regard to departing trains are to:

- Persevere with servicing, examination and train stabling at the terminals by building additional capacity, or reconfiguration.
- Move to a “dump-and-go” approach and consolidate the activities at a site that can service all three facilities.

Discussion

The primary advantage of constructing arrival tracks immediately adjacent to the dump stations is that it minimises the risk of delays. Trains can be called forward as required without the need to secure a path on the mainline, and hence without any risk of interference between trains proceeding to different dump stations.

The advantage of providing a holding yard remote from the terminals is the benefit of economies of scale and the enhanced resequencing ability. A single multi-track holding facility would provide high levels of flexibility and may be able to achieve greater overall holding capacity for the same amount of infrastructure.

However, given the highly constrained environment around the terminals the primary determinant of a solution may be the availability of suitable sites. Crewing arrangements may also be a consideration.

A full assessment of options is required to determine an optimised solution.

The advantage of persevering with the current arrangements for train departures is that there is already some infrastructure in place.

The locomotive provisioning process requires trains to be stabled while the locomotives are detached, moved to No 3 road, provisioned, and then returned to their train. One solution to this would be to provide provisioning facilities on additional, and potentially all, departure roads. However, this would still result in trains occupying departure roads for an extended time, which will continue to cause unacceptable congestion. Also, the NCIG terminal will have no provisioning facilities, meaning that locomotives would need to shuttle between NCIG and Kooragang for provisioning if the facility remains at Kooragang, further increasing congestion.

The only real option for accommodating train inspections and the standing of trains awaiting a path while remaining in the existing terminal area is the construction of additional departure tracks. Given the physical constraints of the site this is likely to prove challenging.

The advantages of moving to a new site for yard type activities are that it:

- Moves the activities to a remote location, reducing congestion at the terminals.

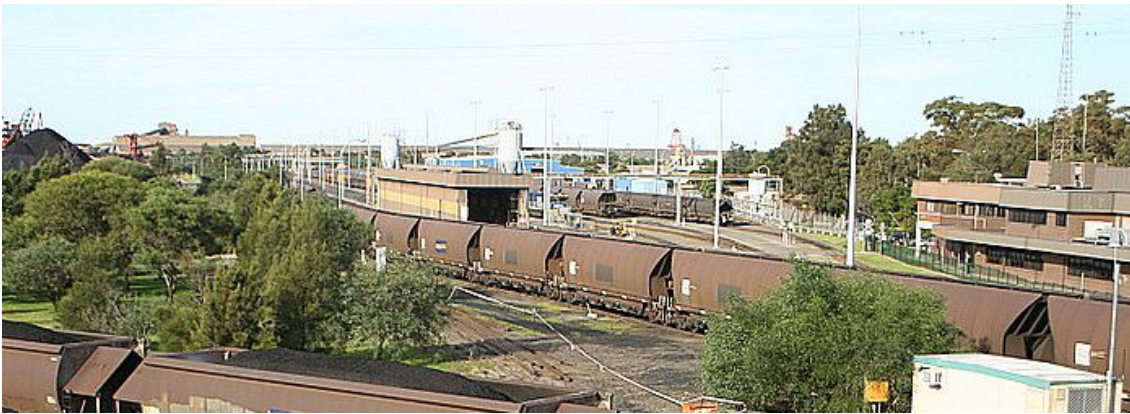
- Provides economies of scale by being able to accommodate all activities at a single site.
- Avoids expensive brownfields construction.

ARTC has been promoting a move to a remote location for some years. After extensive discussions with rail operators it became apparent that the objectives would be best met by ARTC taking the lead in the development of a single multi-user facility. ARTC is now pursuing this path and has selected a preferred site at Rutherford (immediately to the north of Maitland). This facility would be a multi-user facility offering fuelling, sanding, shunting and some stabling, with the option for a small maintenance centre co-located on the site.

Proposal

It is provisionally proposed that two holding / arrival tracks be constructed by 2012. Depending on the final design of further terminal enhancements, up to two further tracks may be desirable at a later stage. However, scope and timing will be heavily influenced by tactical considerations around site options and construction efficiency.

ARTC proposes that all fuelling and provisioning be relocated out of the terminal areas as soon as possible. Given that rail operator initiatives in this area have failed to gain momentum to date, ARTC is now proceeding with establishing a multi-user facility itself. Investigations to date have identified that construction of a facility at Rutherford, immediately to the north of Maitland, is the preferred solution. ARTC will be considering a range of commercial structures for this project and might not directly fund all or part of the project itself.



