ARTC

AUSTRALIAN RAIL TRACK CORPORATION LTD

Hunter Valley Corridor 2012-2021 Capacity Strategy Consultation Document

April 2012

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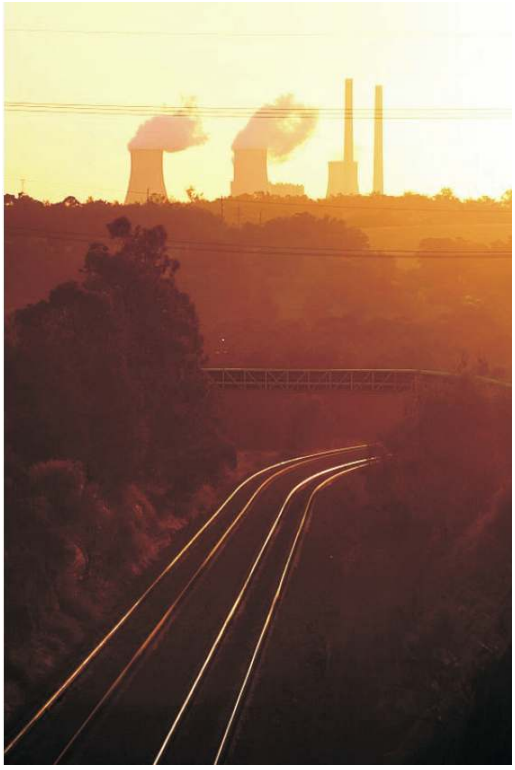

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Introduction

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.

ARTC had previously controlled the interstate rail network within the area bounded by Albury on the NSW/ Victoria border, Kalgoorlie in Western Australia and Broken Hill in western NSW. The commencement of the NSW lease consolidated control of most of the interstate rail network under ARTC.

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 2012 - 2021 Capacity Strategy is the sixth of these annual strategies. It updates the 2011 - 2020 Hunter Valley Corridor Capacity Strategy.

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 provide sufficient capacity to meet contracted volumes based on the principles of the ARTC Hunter Valley Access Undertaking, while also having regard to and identifying those projects that would be desirable to accommodate prospective volumes that have not yet been the subject of a contractual commitment. In particular, this Strategy identifies a preliminary scope of work to accommodate prospective volumes for 2016 and beyond that would use the proposed Terminal 4 (T4) on Kooragang Island.

As noted in the 2011 Strategy, the projects required to accommodate growth are becoming increasingly complex as the simple locations for new loops on the single track sections are largely exhausted and projects on the double-track sections frequently encounter corridor width issues. At the same time, the environmental and planning approvals process has become more challenging and is tending to prolong the development stage of projects. ARTC has increasingly refined its project development and delivery process, but timely project delivery remains a significant challenge.

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

In determining capacity ARTC makes certain assumptions which are generally covered in this Strategy. The delivery of throughput to align to capacity can be impacted by a range of performance issues across the supply chain. While some of these performance issues are covered in this document, it is not the key purpose of the Strategy.

Volume Forecasts

The move to the new Hunter Valley contractual arrangements within the framework of the Hunter Valley Access Undertaking is now essentially complete and this has provided greater certainty over volume forecasts than in previous years.

Contracted volumes are for export coal demand from the Hunter Valley of about 151 mtpa in 2012. Volumes that

1. Note total train numbers in figure 3 are 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.
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.

are contracted, or for which producers have indicated a willingness to contract, increase to around 180 mtpa in 2013, 201 mtpa in 2014, 213 mtpa in 2015 and 235 mtpa in 2016. These volumes continue to increase over the following three years before stabilising at 239 mtpa. Volume beyond 2014 is significantly above planned terminal capacity in the absence of T4.

In addition, ARTC, in consultation with the Hunter Valley Coal Chain Coordinator (HVCCC) has identified new and existing mines that producers have plans to develop in the

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

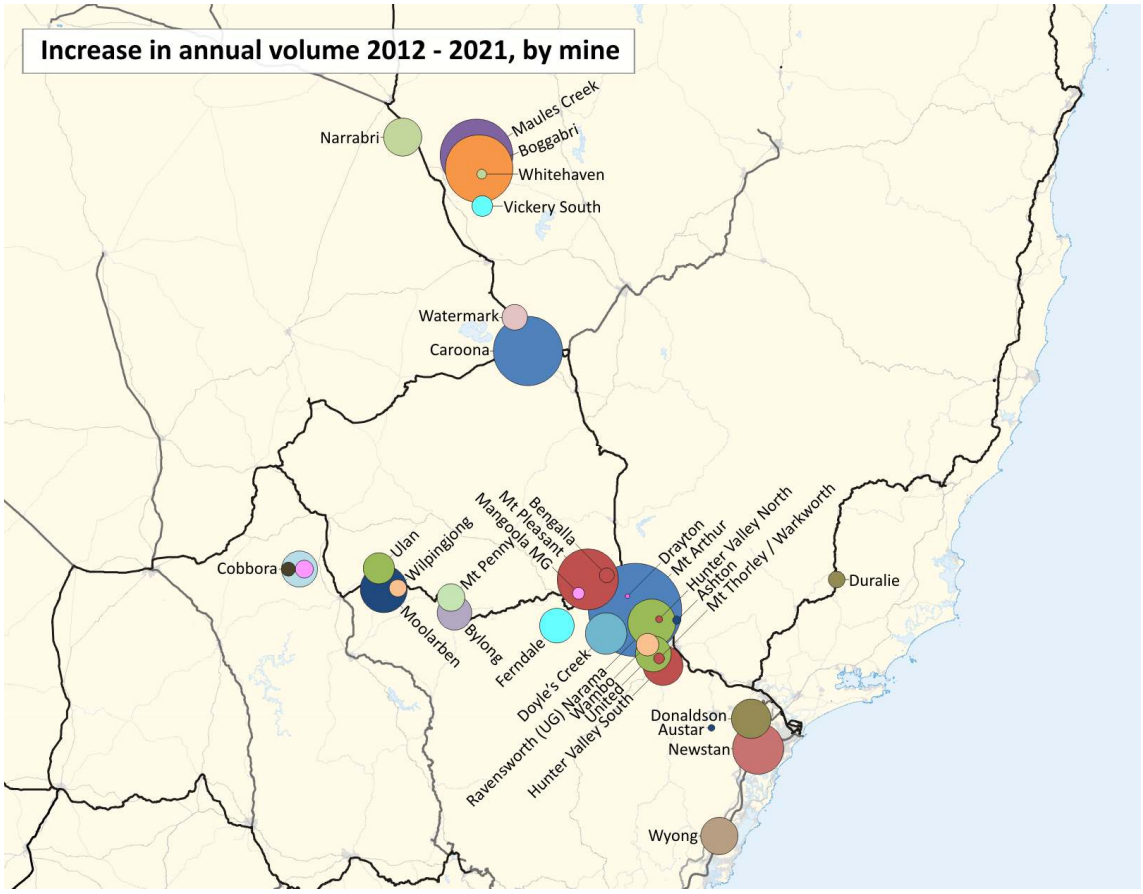

Figure 2 - Volume forecasts by mine, contracted plus prospective. Note that growth is represented by circle width, not by area.

medium term. These projects have not proceeded to a stage where producers would want to commit to take-or-pay contracts. This prospective volume has been estimated at around 14 mtpa in 2015, 29 mtpa in 2016, 37 mtpa in 2017, 53 mtpa in 2018 and then stabilising at 55 mtpa from 2019.

As in previous years, volume forecasts are lower in the short-term than in the previous Strategy. Specifically, contracted 2012 volume is down by 11 million tonnes, while 2013 volume is reduced by 10 million tonnes and 2014 by 7 million tonnes. However, total volumes, contracted and prospective, are significantly higher than in previous Strategies.

Traffic Patterns

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

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

Domestic coal is also transported over the same network. This sector is growing rapidly, especially on the Ulan and Upper Hunter lines. The largest volume is for Macquarie Generation at Antiene, which is receiving growing volumes of coal originating from mines on the Ulan line.

Export coal also arrives at the terminal 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, outside of the Terminal location, and accordingly this strategy does not specifically discuss the network between the Terminals and Sydney.

The Hunter Valley coal network consists of a dedicated double track 'coal line' between Port Waratah and Maitland, a shared double track line (with increasingly significant stretches of third track) 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 producing high

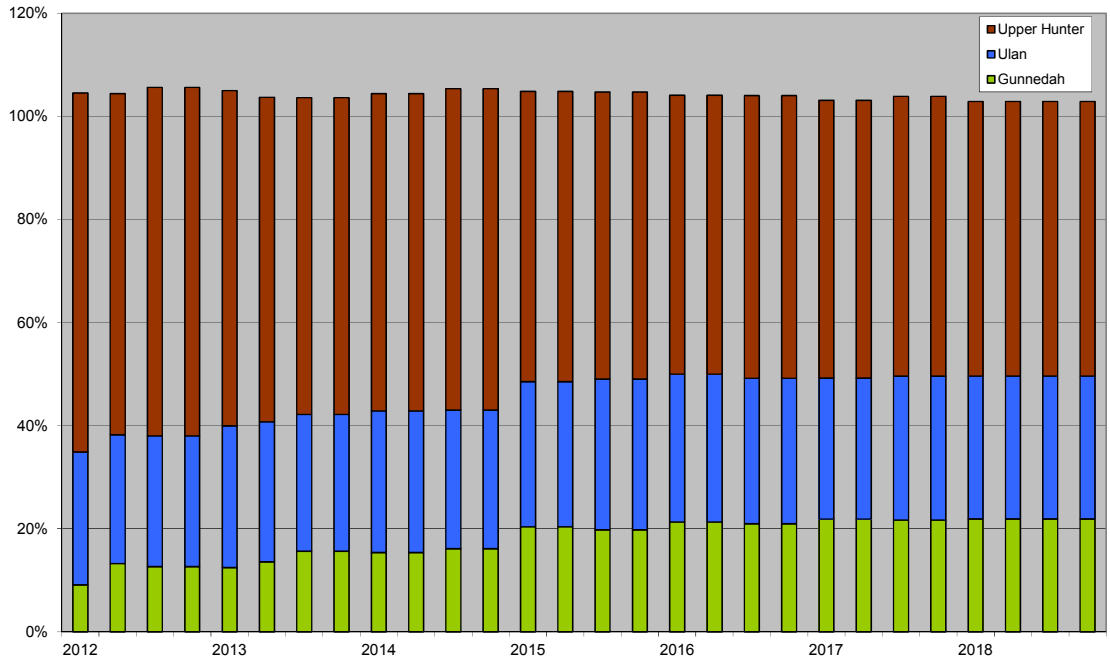

Figure 3 - Percentage of Trains by Sub-Network by Year, including prospective volume.

rates of growth in percentage terms (Figure 2 and Figure 3[1]), necessitating a strong focus in this Strategy on the single track sections of the network.

Operations

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).

Weighted average coal capacity per train averaged 6,932[2] net tonnes in 2011. This compares to a figure of approximately 6,996 tonnes at the time of the 2011-2020 Strategy. At the 2012 Hunter Valley system capacity declared by the HVCCC, an average of around 57 loaded trains need to be operated each day, or one train every 25 minutes.

Train lengths vary from around 1,250 metres to 1,565 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. Because most of the coal trains are '120 tonne wagon' trains, the coal network tends to be limited to a maximum speed of 60 km/h in the loaded direction and 80 km/h in the empty direction.