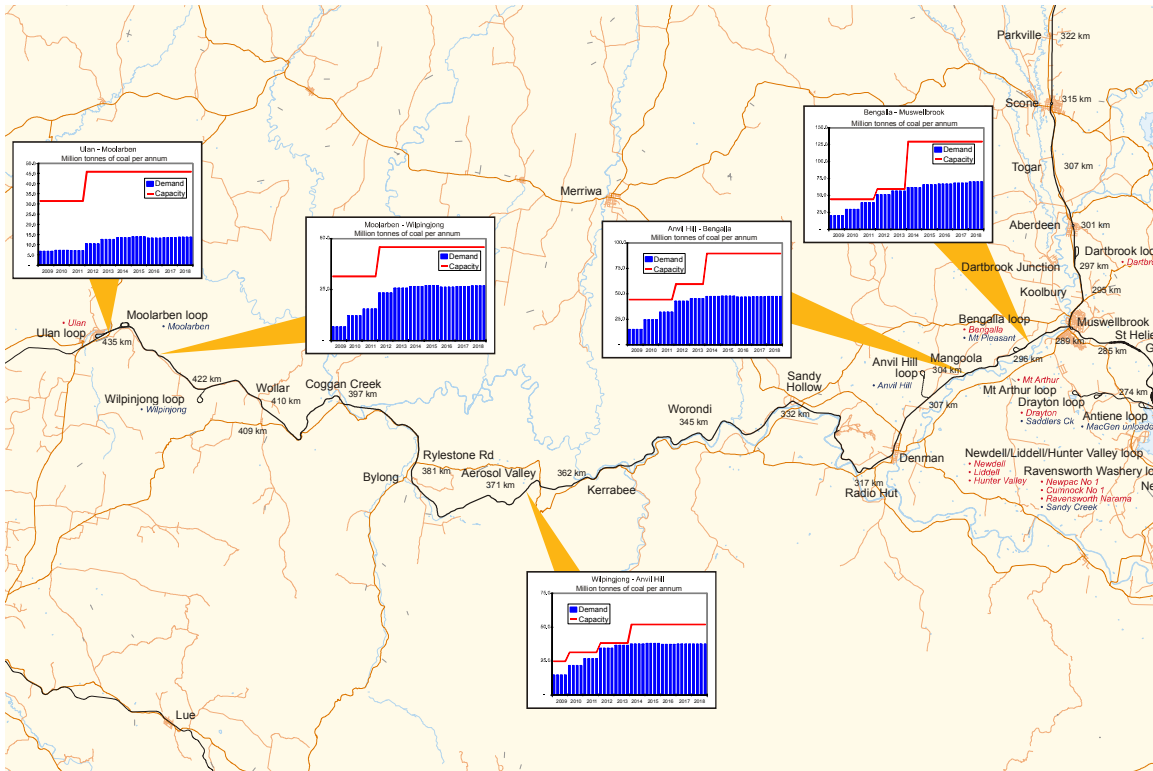


Figure 19 - Demand and theoretical capacity: Ulan Line.

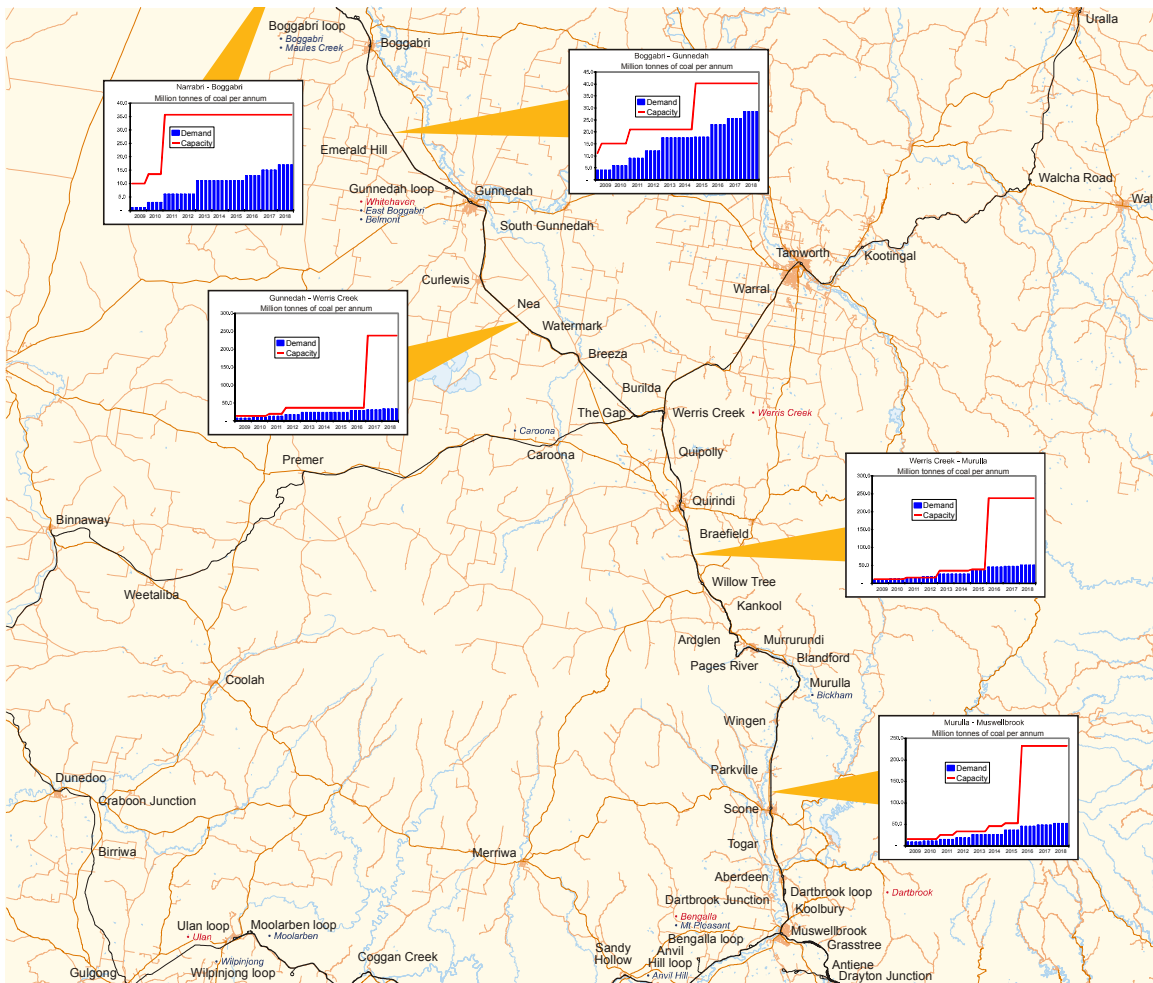


Figure 20 - Demand and theoretical capacity: Muswellbrook to Ports.

as Radio Hut loop has been brought slightly forward.

Performance under this Strategy is generally either stable or improving.

A project by project analysis has also been done to validate the benefit of delivering a project at the recommended time. This has been done by running a simulation without each project in turn, and comparing the result to the base case including the project. The output should show a material increase in delay for each project. Figure 24 shows the results of this analysis.

In a number of cases this analysis does not show such an increase in delay. These projects, and the reasons for nonetheless recommending them, are:

- Maitland – Branxton bi-directional signalling: The simulation modelling does not capture the commercial benefit of being able to sustain a flow of trains to the coal terminals.
- Gunnedah basin line loop projects in 2011 and 2012: The Strategy aims to only proceed with the high-cost New Liverpool Ranges Alignment project when all the capacity from loop projects has been exhausted. This is facilitated by an extensive program of loop extensions. Deleting any one of the projects, as is done in this exercise, results in the simulation having very poor resolution rates, which leads to aberrant results.

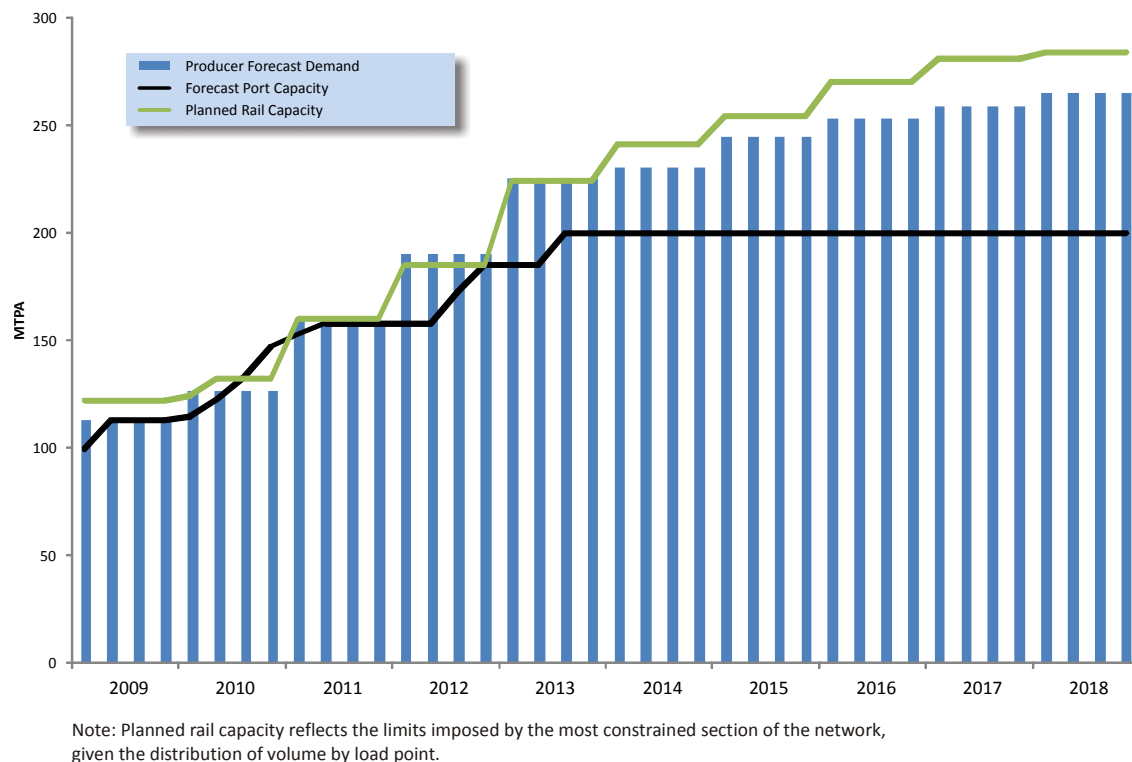


Figure 21 - Rail capacity compared to producer forecasts and port capacity.