There are now four above-rail operators in the Hunter Valley coal business: Pacific National (PN); QR National (QRN); X-Rail and; Southern Shorthaul (SSR).

How this Strategy has been developed

The development of this Hunter Valley Corridor 2012-2021 Capacity Strategy largely retains the methodology of the 2011-20 Strategy.

With the commencement of the ARTC Hunter Valley Access Undertaking, ARTC now has a number of additional obligations that need to be addressed through the Strategy development process. These mainly relate to consultation processes. Specifically:

- The Rail Coordination Group (RCG), which is the official approval body representing miners under the Undertaking, formally signs off on the volume assumptions used for the development of the Strategy.
- Formal consultation is required with PWCS and NCIG on the terminal capacity assumptions.
- The Strategy needs to be released both as an initial consultation document and as a final version, having regard to stakeholder feedback.

In common with the previous Strategies, coal capacity is analysed using a set of principles for the practical utilisation of track. Capacity is calculated using headways. On single track this is then adjusted to reflect practical rather than theoretical capacity using an adjustment factor of 65%. On double-track, the headways are calculated on the basis of a 'double-green' principle. Under this principle both the next signal and the one after are at green, meaning that the driver will never see a yellow signal. This ensures that drivers should always be able to drive at full line speed.

On single track there is also a transaction time applied to recognise the time incurred by trains executing a cross, specifically signal clearance time, driver reaction time, acceleration and delays to the through train when it approaches the loop before the train taking the loop has fully cleared the mainline. In past strategies this has been set at five minutes. Simultaneous entry loops and passing lanes reduce this transaction time by reducing both the probability and time delay from both trains arriving at the loop at around the same time. As the Strategy envisages a significant increase in the proportion of these types of loops, the opportunity has been taken to adjust the transaction times to recognise the reduced delay they achieve. This Strategy has adopted a transaction time of 4 minutes where a simultaneous entry loop is involved and 3 minutes where a passing lane is involved.

After removing capacity lost to background (ie non-coal) trains, saleable paths are calculated as a percentage of practical coal paths. This adjustment covers maintenance, cancellations and a buffer. In recent years this adjustment factor has been 75%.

With the approval of the Hunter Valley Access Undertaking, the buffer has been formalised in the form of the Target Monthly Tolerance Cap (TMTC). The TMTC has now been determined through the RCG as shown in Table 1.

The consequent calculation of the adjustment factor, based on cancellation and maintenance loss assumptions for 2012, is shown in Table 2. Note that the adjustments are cumulative (that is, sequentially multiplied) rather than additive.

To the extent that cancellation or maintenance loss assumptions change in future years it will flow through to the required adjustment factor.

For the purposes of this Strategy, an adjustment factor of 71.1% has been used from 2015. This has had the effect of bringing some projects forward and increasing the total scope of work.

Terminal Capacity

Critical to the volume forecasts is Terminal capacity.

Since the 2011-20 Capacity Strategy the way forward with terminal capacity has become clearer. The expansions anticipated by that Strategy have all now been committed, with the exception of T4. The T4 Statement of Environmental Effects has, however, been submitted to the NSW Department of Planning and gone on public display.

ARTC's expectation of approximate terminal capacity is as follows.

- As at Q1 2012 – overall capacity is 160 mtpa.
- Q4 2012 – KCT Stage 4 (PWCS 4th dump station) expansion results in a capacity increase of 15 mtpa, resulting in an overall capacity of 175 mtpa.
- Q1 2013 – NCIG Stage 2AA is expected to be complete, raising capacity to 195 mtpa.
- Q1 2014 – NCIG Stage 2F is expected to be complete, increasing capacity to 208 mtpa.
- Q1 2016 – PWCS T4 first coal, with progressive ramp up to 70 mtpa, giving total capacity of 278 mtpa.

Although ARTC understands that volumes may be transported through T4 in 2015, ARTC's principal contractual nominations associated with T4 are for a commencement date in 2016 and beyond.

The first stage of T4 would be two dump stations. There is the potential to add a further two dump stations if required, which would add 25 mtpa each, giving a total potential Newcastle terminal capacity of 328 mtpa.

Contractual volumes require at least the first dump station to be completed, but given the strong prospective demand, it is understood that PWCS is proceeding on the basis that the first two dump stations will be constructed as

Year	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pricing Zone 1	≈6.3%	≈6.5%	≈6.5%	10%	10%	10%	10%	10%	10%	10%
Pricing Zone 2	≈6.5%	≈6.5%	≈6.5%	10%	10%	10%	10%	10%	10%	10%
Pricing Zone 3	≈5.5%	≈5.5%	≈5.5%	10%	10%	10%	10%	10%	10%	10%

Table 1 - Target Monthly Tolerance Cap

Cancellations	13.60%	13.60%	13.60%
Maintenance	12.60%	12.60%	12.60%
TMTC	5.50%	6.50%	10.00%
Adjustment Factor	**74.10%**	**73.40%**	**71.10%**

Table 2 - Adjustment Factor

a single stage. It has been assumed that it will take two years to ramp up to the full nameplate volume of 70 mtpa. Prospective volume identified by ARTC / HVCCC indicates that there may also be demand for the third dump station (T4 stage 2) from 2018.

Strategies prior to the 2011-20 version needed to address mismatches between producer forecasts and forecast terminal volume. With the move to the new contractual relationships in the Hunter Valley this problem has been largely eliminated. The Strategy now plans to deliver capacity for contracted rail volumes on the basis that these volumes have matching terminal capacity. Projects required to accommodate prospective volumes, which are not the subject of a track and terminal nomination, are separately identified.

One complicating factor, however, is the ability of producers to trade terminal allocations. In the event that a producer trades terminal capacity with another producer for volumes originating further from the terminal, or on a different branch, ARTC may not be able to provide sufficient track capacity for the volume from its new origin.

Notwithstanding this complication, contractual volumes are now relatively closely aligned to terminal capacity until Q1 2016. Beyond Q1 2016 there is a slight mismatch that will be clarified as the T4 ramp-up schedule crystalises over time.

However, there is a considerable amount of prospective demand that it would not appear possible to accommodate given the assumed T4 construction program. It needs to be noted that to the extent that ARTC can determine, this prospective demand is not associated with a current T4 nomination.

This Strategy has identified the timing of projects required for T4 volumes based on the timing aspirations of the producers. However, the 'required by' dates are obviously in advance of the true requirement and in some cases the projects could not be physically constructed in the required timeframe. As such it is inevitable that the project timeframes will be revised in future Strategies.

The relationship between contractual volumes, prospective volumes identified by ARTC / HVCCC, and terminal capacity, is shown in Figure 4.

Continuous Review

ARTC is continuously analysing and reviewing the available options to ensure that the value for money of projects is optimised. This process continues 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.

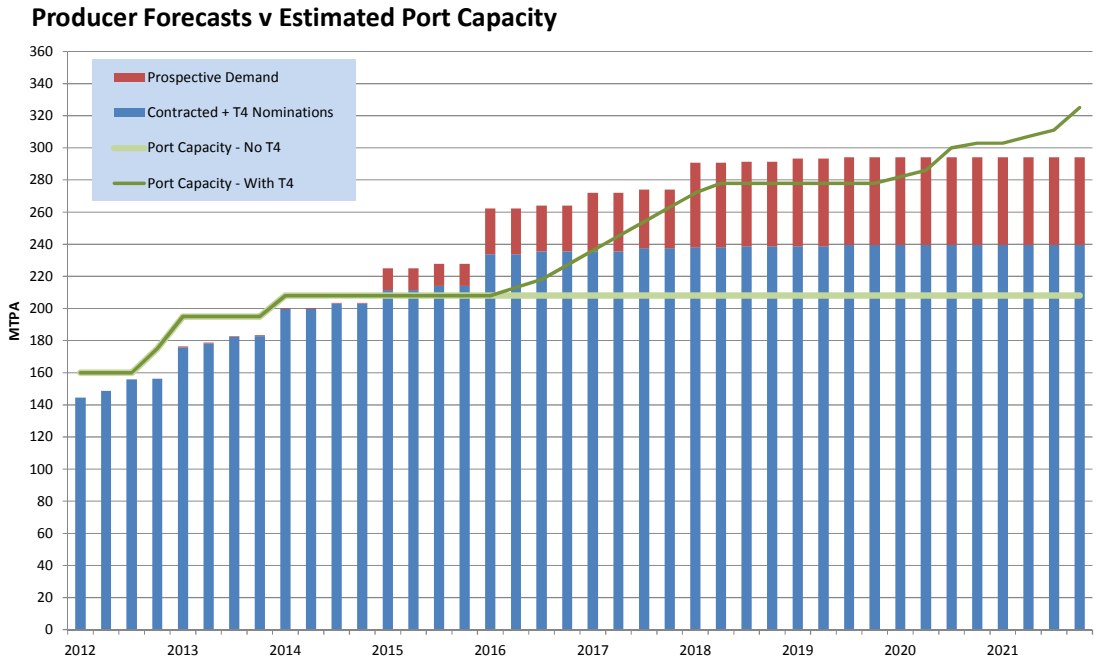

Figure 4 - Forecast volume at Newcastle Port compared to estimated port capacity (mtpa)

HVCCC Master Planning

The HVCCC is responsible for the co-ordination of coal chain planning on both a day-to-day and long term basis. It is continuously 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

'Congestion' Projects

ARTC's objective in its infrastructure strategies has been to provide track capacity ahead of demand. ARTC is in a good position to assess the track capacity required and to identify optimised solutions and timing to provide that capacity.

There are, however, a number of operational challenges that potentially constrain capacity and for which the provision of additional track is one potential mitigation. 'Congestion' has become a common term used to describe these challenges, which include resequencing, provisioning, crew changes and empty train holding. These challenges are whole-of-chain issues that ARTC is not in a good position to model and for which it looks to the HVCCC to take the lead.

It is also important to be clear that these 'congestion' issues are not issues of track capacity. Rather, they are system issues for which additional rail infrastructure is one option to enable the full capacity of the rail network to be realised. Equally, delivering improvements to network operations to ensure that utilisation of the network is optimised offers other potential solutions.

While this Strategy principally focuses on infrastructure upgrades, ARTC supports industry initiatives to deliver operational efficiencies. ARTC is driving or supportive of the following important initiatives within the Hunter Valley:

- The Live Run Implementation Team establishment as proposed by the Live Run Management Group Steering Committee.
- A forum with rail operators, recently initiated by ARTC, to jointly consider improvements to operational performance.
- Consideration jointly with the HVCCC of a potential train parkup strategy to provide for efficient management of excess rollingstock at lower demand periods.
- Commencement of the assessment of maintenance practices that reduce the need for track based inspections and physical maintenance interventions.
- Early commencement of the review as required under the Hunter Valley Access Undertaking to assess incentive mechanisms to minimise coal chain capacity losses.

- Development of train staging and storage initiatives during close-down possessions.

Advanced Train Management System (ATMS)

ARTC's ATMS project is currently at the end of the proof of concept stage, with field trials successfully completed on the Crystal Brook – Port Augusta section. A product safety case is expected to be completed by July 2012, following which it is expected the system will move into a field trial phase to demonstrate the functionality of the system in a live environment.