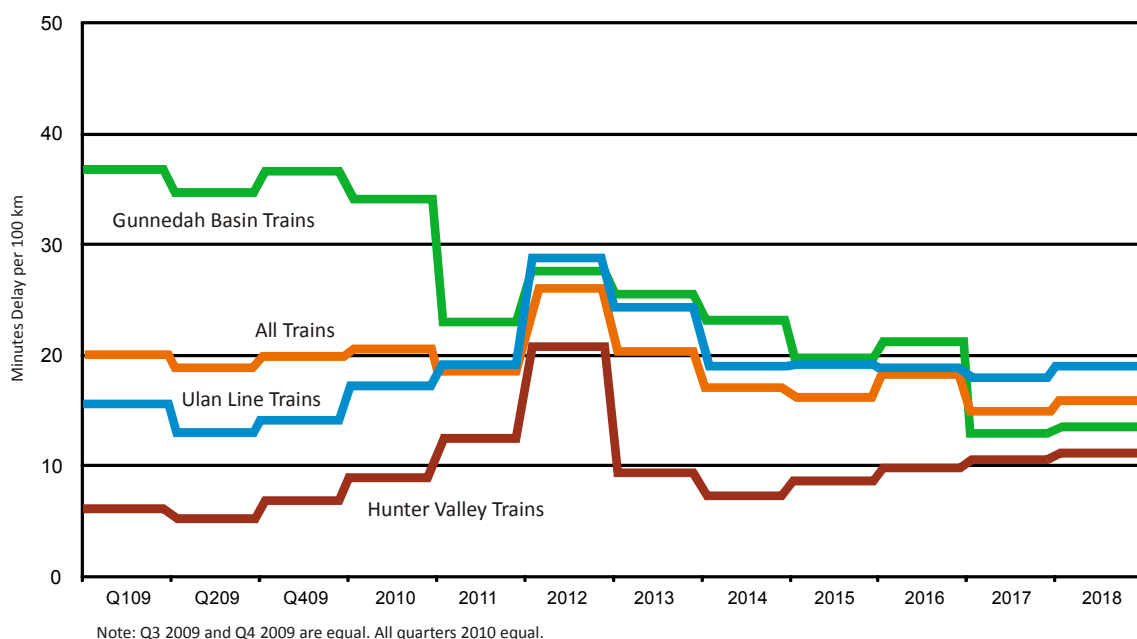


Figure 22 - Performance of the Hunter Valley Network, 2008 Trains, Infrastructure as per the 2009-2018 Strategy.

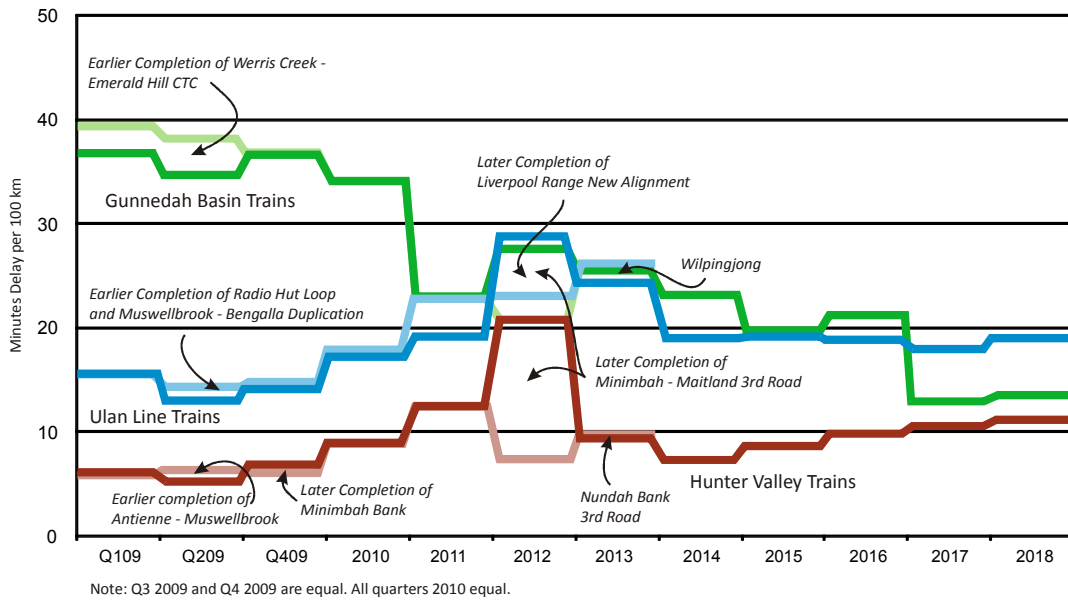


Figure 23 - 2007 infrastructure – 2008 infrastructure performance differentials.

Increase in delay due to exclusion of projects

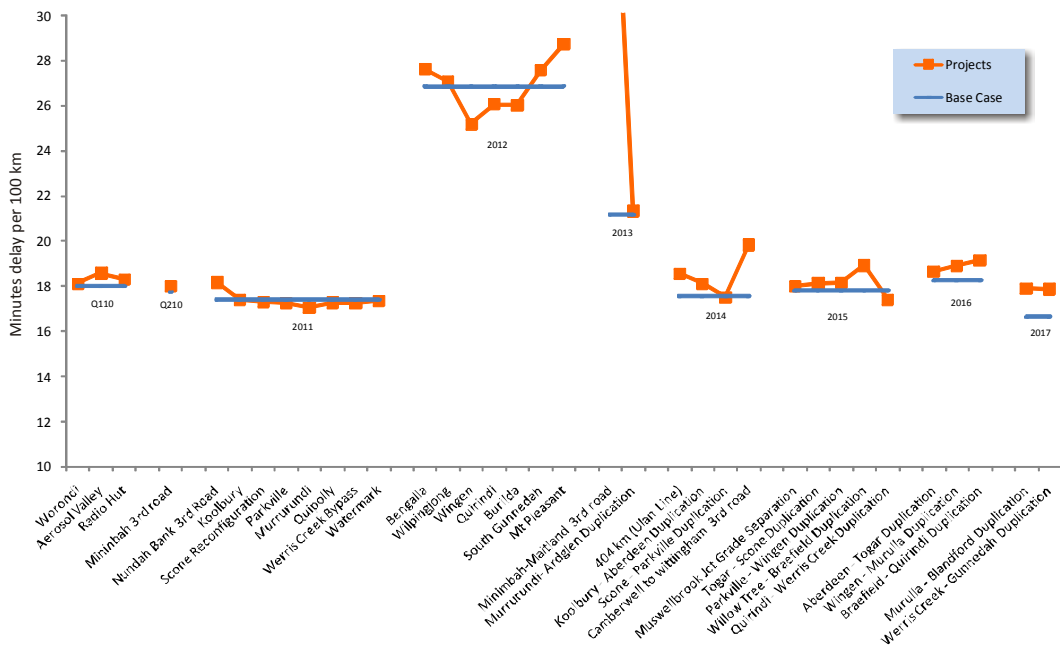


Figure 24 - Increase in Delay Due to Exclusion of Projects.



An empty coal crossing a loaded grain train at Ardglenn.

Overview of the recommended projects

Table 4 (overleaf) provides a summary of projects by availability date.

Figure 25 provides a summary of the design and construction timeframes for the proposed major projects. Timeframes for the projects to be delivered early in the Strategy are based on properly developed project plans, while later projects are an approximation based on recent experience.

Table 3 (opposite) shows current project cost estimates. The level of detail in these budget estimates varies, with the earlier timed projects developed to a higher level of accuracy. These project cost estimates should be interpreted in the context of the comments in Section 1 under the heading "Project Costs".

The projects set out in this Strategy amount to \$1,414 million over the next five years on the ARTC network. Projects recommended for the RIC controlled network between Werris Creek and Narrabri amount to \$58 million. Accordingly, total investment on capital enhancements amounts to \$1,472 million.

The second five years of the Strategy envisages an additional \$605 million being spent on the ARTC network and \$222 million on the RIC network for total expenditure of \$827 million.

Total expenditure over 10 years is \$2,299 million.

In comparison to the 2007 – 2012 Strategy, cost estimates for proposed projects have increased by \$151.9m (or 18%), reflecting a better understanding of scope and market costs as projects have been better defined, as well as general inflation.

The capital investment proposed by ARTC is large and continuing to grow. However, as in previous Strategies these investments will be made in the context of - and within timeframes that match - a large growth in the volumes of coal to be transported. They will also be subject to close consultation with the coal industry to validate their benefits as they move forward. These projects, as with all projects, will only proceed if they receive the support of the industry.