ARTC has identified that the strongest case for roll-out of the ATMS system is in the Hunter Valley, where the capabilities of the system may both allow some projects to be deferred, and reduce the construction cost of others. However, the case is largely driven by the significant scope of work required to accommodate the volumes from 2016 and beyond. To the extent that ATMS is not available for roll-out in alignment with the development of T4, it undermines the business justification.

This Strategy has identified a scope of work required for prospective volumes under a 'without ATMS' scenario. A separate Hunter Valley ATMS Business Case will outline the reduced scope of work from implementing ATMS, as well as identifying the other consequential benefits from adoption of the technology.

From an industry perspective ATMS is likely to offer significant benefit. However, there remains a delivery risk and ARTC and the industry will need to make a threshold decision on whether or not to proceed on the basis of ATMS. This decision is likely to need to be made by late 2012 .ARTC will also seek the HVCCC to undertake modelling of system capacity incorporating ATMS as a key assumption in order to understand the impact that it may have on all parts of the chain.

Other Assumptions and Qualifications

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

- Estimates of the numbers of trains required to carry the forecast coal tonnages are based on train consists nominated by producers under the contracting process. Assumed average train capacity by section by year is shown in Table 3.

- Trains are, on average, loaded to 98% of their theoretical capacity.

- It is assumed that track closures for maintenance purposes will consume the same relative proportion of capacity as at present. That is, in undertaking

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Narrabri - Boggabri	5,733	5,880	5,917	5,954	5,954	5,954	5,954	5,954	5,954	5,954	5,954
Boggabri - Gunnedah	5,628	5,809	5,859	5,923	5,924	5,924	5,924	5,924	5,924	5,924	5,924
Gunnedah - Watermark	5,762	5,823	5,855	5,922	5,923	5,923	5,923	5,923	5,923	5,923	5,923
Watermark - Caroona	5,762	5,823	5,855	5,922	5,923	5,923	5,923	5,923	5,923	5,923	5,923
Caroona - Werris Creek	5,762	5,823	5,855	5,922	5,923	5,923	5,923	5,923	5,923	5,923	5,923
Werris Creek - Scone	5,601	5,485	5,630	5,823	5,825	5,825	5,825	5,825	5,825	5,825	5,825
Scone - Dartbrook	5,601	5,485	5,630	5,823	5,825	5,825	5,825	5,825	5,825	5,825	5,825
Dartbrook - Muswellbrook	5,601	5,485	5,630	5,823	5,825	5,825	5,825	5,825	5,825	5,825	5,825
Cobbora - Ulan	-	-	-	-	-	7,693	7,693	7,693	7,693	7,693	7,693
Ulan - Moolarben	8,330	8,330	8,330	8,330	8,330	8,130	8,101	8,070	8,070	8,070	8,070
Moolarben - Wilpingjong	8,330	7,790	7,887	7,769	7,769	7,753	7,751	7,748	7,748	7,748	7,748
Wilpingjong - Bylong	7,975	7,759	7,822	7,752	7,752	7,733	7,731	7,730	7,730	7,730	7,730
Bylong - Ferndale	7,975	7,759	7,822	7,752	7,752	7,733	7,731	7,730	7,730	7,730	7,730
Ferndale - Mangoola	7,975	7,759	7,822	7,752	7,752	7,733	7,731	7,730	7,730	7,730	7,730
Mangoola - Mt Pleasant	8,070	7,864	7,906	7,853	7,864	7,826	7,822	7,818	7,818	7,818	7,818
Mt Pleasant - Bengalla	8,070	7,864	7,943	7,911	7,919	7,881	7,876	7,872	7,872	7,872	7,872
Bengalla - Muswellbrook	8,093	7,921	7,983	7,950	7,958	7,921	7,916	7,911	7,911	7,911	7,911
Muswellbrook - Antiene	7,333	7,286	7,288	7,197	7,207	7,226	7,232	7,240	7,240	7,240	7,240
Antiene - Drayton	7,333	7,286	7,288	7,197	7,207	7,226	7,232	7,240	7,240	7,240	7,240
Drayton - Newdell	7,457	7,387	7,354	7,255	7,247	7,094	7,100	7,107	7,107	7,106	7,106
Newdell - Mt Owen	7,407	7,375	7,374	7,285	7,276	7,153	7,157	7,161	7,160	7,160	7,160
Mt Owen - Camberwell	7,499	7,454	7,436	7,344	7,334	7,215	7,217	7,219	7,219	7,218	7,218
Camberwell - Whittingham	7,481	7,441	7,427	7,340	7,330	7,216	7,218	7,220	7,219	7,219	7,219
Whittingham - Maitland	7,589	7,547	7,517	7,455	7,448	7,346	7,345	7,345	7,344	7,343	7,343
Maitland - Bloomfield	7,236	7,253	7,283	7,189	7,258	7,159	7,161	7,164	7,164	7,163	7,163
Bloomfield - Sandgate	7,256	7,275	7,301	7,216	7,283	7,186	7,187	7,190	7,189	7,189	7,189

Table 3 - Assumed Average Train Capacity under Contracted Volumes (tonnes)

capacity assessments it is assumed that a number of paths are required for maintenance which will increase as overall capacity increases this.

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

- Infrastructure is treated as being available for a quarter if it is projected to be available by the end of the first month of the quarter. 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 competed until 1 May it would be treated as being available for the third quarter.

2

What has changed between the last strategy and this one

This section summarises the key methodology, assumption and outcome changes between the 2011-2020 Strategy and this 2012–2021 Strategy to allow ready comparison between the two.

Hunter Valley Access Undertaking Requirements

As already discussed in Chapter 1, the ARTC Hunter Valley Access Undertaking came into effect during the past year and now imposes certain procedural requirements on ARTC in relation to the preparation of this Strategy. These requirements include:

- That the RCG endorse the volume forecasts that form the basis of the Strategy.
- That ARTC formally consult with PWCS and NCIG in relation to the capacity of the port and terminals and the timing of increases in that capacity.
- That the Strategy be released as both consultation and final versions.

Volume forecasts

Volume forecasts have been updated based on contracted volumes. This Strategy maintains the distinction created in the last Strategy between those volumes that are subject to a binding contract and those that are associated with projects that are moving forward but not yet at a stage where producers wish to commit to a contract. The latter category is referred to as prospective volumes.

Given that ARTC has received nominations for T4 volumes and that producers have indicated a willingness to contract for these volumes, this Strategy also identifies a third scope of work based on contracted volumes plus T4 nominations.

Figures 5 to 8 compare the forecast volumes from the 2011 – 2020 Strategy with the forecasts used for this Strategy. A comparison is made at the terminal, at Muswellbrook, for the Wilpingjong – Mangoola section (which is the majority of the Ulan line), and Werris Creek – Scone (which is representative of most of the Gunnedah basin line).

Capacity Calculation Methodology

As discussed in Chapter 1, the formalisation of the Target Monthly Tolerance Cap has led to a need to change the adjustment factor used to recognise maintenance, cancellations and a buffer or surge allowance in the capacity calculation. From 2015 this adjustment factor, which brings practical annual path numbers down to a saleable number of annual paths, has changed from 75% to 71.1%.

A refinement has also been made to the way that transaction time for crosses on single track is recognised. This has previously been set at a standard five minutes, but with the growth in simultaneous entry loops and passing lanes it was considered appropriate to explicitly recognise the operational efficiencies of these loop configurations by reducing the transaction time to 4 minutes and 3 minutes respectively.

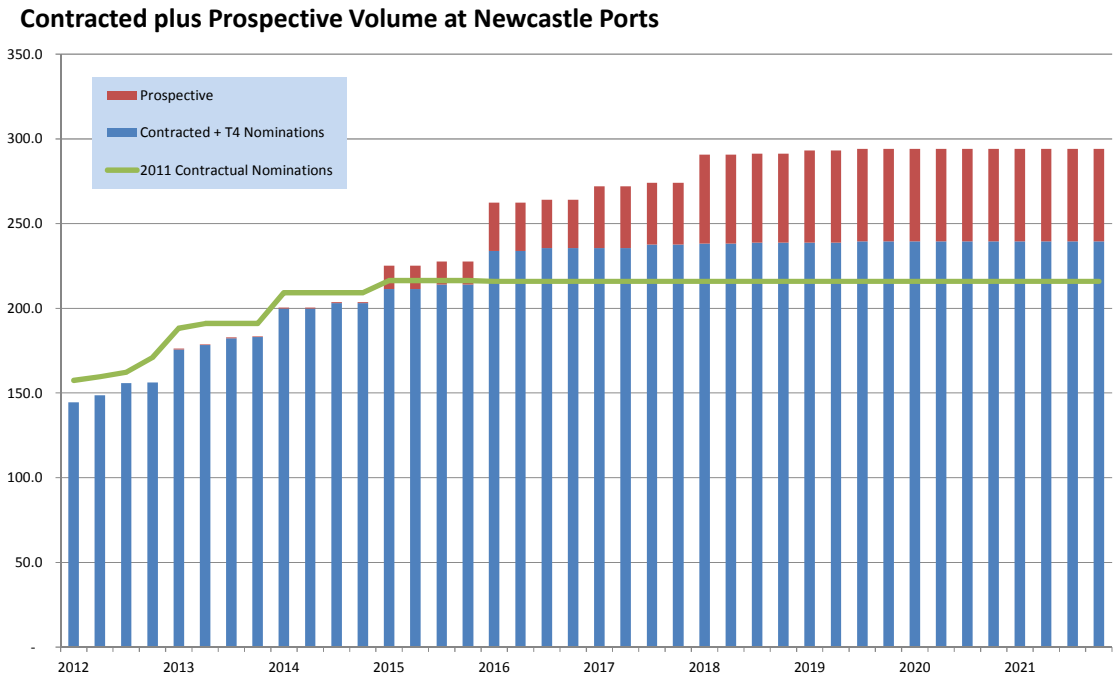

Figure 5 - Current Volume Forecasts vs 2011-20 Volume Forecast, Newcastle Terminals (mtpa)

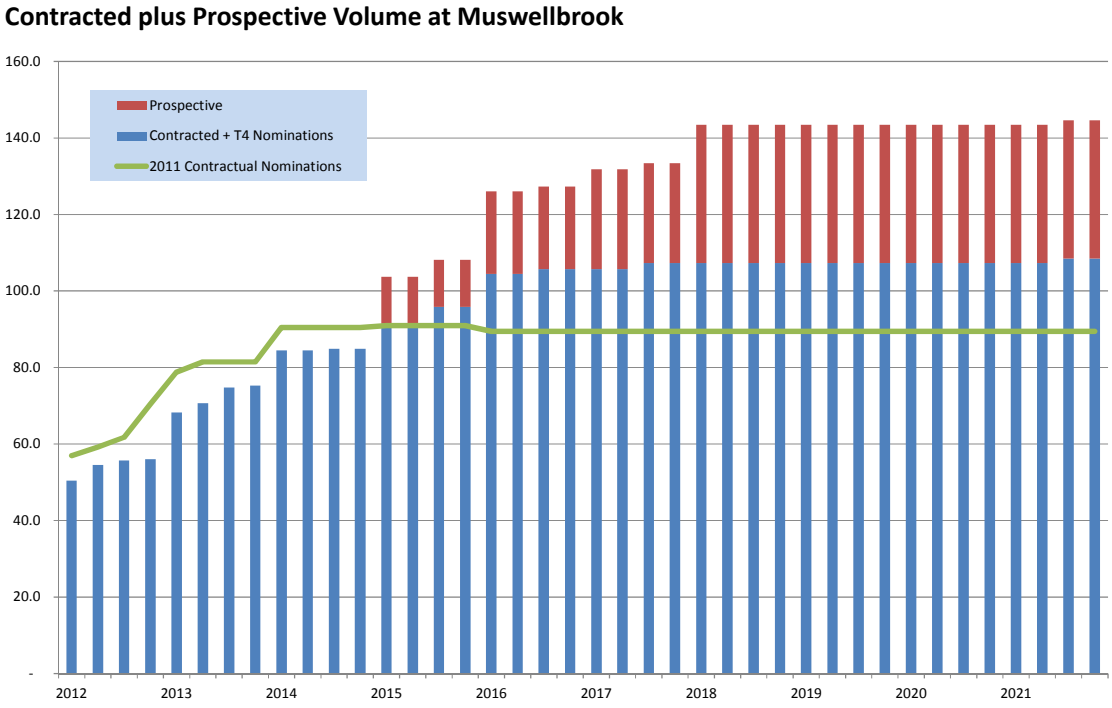

Figure 6 - Current Volume Forecasts vs 2011-20 Volume Forecast, Muswellbrook (mtpa)

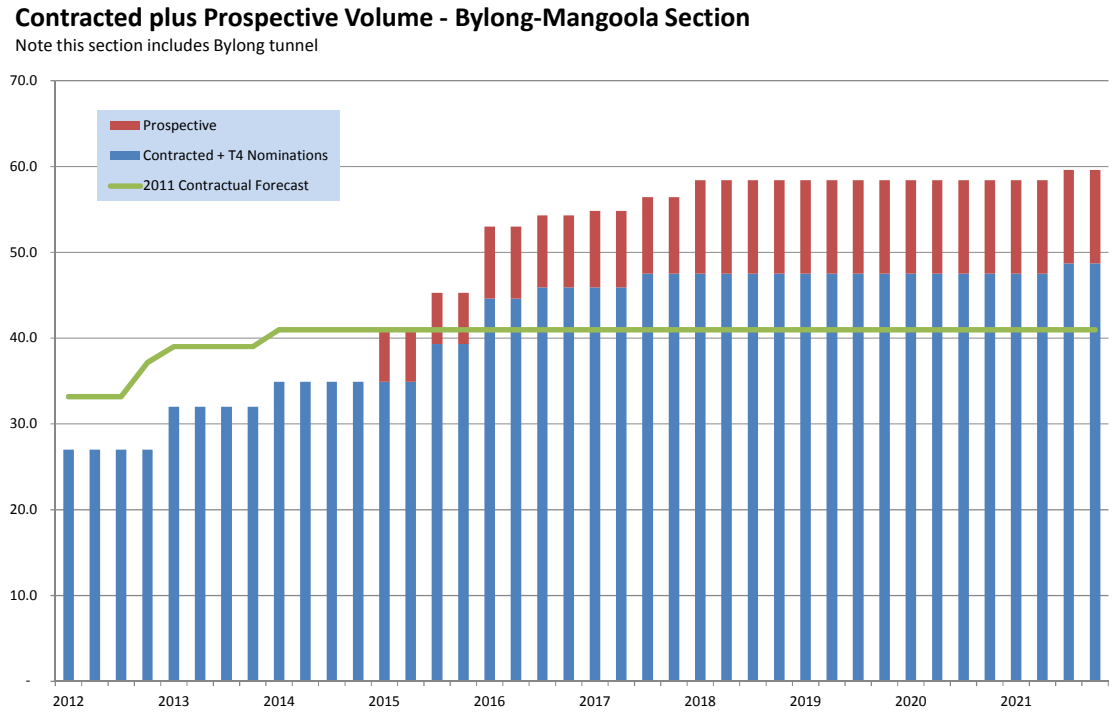

Figure 7 - Current Volume Forecasts vs 2011-20 Volume Forecast, Bylong—Mangoola (mtpa)

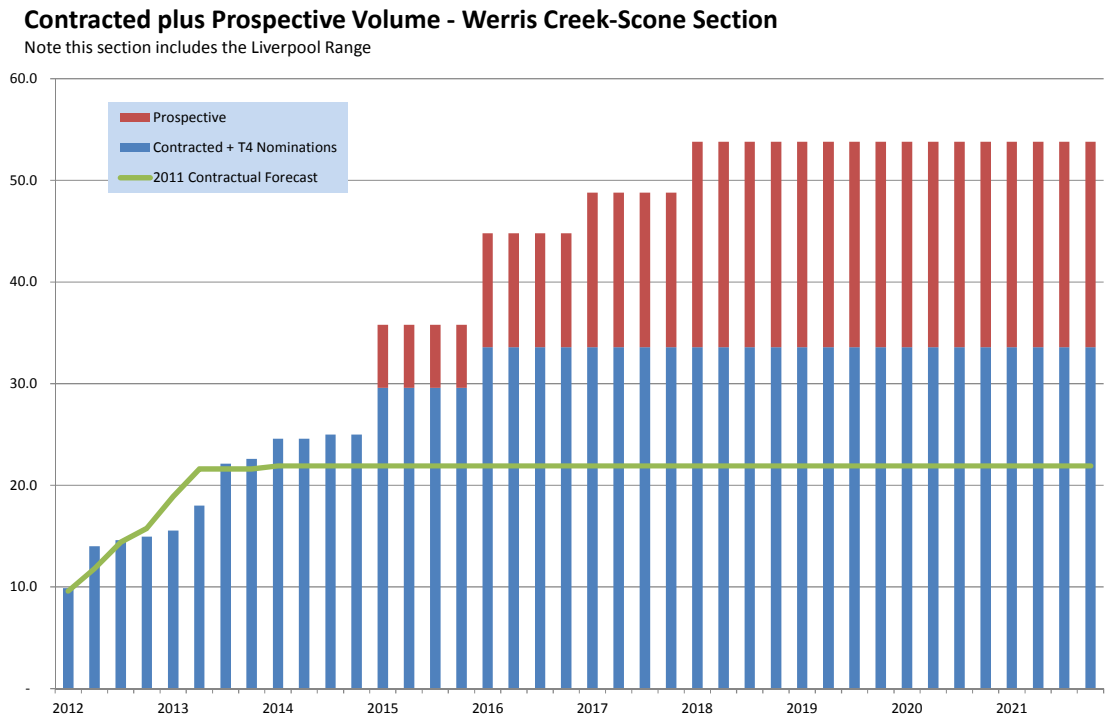

Figure 8 - Current Volume Forecast vs 2011-20 Volume Forecast, Werris Creek—Scone (mtpa)

Completed Projects

The following projects have been completed since the release of the 2011 – 2020 Strategy and the benefits of the projects are now built into the starting assumptions:

- Maitland CBI
- Wilpingjong and Bengalla loops on the Ulan line.
- Koolbury, Bells Gate and Burilda loops on the Gunnedah basin line.

Recommended projects and timing

A summary of the recommended projects comparing previous and new proposed delivery timeframes is shown in Tables 7 & 8 in Chapter 7, for both contracted and prospective volumes.

3

Increasing Capacity between Narrabri and Muswellbrook

Context

The Narrabri-Gap section of the route was until 1 July 2011 managed by ARTC on behalf of the NSW Country Regional Infrastructure Authority (CRIA). From that date ARTC incorporated the section into its lease and now exercises full management control over the line, including for all investment and pricing decisions.

The single-track Narrabri-Werris Creek-Muswellbrook 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, cotton and flour train activity. This 'background' traffic is up to seven trains each way between Narrabri and Scone, and 10 trains each way per day south of Scone.

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 now four coal train origins and destinations along the route, at Turrawan, Gunnedah Boggabri and Werris Creek[3]. Four major new mines are proposed for the Gunnedah basin: Maules Creek, Vickery South, Caroona and Watermark. Maules Creek is assumed to load from a balloon loop on a new branch connecting close to the existing Boggabri balloon loop. The Boggabri mine will also in future load from a balloon loop off this new branch. Vickery South is assumed to load in the vicinity of Gunnedah. It is understood that Watermark and Caroona will load from new load points either side of Breeza, at approximately the 443.5 km and 424 km points respectively.

The Ardglen bank, crossing the Liverpool Range, is a particular impediment on this corridor. 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.

Passing loops on the Muswellbrook–Narrabri route had highly variable lengths when ARTC first started investing in capacity enhancement on this corridor. The majority of loops are now 1350 m – 1450 m with only a small number of short loops remaining. Of these short loops, Gunnedah, Quirindi, Kankool and Scone have specific challenges that make extension undesirable.

The track north of Dartbrook is only rated for 25 tonne axle loads (i.e. '100 tonne' wagons), compared to 30 tonnes on the rest of the network.

All of the network carrying coal is CTC controlled.

Liverpool Range

In 2007 ARTC completed a study looking at options for a new rail alignment across the Liverpool Range in the vicinity of Ardglen. This report assessed four tunnel options and two surface alignment options as well as duplication of the existing alignment.

In the 2011-2020 Strategy ARTC indicated that its assessment of the costs and benefits of the options suggested that staged duplication of the existing line on the existing gradient was the best solution and that duplication would be treated as the default solution.

The Liverpool Range poses some particular complexities due to grades, curvature and geology. However, the decision to proceed with, initially, additional loops, followed by progressive duplication, means that in practical terms

3. The Dartbrook mine just north of Muswellbrook is closed and is not expected to reopen during the course of the Strategy.

the Liverpool Range will essentially see a similar approach to capacity enhancement as the rest of the corridor. As such the staging of the enhancements is discussed in the context of 'Loops & Passing Lanes' below.

Werris Creek Bypass

Long coal trains standing in Werris Creek loop create operational complexities at Werris Creek, where 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 exists to resolve this problem and achieve a number of other desirable operational outcomes through reopening and reconfiguration of the alternative Gap – Werrris Creek line. 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.

This configuration would also have potential benefits for grain services, particularly if a triangle connection was provided at the north end, with the Werris Creek sub-terminal effectively located on a balloon loop for trains from both the north and the south.

A Werris Creek bypass would also provide useful train park-up capacity.

While this project has these additional benefits, its timing is being driven by the requirement to enhance capacity and as such it is addressed in the section on Loops & Passing Lanes below.

Scone Reconfiguration

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.

For some time the local Council has indicated a concern about the effect of coal trains on traffic on the New England Highway, which crosses the line just north of the town. Funding has now been provided for the Roads and Maritime Authority to undertake an assessment of the options to address this issue. While ARTC has developed a preferred option for the reconfiguration of Scone, it faces a number of environmental and construction challenges, and given the circumstances ARTC has placed this project on hold until the future of the New England Highway level crossing becomes clearer.

Axle Load Increase

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.

Over recent years considerable resleepering of the Gap – Gunnedah section in concrete has occurred. ARTC has a program in place to progressively replace the sleepers on the Dartbrook – Werris Creek section with concrete. While a number of other investments would be required to achieve 30 tonne axle loads, much of this expenditure would be bringing forward upgrading that would anyway be required in future years.

A practical concern for increasing train weight, either through increased length or axle load, is the operation of bank engines on the Liverpool Range. ARTC understands that a commonly accepted practical limit is that there should be no more than 10,000 hp applied to the rear of the train. The banking operation on the Liverpool Range is currently at approximately this limit.