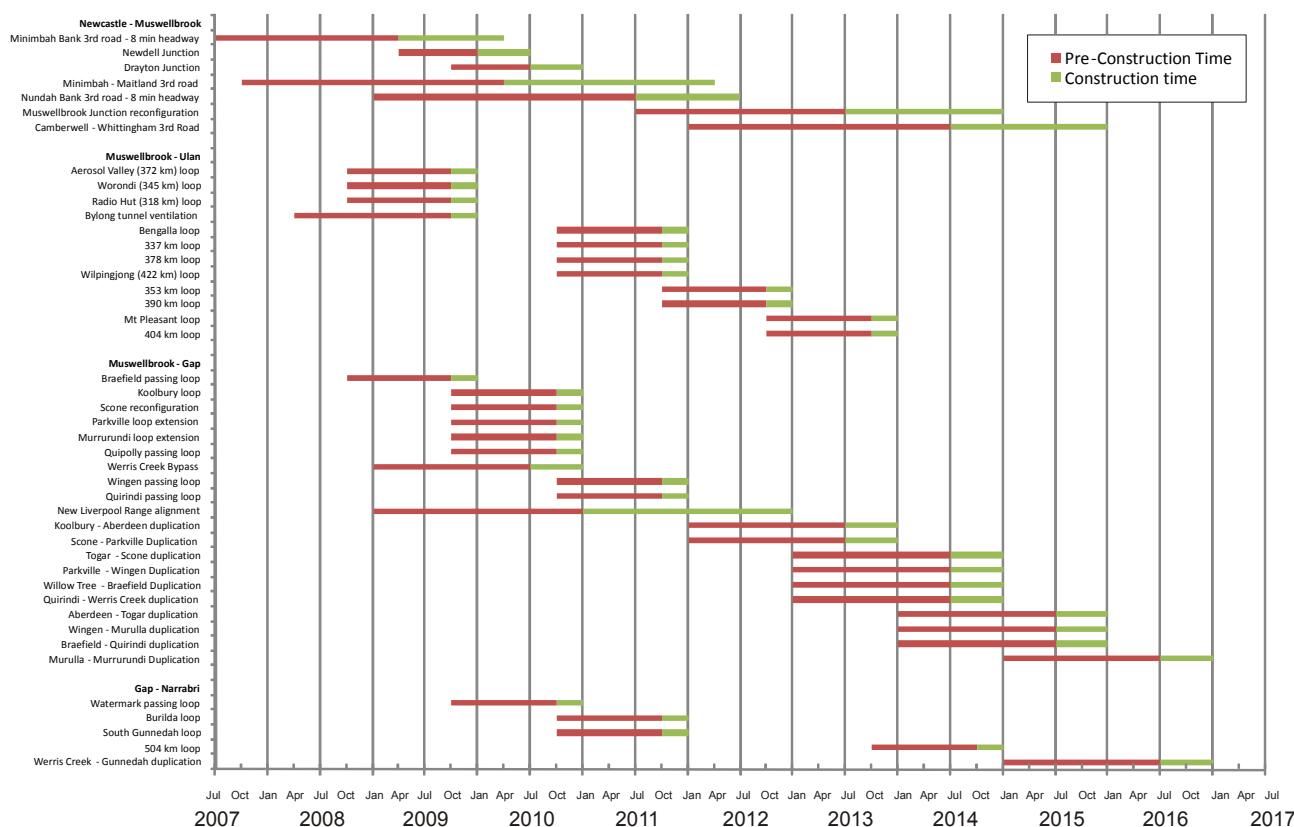


Figure 25 - Indicative work program for the projects recommended in this Strategy.

\$ 2008 m - (indicative costs)	2009	2010	2011	2012	2013
Newcastle - Muswellbrook					
St Heliers - Muswellbrook duplication	27	-	-	-	-
Bidirectional signalling Maitland to Branxton	40	-	-	-	-
Newdell Junction Upgrade	-	12	-	-	-
Drayton Junction upgrade	-	12	-	-	-
Minimbah Bank 3rd road - 8 min headway	-	120	-	-	-
Minimbah - Maitland 3rd road	-	-	300	-	-
Provisioning Centre *	-	-	125	-	-
2 Export Terminal Arrival Tracks	-	-	50	-	-
Nundah Bank 3rd road - 8 min headway	-	-	-	125	-
Muswellbrook - Ulan					
Aerosol Valley (372 km) loop	10	-	-	-	-
Worondi (345 km) loop	10	-	-	-	-
Radio Hut (318 km) loop	10	-	-	-	-
Bylong Tunnel Ventilation	10	-	-	-	-
Bengalla loop	-	-	10	-	-
Wilpingjong (422 km) loop	-	-	10	-	-
337 km loop	-	-	10	-	-
378 km loop	-	-	10	-	-
390 km loop	-	-	-	10	-
353 km loop	-	-	-	10	-
404 km loop	-	-	-	-	10
Mt Pleasant loop	-	-	-	-	10
Muswellbrook - Gap					
Braefield loop	12	-	-	-	-
Quipolly loop	-	8	-	-	-
Parkville loop extension	-	8	-	-	-
Murrurundi loop extension	-	8	-	-	-
Scone reconfiguration	-	2	-	-	-
Koolbury loop	-	10	-	-	-
Werris Creek Bypass	-	15	-	-	-
Quirindi loop extension	-	-	10	-	-
Wingen loop	-	-	10	-	-
New Liverpool Range alignment / duplication *	-	-	-	300	-
Scone - Parkville Duplication	-	-	-	-	40
Koolbury - Aberdeen duplication	-	-	-	-	60
Gap - Narrabri (RIC)					
Boggabri loop extension	10	-	-	-	-
Emerald Hill - Narrabri CTC	15	-	-	-	-
Watermark loop	-	11	-	-	-
Burilda loop	-	-	11	-	-
South Gunnedah loop	-	-	11	-	-
Subtotal ARTC	119	195	660	320	120
Subtotal RIC	25	11	22	0	0
Total	144	206	682	320	120

* ARTC may adopt commercial models for these projects that mean that ARTC does not directly fund all or part of the project.