To go to heavier trains therefore means additional locomotives at the front or inserted into the middle of the train. Adding and removing locomotives in the middle of the train is a relatively time consuming exercise. Additional locomotives on the front of the train is more straightforward but would still impose a material time penalty to the banking operation compared to current practice.

Consequently it will be necessary to either adopt a significantly less efficient banking operation, or provide more locomotive power on the train for its entire journey. Either approach has cost penalties.

The timing of projects under the prospective scenario but with 30 tonne axle loads is documented in the Loops and Passing Lanes section below, using an assumption that 30 tonne axle loads would become effective by Q1 2015. As already noted, the reduced investment in loops / passing lanes would need to be offset by bringing forward some track renewals as well as undertaking some other

track strengthening activities that would not otherwise be required.

It is a matter for the industry to determine whether there is a net benefit from moving to 30 tonne axle loads and further consultation is required having regard to all of the costs and benefits.

Train Lengths

Refinement of wagon designs has led to the recent introduction of new wagons that are materially shorter than the existing fleet. Approximately 82 of these wagons can fit in the loops built for 72 wagon trains. ARTC has now approved the introduction of trains of up to 1329 metres. This represents a practical limit given current loop lengths and the need to allow a margin at the loop ends. There will be no further increase in length until the track configuration changes to facilitate it.

As the corridor is progressively enhanced and passing lanes become common, the length constraint imposed by passing loop length will by default become less of an issue. However, at this stage it is still anticipated that there will still be a number of loops which would constrain train length.

For various operational reasons ARTC has been building an increasing number of loops with a 'simultaneous entry' configuration. This configuration allows for a more efficient cross to occur when opposing trains arrive at the loop at around the same time, an event which becomes increasingly probable as the distance between loops declines. A simultaneous entry configuration requires a minimum extra 300 metres 'overlap' to be added to the loop length, making the loops nominally 1650 metres, though in the simultaneous entry configuration the extra length is not available to use for longer trains. However, if and when ATMS is introduced into the Hunter Valley it will be possible to allow simultaneous entry without the additional overlap, meaning that loops built in this style would immediately be available for trains of the standard Hunter Valley length of 1565 metres.

Given this opportunity to move progressively towards the introduction of the standard Hunter Valley train to the Gunnedah basin, ARTC is moving toward an approach of building all new loops to the simultaneous entry

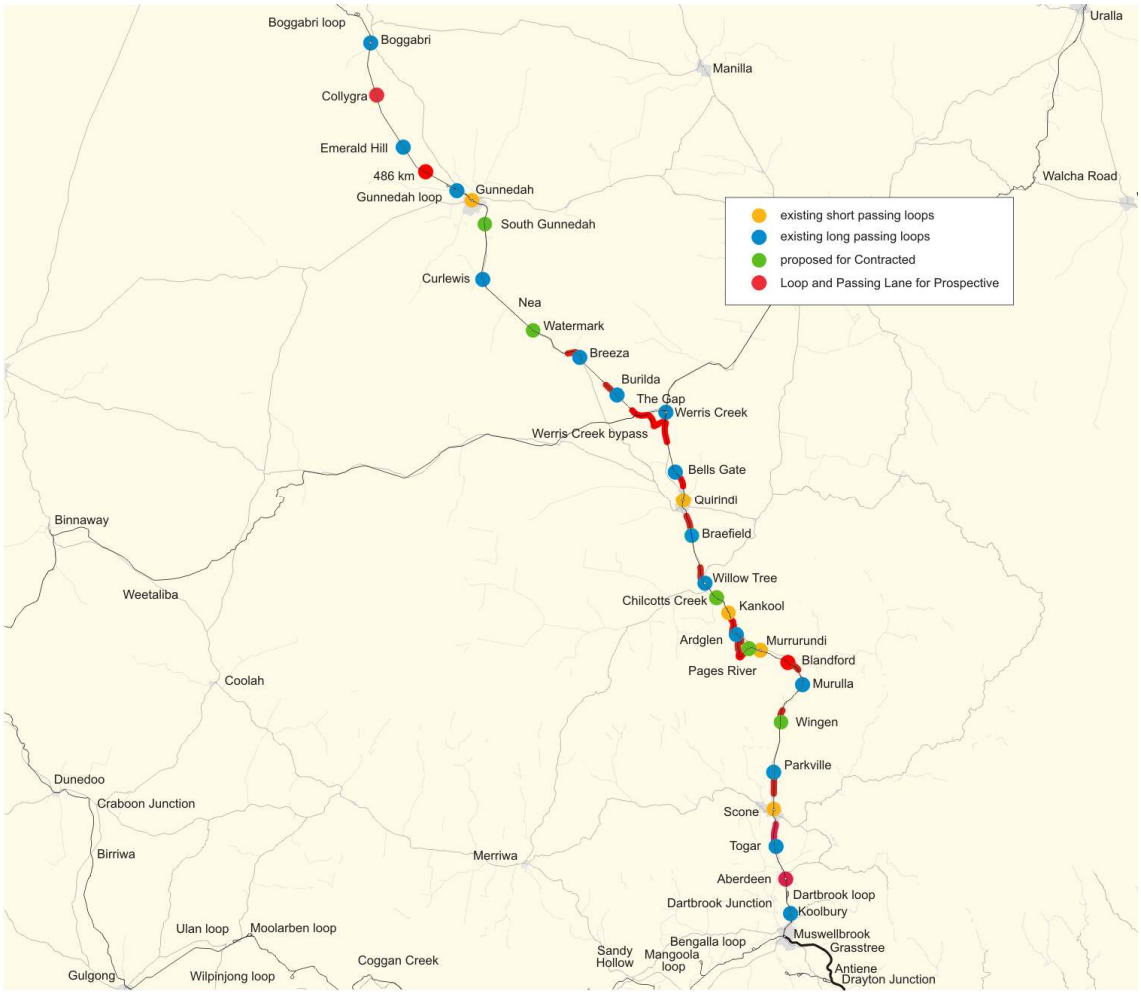

Figure 9 - Muswellbrook to Narrabri Loops

configuration, which provides short-term operational benefits and the ability to easily move to longer trains if and when ATMS is introduced.

Loops & Passing Lanes

Progressive lengthening of selected existing passing loops, and constructing additional passing loops, has been the primary mechanism for accommodating volume growth to date. However, only two loops (Aberdeen and Murrurundi) remain for potential extension. Opportunities to insert additional mid-section loops are becoming constrained due to the effects of grades and level crossings, while the increasingly short distances between loops mean that additional mid-section loops are of declining benefit due to the transaction times at the loop. As a result, much of the investment to accommodate prospective volumes will be through extension of loops into passing lanes.

Passing lanes pose an additional optimisation challenge compared to loops, since they can be built to precisely the length nominally required to accommodate a given volume, subject to tie-in point, grade and level crossing constraints. However, in an environment where volume is progressively increasing, this required tie-in point will change as frequently as each quarter. Clearly it does not make sense to be repeatedly extending the passing lane. The proposed scope of work, particularly for prospective volumes, generally seeks to build each extension to the length ultimately required once volumes plateau. However, as the program moves forward, opportunities may arise to refine the scope at each stage to minimise the net present cost.

Table 4 shows the new loops, loop extensions and passing lanes proposed on the basis of addressing the capacity constraint on each local section as demand requires, for the three different demand scenarios being considered in this Strategy, and a 30 tonne axle load scenario. The location of each of the projects is shown on Figure 9.

Project Name	Contracted	T4 Nominations	Prospective	Prospective at 30 tal
Pages River loop	Q2 2013	Q2 2013	Q2 2013	Q2 2013
Chilcott's Creek loop	Q4 2013	Q4 2013	Q4 2013	Q4 2013
Watermark loop	Q3 2013	Q3 2013	Q3 2013	Q3 2013
South Gunnedah loop	Q3 2013	Q3 2013	Q3 2013	Q3 2013
Scone reconfiguration	Q1 2015	Q1 2015	Q1 2015	Q1 2015
Wingen loop	Q1 2015	Q1 2015	Q1 2015	Q1 2015
Aberdeen loop		Q1 2016	Q1 2015	Q1 2015
Blandford loop		Q1 2015	Q1 2015	Q1 2015
Kankool - Ardglen		Q1 2015	Q1 2015	Q1 2016
Braefield north extension (to 390.7 km)		Q1 2016	Q3 2017	Q1 2016
Werris Creek bypass (Gap – 407.5 km)		Q1 2015	Q1 2015	Q1 2015
Collygra loop (504 km)		Q1 2015	Q1 2015	Q1 2015
Togar north extension (to 310.5 km)			Q1 2015	Q1 2016
Bells Gate south extension (to 395 .6 km)		Q1 2016	Q2 2015	Q1 2016
Burilda north extension (to 424.5 km)			Q1 2016	
486 km loop			Q1 2015	Q1 2016
Parkville south extension (to 317.6 km)			Q1 2016	
Pages River – Pangella (360.0 km)			Q1 2017	
Willow Tree north extension (to 380.9 km)			Q1 2016	Q1 2018
Werris Creek south extension (to 405.5 km)			Q1 2017	
Werris Creek north extension (to 418.5 km)			Q1 2018	
Breeza north extension (to 439.4)			Q1 2016	
Wingen north extension (to 333.6 km)			Q1 2017	
Blandford south extension (to 344.0 km)			Q1 2018	

Table 4 - Narrabri to Muswellbrook Loops - Timing under different volume scenarios

4

Increasing capacity between Ulan and Muswellbrook

Context

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 Bengalla, Mangoola, Yarrawa, Sandy Hollow, Kerrabee, Baraemi, Murrumbo, Bylong, Coggan Creek, Wollar, Wilpingjong and Ulan (though the Ulan loop is only 980 m) and is CTC controlled.

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 Wilpingjong, Moolarben and Mangoola mines have all commenced production in recent years.

Five new mines (Mt Pleasant, Ferndale, Bylong, Mt Penny and Cobbora) are at various stages of the development and approval process. The first four of these mines will be standard thermal coal export mines.

The Cobbora mine, approximately 33 km north-west of Gulgong, is being developed primarily to produce coal suitable for domestic power generation. The Cobbora Coal Project is a NSW government initiative linked to the privatisation of the NSW electricity industry. Despite some uncertainty after the change of Government in NSW, this mine is now a very firm prospect and the three electricity generators, who will be responsible for transport of the coal, are moving to contract track capacity for their required volumes. These volumes have been treated as contracted.

The mines on this sector are clustered either at the start of the line near Muswellbrook (Bengalla, Mangoola, Mt Pleasant) or at the end of the line around Ulan (Ulan, Wilpingjong, Moolarben). This gives rise to a long section in the middle with homogenous demand. The proposed Mt Penny and Bylong mines will be toward the Ulan end, but 30 km closer to Muswellbrook.

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 nominal sites has progressed, it has become necessary to consider alternative solutions. Specifically, in some cases it has become necessary to construct “passing lanes”,which are effectively short sections of double track. These will necessarily be materially more expensive than straightforward loops.

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 has been considered a problem. Train spacing and track maintenance has been limited by the ‘purge times’ for air in the tunnel, with an operating rule currently limiting trains to operating at an arbitrary 30 minute minimum frequency. There is a critical need to move beyond this limitation.

This analysis of the Ulan line assumes that there is no change to the current pattern of limited background (non-coal) trains on this line.

Tunnel Ventilation

The tunnel ventilation issue remains under investigation. However, extensive air quality testing and monitoring has been completed and the results suggest that it will be possible to manage the air quality issue in the medium term without the need for an engineering solution.

In the longer term, it will be necessary to extend the Bylong loop to the western tunnel portal to accommodate prospective volumes. It will be necessary to build this extension to a new vertical alignment, with the track cresting at a point around one kilometre before the portal so that trains are able to start on an acceptable gradient. This configuration will also reduce the requirement for trains to be powering as they enter the tunnel, providing further mitigation of the air quality issue.

Increasing Train Speed

The default solution for increasing capacity is to build additional loops or track. However, there is also an option to reduce section running times, and hence increase capacity, by lifting train speed. This option was reviewed in the context of the 2011 – 2020 Strategy.

A 33% increase in loaded coal train speeds on the Ulan line from 60 km/h to 80 km/h would give a transit time reduction of around 15 minutes, or 8%. This is compara-

tively low 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. Increasing the speed of the empty trains from 80km/h to 100 km/h does not produce any significant transit time reductions due to the constraints of curvature across most of the corridor.

Looking at the transit time effects in detail, increasing speed limits has some benefits at both ends of the line, but has no material impact in the middle sections. From a program perspective, the only effect would be to allow the proposed loop at Widden Creek to be deferred by one year. While this is an option, the benefit of a one year deferral is relatively small compared to the cost and complexities of increasing train speed. The preferred solution is therefore to continue with the passing lanes/loops program, though the option of increasing speeds will be reviewed again as the scope for prospective volumes is firmed up.

Cobbora — Ulan

The Cobbora mine is located approximately 50 km west of Ulan. It is proposed to connect a new balloon loop to the Gulgong – Merrygoen line at Tallawang. This would add approximately 40 km of track to the network used by coal services.

A key issue for this traffic is train length. Existing facilities at the Eraring and Vales Point power stations, which connect to the RailCorp network, are length constrained. ARTC has indicated that it would be undesirable to operate trains on the Ulan line that were shorter than the current fleet.

The track between Ulan and Tallawang will require upgrading to accommodate 30 tonne axle loads and the signalling system will need improvement. An additional loop, nominally north of Gulgong, will be required, though the option of extending the existing loop at Ulan will also be assessed.

Denman Bypass

The 2011-2020 Strategy identified an option to construct a bypass of Denman, from just east of Sandy Hollow to just west of Mangoola, as an alternative to an additional loop (nominally at 324 km) on this section. The 11.5 km bypass would provide operational efficiencies (reducing route length by 8.7 km) as well as creating capacity by effectively making the section double track.

The HVCCC has now identified the Denman bypass as a good potential option for creating additional train park-up capacity, as discussed in more detail in Chapter 6. The bypass option will continue to be assessed in the context of all three of these potential sources of benefit.

Additional Passing Loops/Passing Lanes

Additional passing loops, or where necessary passing lanes, represent the main mechanism to deliver further incremental increases in capacity on the line. Site investigation has continued since the release of the 2011-2020 Strategy, allowing further refinement of the proposed solutions.

The currently identified scope is set out in Table 5.

The location of existing and proposed loops is shown in Figure 10.

Project Name	Contracted Volumes	T4 Nominations	Prospective Volumes
Coggan Creek West Extension (to 400.7 km)		Q1 2017	Q3 2016
Bylong West Extension (to 386.7 km)	Q3 2016	Q1 2016	Q1 2016
Bylong East Extension (to 377.0 km)			Q3 2015
Murrumbo West Extension (to 374.1 km)	Q3 2017	Q1 2016	
Widden Creek Loop (formerly 353 km loop)	Q1 2016	Q1 2016	Q1 2015
Baerami West Extension			Q1 2018
337 km loop			Q1 2016
324 km loop		Q1 2016	Q3 2015
Mangoola West Extension (to 310.5)			Q1 2018
Bengalla West Extension (to 296.15)	Q3 2015	Q3 2015	
Bengalla West Extension (to 299.1)			Q1 2015

Table 5 - Ulan - Muswellbrook Loops, timing under different volume scenarios

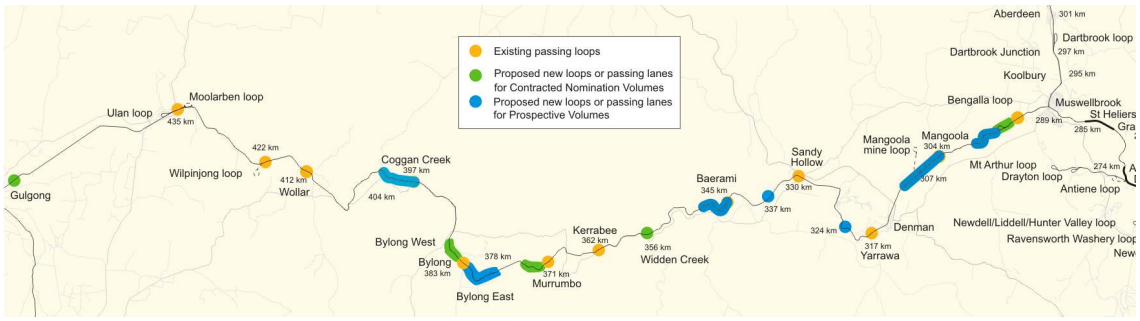

Figure 10 - Ulan Loops

5

Increasing capacity between Muswellbrook and Hexham

Context

The major issues affecting the line between Maitland and Muswellbrook are:

- Headways
- Junctions
- Continuous flow of trains

Headways are fundamentally a function of signal spacing and design. Drivers should ideally only ever see a green signal, so that they do not slow down in anticipation of potentially encountering a red signal. To achieve this outcome, a train needs to be at least 4 signals behind the train in front so that the signal a driver encounters, and the next one beyond, are both at green. Signal spacing also needs to take into account train speed and braking capability. Signals need to be spaced such that a train travelling at its maximum speed and with a given braking capability can stop in the distance between a yellow and a red signal. In some cases these constraints start to overlap, in which case it becomes necessary to go to a fifth signal, with a flashing yellow indication, between trains.

Ideally, headways on the whole corridor from Muswellbrook to the Terminal should be consistent so that trains can depart at regular intervals, and as additional trains join the network they can slot in to a spare path without impacting a mainline train. This headway target needs to be around 8 minutes[4] once volume exceeds around 245 mtpa. This has been tightened from the 10 minute frequency proposed in early Hunter Valley Strategies.

While this principle has been adopted in the signalling design for new works, there have not as yet been any specific projects directed specifically at reducing signal spacing. At this stage effective headway is at around 8 minutes south of Minimbah, but increases further up the line. Spacing is as high as 16 minutes in the vicinity of Drayton Junction.

There are three major banks (sections of steep grade) on the Muswellbrook - Maitland section that particularly affect the headways for trains; Nundah Bank, Minimbah Bank and Allandale Bank (Figure 11). The steep grades on these banks slow down trains to such an extent that it is not possible to obtain an adequate frequency of trains irrespective of how closely the signals are spaced. This requires a third track to be constructed at the banks.

The third track on Minimbah bank has been completed. Nundah bank is discussed in more detail below. Allandale bank is relatively modest and is effectively being triplicated by the Minimbah – Maitland third track project, also discussed below.

There are numerous **junctions** on the Hunter Valley rail network where train conflicts at the at-grade interfaces impact on capacity (Figure 12).

The connection between the main lines north of Maitland and the main lines to the east is through a set of old slow-speed high-maintenance turnouts. There are also a number of similar turnouts on the city side of Maitland. The main issue this raises is the amount of possession time required to maintain these turnouts. Congestion is also exacerbated by the slow speed turnouts, but at current forecast volumes this is manageable. There is also a small amount of conflict with trains off the Pelton branch line.

Whittingham junction turnout speeds were upgraded to 70 km/h in conjunction with the 80 km/h approach to Minimbah bank project, and the junction now has a three track configuration as a result of the Minimbah bank third track project. This allows loaded trains to exit the branch without needing to find a slot between loaded mainline trains. Accordingly this junction is now highly efficient.

Mt Owen and Camberwell Junctions have slow speed turnouts. Camberwell Junction will be upgraded to high speed turnouts in conjunction with the Nundah bank third track project. The volume from Mt Owen means that its junction does not have a significant impact on capacity.

Newdell Junction has been upgraded with high-speed, low maintenance turnouts. While this was primarily maintenance driven, the speed upgrade means that this junction is now highly efficient.

Drayton Junction has slow-speed high-maintenance turnouts rated at 40 km/h. While the main short-term issue is the unreliability, cost and possession time for maintenance of these turnouts, the significant contracted

4. Signal clearance times depend on the length and speed of trains, so there is no single absolute number for actual signal spacing.

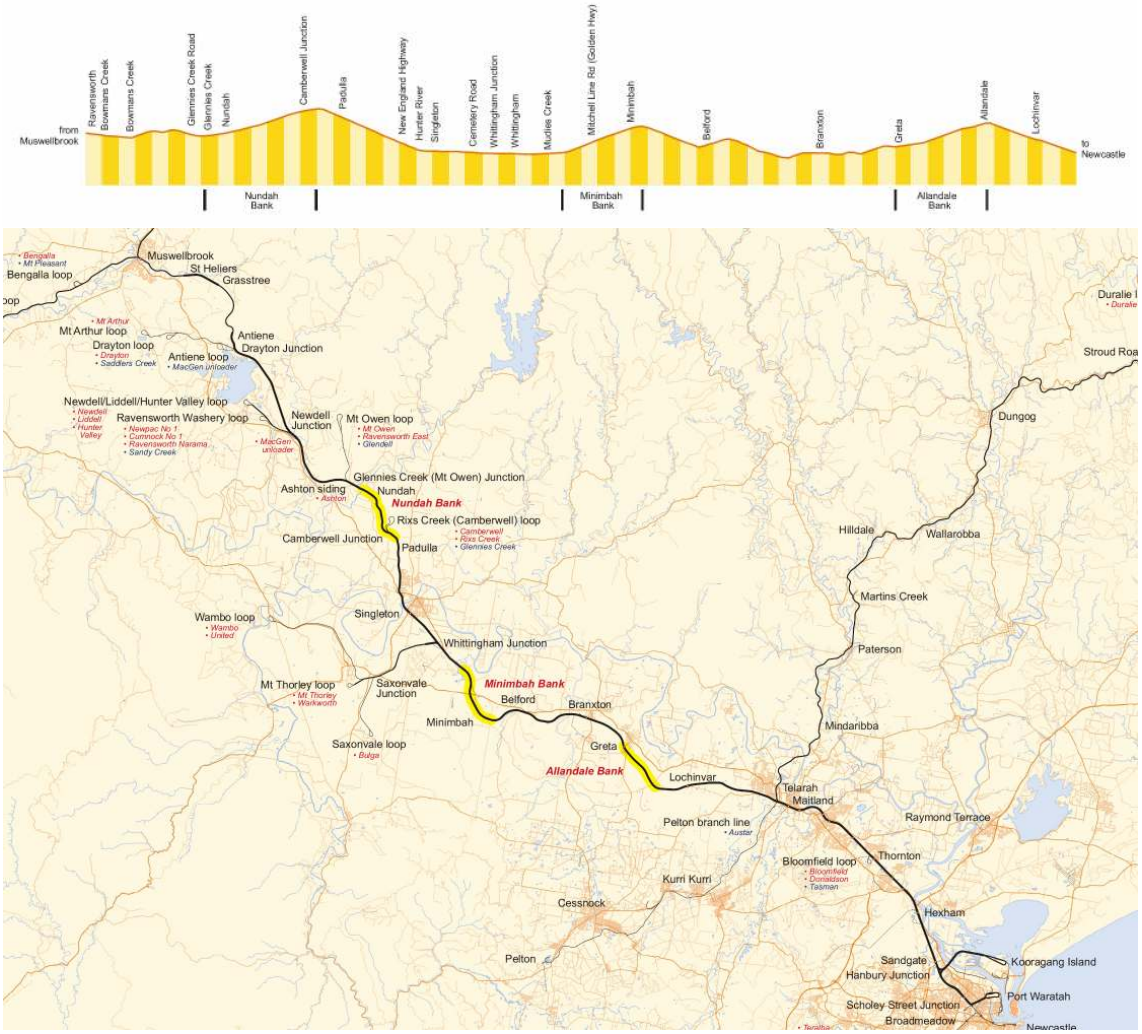

Figure 11 - The Nundah, Minimbah and Allandale Banks.