Note: All the above projects (including scope, timing, and funding arrangements) are subject to consultation with and endorsement by the industry.

Note: Dollar estimates are based on current known: Scope; Survey and geotechnical knowledge; legislation and tax regimes. Project dollars are order of magnitude estimates only and do not represent concluded project dollars.

Note: Amounts are shown in the year preceding the year in which the project will be available on the basis that this is the year in which the majority of investment will occur.

Note: Costs to introduce 30 tonne axle loads to the Gunnedah Basin have not been included in this scope. This issue is discussed in detail in Section 8.

Table 3 - Proposed investment program expenditure by year in which construction completed.

Q1 2010	Q2 2010	Q3 2010	Q4 2010	2011	2012	2013	2014	2015	2016	2017
Braefield loop	Minimbah Bank 3rd road - 8 min headway	Newdell Junction Upgrade		Koolbury loop	Minimbah - Maitland 3rd road	Nundah Bank 3rd road - 8 min headway	404 km loop (Ulan Line)	Muswellbrook Jct Reconfiguration	Aberdeen - Togar Duplication	Murulla - Murrundi Duplication
Worondi-Baerami (345 km) loop				Scone Reconfiguration	Wingen loop	New Liverpool Range Alignment/ Duplication	Mt Pleasant Loop	Togar - Scone Duplication	Wingen - Murulla Duplication	Werris Creek - Gunnedah Duplication
Aerosol Valley-Murrumbidgee (372 km) loop				Parkville loop extension	Quirindi loop extension	353 km loop (Ulan Line)	Koolbury - Aberdeen duplication	Parkville - Wingen Duplication	Braefield - Quirindi Duplication	
Radio Hut-Yarrawa (318 km) loop				Murrumbidgee loop extension	Burilida loop	390 km loop (Ulan Line)	Scone - Parkville Duplication	Willow Tree - Braefield Duplication	Camberwell to Wittingham 3rd road	
				Quipolly loop	South Gunnedah loop			Quirindi - Werris Creek Duplication		
				Werris Creek Bypass	Bengalla Loop			504 km loop (Gunnedah line)		
				Watermark loop	337 km loop (Ulan Line)					
				Drayton Junction upgrade	378 km loop (Ulan Line)					
					Wilpingong (422 km) loop					
					2 Export Terminal Arrival Tracks					
					Multi-use Provisioning Centre					

Table 4 - Proposed investment program by quarter/year each project is proposed to be available.



Appendix 1 - Modelling Methodology

The development of this Hunter Valley Corridor 2009-2018 Capacity Strategy largely retains the methodology of the 2007 – 2012 Strategy.

Coal capacity is analysed using a set of principles for the practical utilisation of track. ARTC then validates the results of the theoretical calculations using a network modelling package which simulates the interactions of trains with the infrastructure and each other.

The calculation of practical coal capacity varies between single and double track sections.

On single track the methodology uses a simple principle that theoretical daily capacity on a given section of track is equal to the number of minutes in the day divided by the section running time of the longest section, plus an allowance for safeworking / signal clearance.

This theoretical calculation implies continuous occupation of the longest section, which is unworkable in practice. Accordingly, the theoretical capacity needs to be adjusted to practical capacity using a factor. An adjustment rate of 65% has been adopted for this analysis. That is, it is realistic to expect a section of track to carry 65% of its maximum theoretical capacity.

The theoretical calculation is complicated where a line section has a mix of loop lengths as the longest section then varies depending on the length of any given combination of trains. The methodology used in this Strategy makes an allowance for this by calculating capacity at a series of train length thresholds and allowing short trains to take advantage of the capacity available with short loops before consuming the capacity of the longer loops.

The box below shows a worked example of the calculation of capacity on a single track section:

Worked example of theoretical single track capacity based on Wilpington - Mangoola Q1 2009

a	Highest nominal average loop-to-loop headway (minutes)	36.8	
b	Minutes per day	1,440	
c	Absolute paths per day	39.1	$c = b / a$
d	Single direction paths per day	19.6	$d = c / 2$
e	Practical single track path utilisation factor	65%	
f	Practical single direction paths per day	12.7	$f = d \times e$
g	Non-coal trains per day	0.5	
h	Practical single direction coal paths per day	12.2	$h = f - g$
i	Maintenance path loss	12%	
j	Nominal average coal paths per day	10.8	
k	Surge capacity	15%	
l	Cancellations against planned paths	9%	
m	Average coal paths as percentage of peak planned paths	76%	$m = 1 - k - l$
n	Average coal paths	8.2	$n = j \times m$
o	Average train net weight (at Wilpington)	8,014	Assumes 95% effective loading
p	Theoretical coal capacity (mtpa)	23.9	$p = n \times o \times 365$

To calculate the capacity available for coal traffic, existing 'background' general freight and passenger services are deducted. The remaining capacity is then adjusted down by 9% for cancellations and 15% to allow for volume surges.