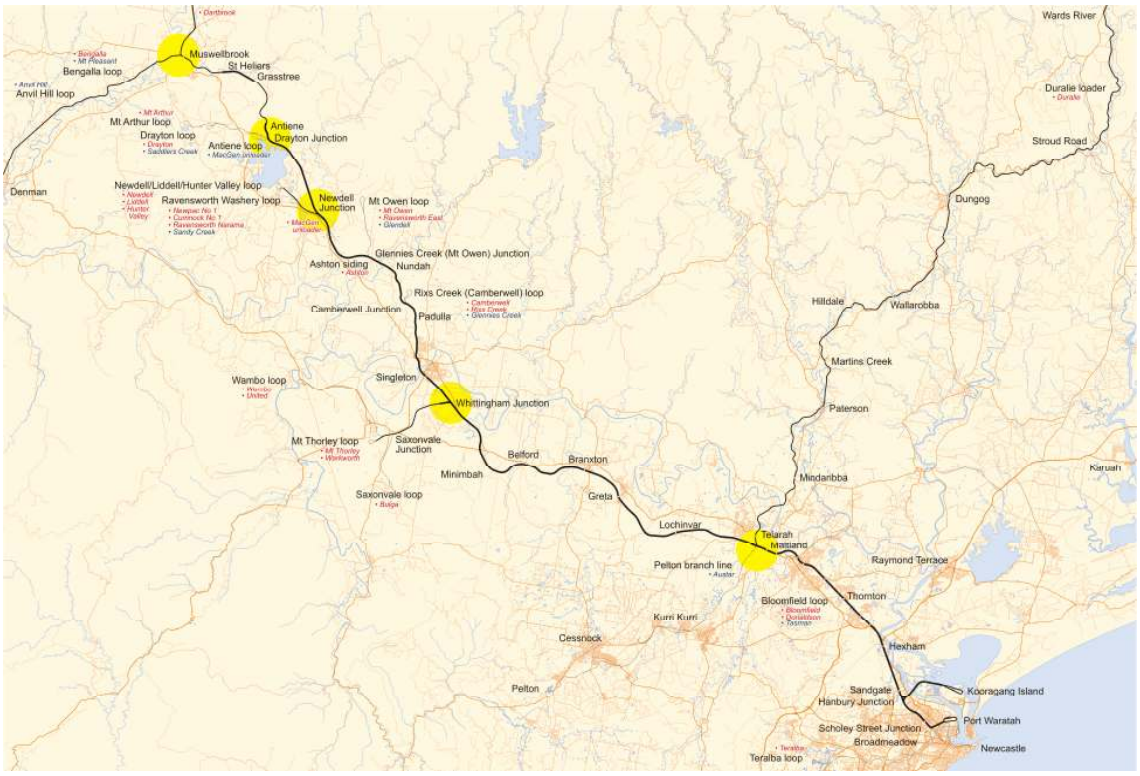

Figure 12 - Maitland, Whittingham, Newdell, Drayton and Muswellbrook Junctions

volume growth from the Drayton branch will place increasing pressure on this junction.

With the strong growth of coal volume from both the Ulan and Gunnedah basin lines, the junction of these two lines at Muswellbrook will come under increasing pressure

A key issue for efficiency at the terminal is the need for the dump stations to receive a **continuous flow of trains**. When the flow of trains at the dump station is interrupted, this creates a direct unrecoverable loss of coal chain capacity, except to the extent that maintenance downtime of the terminal infrastructure can be aligned to the rail side disruption. A critical consideration for the coal chain as a whole is therefore maximising the continuity of trains rather than simply total track capacity.

The following sections discuss in turn each of the major projects arising from these issues, and the further projects that will be required for 2016 volumes:

Drayton Junction

Previous strategies have proposed that Drayton Junction be renewed with 1:18 turnouts, primarily to improve junction reliability and minimise maintenance down-time, but with the consequential benefit of raising the junction speeds for trains moving onto and off the branch line to 60 km/h.

During 2010 work was undertaken to improve the condition of the existing turnouts, which also allowed the speed for trains exiting the branch to be increased to 40 km/h. This allowed the turnout upgrades to be deferred.

Contracted volumes from the Drayton branch are expected to increase significantly as the Mount Arthur North mine expands. BHP continues to assess options for its mine loading facilities but it is understood that there is a clear intention to extend the down 'arrival' track at the junction which is currently too short to hold a full train and essentially provides no operational benefit.

ARTC will continue to advance the full renewal of the junction with completion proposed by Q2 2013.

Nundah Bank

Nundah Bank, approximately 10km north-west of Singleton, has been identified as a future constraint on the network due to the steep rising grade on the Up (loaded direction) track, which results in large headways.

Two options were available to increase capacity on Nundah bank:

- Re-signalling of the current track to reduce signal spacing.
- An additional (third) track.

The 2009 – 2018 Hunter Valley Strategy recommended pursuing a third track and this project has now moved with industry support into construction. The agreed option is a minimalist solution with construction of a new track at the existing 1 in 80 grade between 249.5 km and 245.24 km. It will be possible for one train to come to a stand over the crest of the grade if necessary. The presence of the Camberwell loop at the top of the bank considerably complicated options for a grade-eased (1 in 100) solution and made them financially unattractive.

Provision of a third track will allow alternate trains to be directed to opposite tracks, effectively doubling the capacity. This option also:

- Allows two trains to be on the grade without the risk of the second train needing to come to a stand.
- Provides greater recovery flexibility if a train stalls on the grade.
- Reduces 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.
- Permits re-sequencing of coal trains if this is required.

The alternative option of resignalling was rejected as it would have only provided a temporary solution and carried significant risk. Completion is expected by Q1 2013.

Minimbah—Maitland Third Road

The long section of track between Minimbah and Maitland carries the highest volume on the Hunter Valley network and is constructed on relatively poor formation. As a result it requires a significant maintenance effort, which is a major contributor to interrupting the continuous flow of trains. The bi-directional signalling project completed in 2009 eased the effect of maintenance on this section, but as volumes grow it becomes increasingly difficult to make use of the opposing direction track.

To provide a better solution, a third track between Minimbah and Maitland, connecting to the Minimbah bank third track, was proposed. Though this track is technically not required for capacity purposes, it provides the least cost method of providing incremental capacity to the network from an holistic perspective. In addition, it will provide valuable opportunities to queue and resequence trains during disruption.

This project is now under construction. Following a review of the scope as part of Phase 2, a decision was taken to move forward on the basis of a reduced scope that provides for two sections of third track, excluding the section between Greta and Branxton. The excluded section is approximately 5.5km long and eliminates the need for costly work at both Greta and Branxton Stations and associated track slews, as well as the replacement of the Nelson Street Bridge. The third track has also been cut back by 1.2 km at the Maitland end, to the north of Wollombi Road. This removed the need for a significant bridge over Wollombi Road and Stoney Creek, a retaining wall at Energy Australia, and a significant relocation of the Jemena Gas main. The sections where a third track is not going to be built will have the existing loaded direction track upgraded as part of the scope so as to minimise the requirement for maintenance going forward.

The project is being opened in stages with the forecast completion date for Minimbah – Branxton by Q4 2012 and Greta – Farley by Q1 2013.

Muswellbrook Junction

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. The 2011 – 2020 Strategy included a discussion that noted that for contracted volumes:

- Southbound trains are likely to be delayed around 20% of the time for an average of 6 minutes.
- Northbound trains are likely to be delayed around 16% - 20% of the time for an average of 10 minutes.

It noted that while these levels of delay are material, they do not reach a level where they are likely to have a major negative impact on capacity, or the efficient operation of the coal chain and that on this basis it would be possible to do nothing at Muswellbrook for contractual volumes.

However, it also noted that the HVCCC had floated the concept of having some holding / resequencing capacity in the vicinity of Muswellbrook and recommended that further assessment of options be undertaken, including the feasibility of a long-standing concept to bypass Muswellbrook by connecting the Drayton branch to the Ulan line in the vicinity of Bengalla.

Both the Muswellbrook Junction third track and Muswellbrook Bypass options have now had further analysis undertaken on them. The best solution for the Muswellbrook Junction Third Track involves building a new track mostly on the Up side. Due to track geometry issues this would need to extend to the 286.3 km point, giving a third track of approximately 2.6 km standing room.

A feasible alignment for a Muswellbrook bypass has been designed, connecting the Drayton branch to the Ulan line just to the west of the Bengalla balloon loop junction. It is envisaged that this track would be used by down trains, with up trains continuing to use the existing route via Muswellbrook. A small number of down trains servicing the Macquarie Generation unloading facility at Antiene would also need to continue to use the existing alignment.

The advantage of the bypass option is that it would avoid down Ulan line and Gunnedah line trains blocking each other while waiting for paths at Muswellbrook. Conflicts between up Ulan trains and down Gunnedah trains would, however, remain. The bypass option would also not provide any resequencing opportunities. An initial assessment suggests that the bypass option would have fewer environmental constraints than a third track in Muswellbrook.

The cost of the third track solution is higher than originally anticipated due to the need for greater length as a result of the track geometry constraints, though it remains substantially less costly than the bypass option.

A further solution to the constraints at Muswellbrook would be to duplicate both the Ulan line between Muswellbrook and Bengalla and the Gunnedah line between Muswellbrook and Koolbury. These duplications were assessed in 2008 and considered to be both costly and environmentally challenging. This option has been reassessed and the previous conclusion reconfirmed.

As noted in the 2011-2020 Strategy, the level of congestion at Muswellbrook, while material under contracted volumes, is tolerable, and these options were further reviewed in the context of the solution potentially providing good resequencing opportunities. The work done to date would suggest that all of the solutions are only worth pursuing once volume growth, and hence congestion, approach a level where a solution is unavoidable. This

threshold has been set at 130 mtpa, which would require a solution by Q1 2017.

Maitland Junction

The primary issues at Maitland are related to the maintenance of the old slow-speed turnouts and accordingly the primary focus has been the most effective way to replace these turnouts with low-maintenance high-speed units. Leveraging this renewal to increase capacity by improving train speeds and reducing crossing conflicts has been a secondary consideration.