In the previous strategies no specific allowance was made for maintenance possessions on single track. In this Strategy track capacity has been adjusted downwards by 12% to reflect maintenance downtime.

On double track a similar methodology applies. Theoretical capacity is determined as the number of minutes in the day divided by the maximum signal clearance time for the relevant section. This is adjusted down from a theoretical capacity to a practical coal capacity by discounting the available paths by 50%. This 50% nominally covers background general freight and passenger trains, cancellations, surge capacity and maintenance possessions³. An adjustment to allow for junction conflicts is also made.

The box below shows a worked example of the calculation of the capacity on a double track section:

Worked example of theoretical double track capacity based on Camberwell Jct - Whittingham Jct 2011

a	Nominal average following headway (minutes)	8	
b	Minutes per day	1440	
c	Absolute paths per day	180.0	$c = b / a$
d	Maintenance path loss	12%	weekly average
e	Coal paths consumed by non-coal trains	22%	40 paths - allows loss of approximately 6 paths per passenger train
f	Percent capacity available for coal paths	66%	$f = 1 - d - e$
g	Nominal average coal paths per day	118.4	$g = c \times f$
h	Paths lost to conflicts at Mt Owen and Camberwell Junctions	2.4%	
i	Surge capacity	15%	
j	Cancellations against planned paths	9%	
k	Planned peak coal path requirement as percentage of nominal average per day	76%	$K = 1 - h - i - j$
l	peak coal paths planned	87.8	$L = g \times k$
m	Average train net weight (at Camberwell Jct)	7,640	Assumes 95% effective loading
n	Theoretical coal capacity (mtpa)	244.9	$n = l \times m$

The theoretical capacity is then tested using simulation software. This works by randomly generating timetables for a given scenario of infrastructure and trains. Basic

3. The effect on available paths is calculated as a 12% reduction for maintenance plus a 22% reduction for non-coal traffic to give a nominal average coal path capacity. This is then further reduced by 9% for cancellations plus 15% for surge capacity.

infrastructure is entered into the model at the level of track configuration and safeworking delay. Trains are entered by specifying departure time, length and section running time. The model generates timetables by making random decisions when there is competition between two trains for a single piece of infrastructure, such as when a cross occurs, or a train seeks to enter the network from a loading point close to a through train. It produces a user specified number of timetables.

The box below shows a worked example of the calculation of path numbers for simulation modelling.

Worked example of train numbers for simulation modelling based on anonymous producer Q1 2009

a	Producer demand (mtpa)	4.0	
b	Average train net weight	7,716	Assumes 95% effective loading
c	Average path demand per day	1.4	$c = a / b$
d	Surge capacity	15%	
e	Additional surge paths required	0.2	$e = c \times d$
f	Peak paths run	1.6	$f = c + e$
g	Cancellations	9%	
h	Paths cancelled	0.2	$h = g \times i$
i	Planned peak path demand	1.8	$i = f / (1 - g)$

The key purpose of this approach to modelling is to allow scenarios to be analysed in a manner that is statistically robust. That is, for a given infrastructure scenario and train plan it will generate statistically valid measures of performance which can then be used to make considered judgements on the relative merits of different projects and predict network performance over time. The output data can also be analysed to identify the location of bottlenecks to speed the process of targeting investments.

For the purposes of developing this Strategy, the capacity modelling and simulation modelling have been used interactively and iteratively. Options to ease the capacity constraints identified in the capacity modelling have been validated though simulation. The nature and timing of projects have also then been adjusted based on their effect on delay.

This approach has a number of important implications.

First, it means that the analysis of capacity has regard to both capacity of a section in isolation, and its capacity in an integrated network. The fact that the simulation generates resolved timetables means that the combination of volume and infrastructure at a point in time is compatible and that there is sufficient capacity for the network as a whole to be able to operate. This provides a more holistic view of the network and ensures that the benefit of each of the individual projects results in a capacity increase that is harmonious with the rest of the network.

Second, it creates the opportunity to focus on transit time as a key factor in network performance. To some extent, capacity and transit time are substitutes. That is, an increase in volume can be accommodated on a given infrastructure, but only by accepting an increase in transit time. Alternatively, by bringing forward capacity enhancement projects, it is possible to reduce transit time.

Third, it also considers the robustness of the operation. While it may be technically possible to create a timetable that delivers a target level of capacity, there is a risk that, when applied in the real world, unplanned events propagate in such a way that performance falls below acceptable levels. The simulation modelling aims to demonstrate that there is a sufficient number of timetable solutions that it is possible to have some confidence in the robustness of the scenarios.