However, as discussed below, nominated volumes from 2016 are likely to trigger a need to review the junction configuration from a capacity perspective. A specific proposal on how Maitland Junction might be reconfigured has not yet been developed.

Capacity Issues for Prospective Volumes

For volumes around 245 mtpa at Whittingham Junction, it will be desirable to achieve an 8-minute headway between Muswellbrook and Maitland, so that a consistent 8 minute timetable can be implemented.

A preliminary assessment suggests that this will require:

- Removal of the tonnage signal on the Up Main on Minimbah bank, some signal adjustments on the Up Main on Minimbah bank, and the completion of the two gaps in the third track between Minimbah and Maitland (including extending the third track fully into Maitland), or
- ATMS (with no tonnage restriction on Minimbah bank).

Signal spacing between the end of the Nundah bank third track and Whittingham will constrain headways on this section. A conventional solution would require resignalling. It is also likely that to achieve the required headways with conventional signalling will necessitate an extension of the Nundah bank third track due to signal overlap issues. All of the resignalling could be avoided with ATMS while the extension of the third track could be deferred until volumes exceed around 280 mtpa.

Signal spacing Antiene – Drayton limits trains to approximately 16 minute headways. Reducing this headway would be relatively straightforward to address with conventional signalling, particularly since the Drayton Junction signalling will be upgraded as part of the junction renewal process.

There is also increasing pressure for the bi-directional signalling of the Whittingham – Drayton section (the balance of the Maitland – Muswellbrook corridor is already bi-directionally signalled). This is primarily driven by the growing pressure on maintenance, with maintenance demands growing as volume increases, while the tonnage loss from the same amount of maintenance possession time is also increasing with train frequency. Both the bi-di and Antiene – Drayton signal works would be avoided with ATMS.

The scope of work for prospective volume on this section is shown in Figure 13.

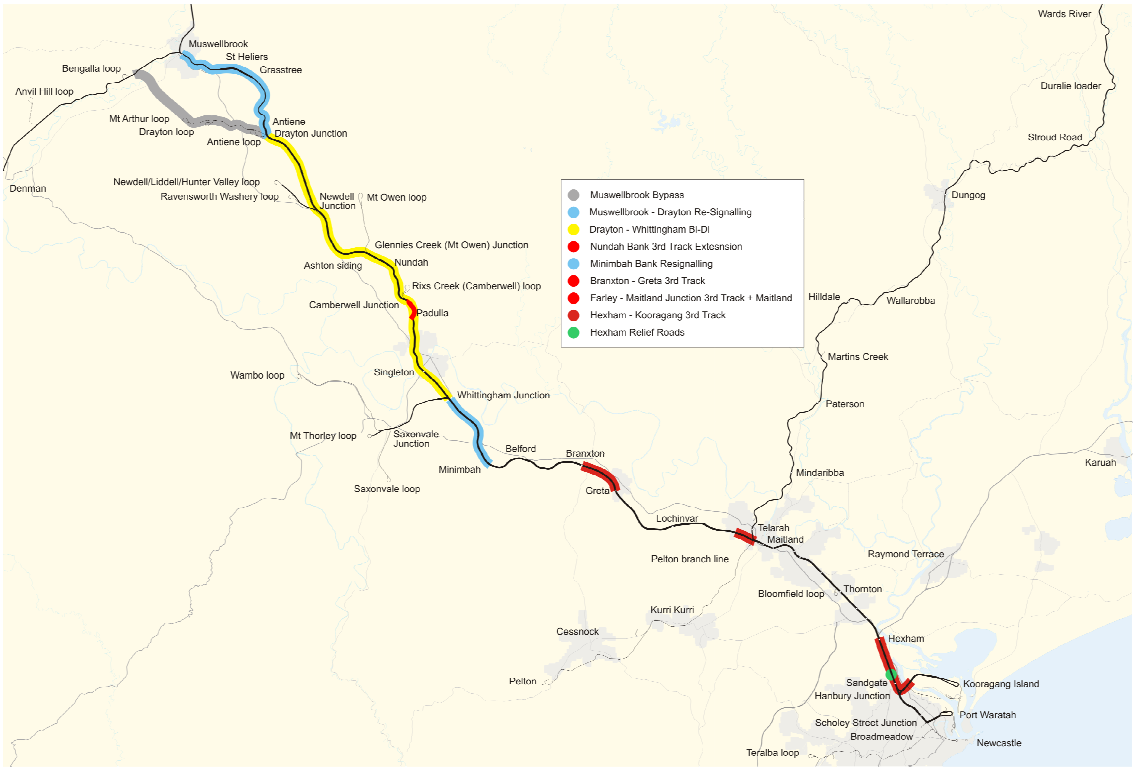

Figure 13 - Muswellbrook—Terminal Projects

6

Terminals and Capacity from Hexham

Context

The Hunter Valley coal industry is now serviced by three coal loader terminals, PWCS Carrington (CCT), PWCS Kooragang Island (KCT) and NCIG Kooragang Island. While the coal loaders are owned by Port Waratah Coal Services (PWCS) and the Newcastle Coal Infrastructure Group (NCIG), most of the track in and around the terminals is leased by ARTC and all train operations are controlled by ARTC.

The Carrington loader is the oldest of the facilities and is located in the highly developed and constrained Port Waratah yard area, with extensive rail facilities servicing a variety of activities. This includes steel products for OneSteel, 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 Carrington 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.

The Carrington facility has a capacity of 25 mtpa, with no expectation of expansion.

PWCS Kooragang Island is better configured for modern rail operations. However, while it has 6 departure roads for its three dump stations, there is only one arrival road for each dump station. As a result, trains need to queue on the mainline before being called forward into the arrival road as the preceding train moves through the dump station.

The other ongoing critical issue at PWCS Kooragang is the use of the departure roads for stabling trains while locomotives are serviced and fuelled and trains are examined, and for holding trains where there is a time delay before their next run.

The PWCS Kooragang Island facility has a program in place to increase capacity up to the order of 118 mtpa. This includes a fourth dump station (DS4) on the existing PWCS Kooragang Island loop which would add around 13 mtpa to capacity. Capacity for PWCS as a whole would increase to 143 mtpa.

Development of dump station 4 will exacerbate the existing problems, and poses significant issues in terms of providing adequate and suitably configured arrival and departure capacity.

The first stage of the NCIG terminal was completed in March 2010 and provides effective capacity of 30 mtpa. Further committed development will take capacity up to 66 mpta. When completed, NCIG will have three arrival roads for its two dump stations and a full grade separation with the Kooragang branch, eliminating conflicts between loaded NCIG bound trains and empty trains from KCT.

The 2011 – 2020 Hunter Valley Strategy continued the commentary on the congestion issues arising from growth in the task, given the limited availability of arrival roads and the use of queuing on the mainline. The HVCCC continues to highlight the congestion consequences of resequencing and has been increasingly flagging the congestion consequences of provisioning, crew changes and empty train stabling. The HVCCC argues that these issues are leading to growing system capacity losses. While this is a whole-of-system issue, additional rail infrastructure may be a means to mitigate some of these problems.

Since the 2011-2020 Strategy was released PWCS has made considerable progress on defining the design of the proposed Terminal 4. That Strategy flagged ARTC's concern that any design should ensure that there were no at-grade conflicts and the proposed T4 solution meets this objective.

The potential development of T4 will also push the double track corridor between Hexham and the terminals toward its limits. To accommodate the full T4 potential volume of 120 mtpa it will be necessary to provide at least an additional track for arriving trains.

Each of the key issues for this part of the network is discussed in turn in the following sections.

5. There will, however, continue to be conflicts between coal trains and the comparatively small number of non-coal trains servicing the industrial area further east at Walsh Point.

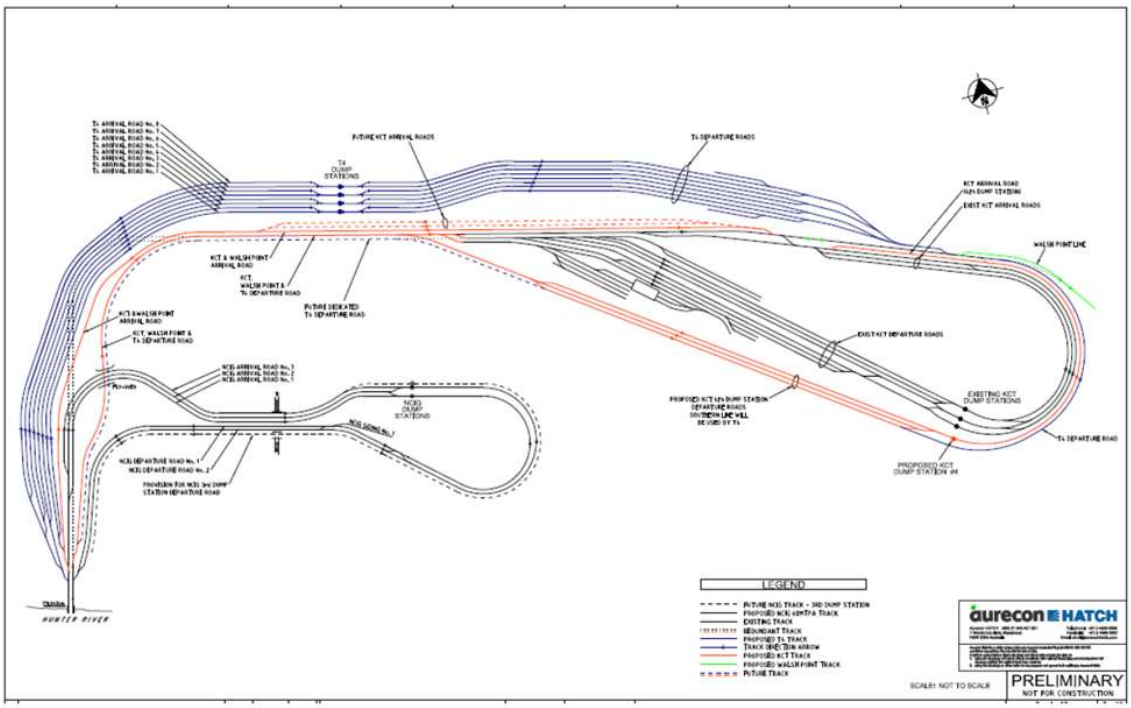

Figure 14 - PWCS Terminal 4

Kooragang Island Configuration

PWCS has now publicly displayed its proposed configuration for the proposed T4.

The critical issue from a track configuration perspective is that the design provides for the arrival tracks, dump stations and departure tracks to sit immediately to the north of the existing Kooragang branch. The departure road would follow the existing KCT balloon loop, curving around the outside, to rejoin the existing down (empty) direction track to the west of the KCT departure tracks. The effect of this design is that it avoids any at grade conflicts and, together with the grade separation of the NCIG junction means that there will be no at grade conflicts of coal trains on the Island[5].

It is also important to note that T4 has been designed with two arrival and two departure roads per dump station.

The proposed T4 track configuration is shown in Figure 14.

Resequencing

Both the 2009-2018 and 2011-2020 Hunter Valley Corridor Strategies discussed the issue of 'congestion' and the justification for building holding roads at Hexham to mitigate the effects of resequencing induced congestion. They argued that the issue is primarily one of the need to resequence trains following either an equipment failure at the dump station / stacker stream, or trains entering the network out of sequence due to either early or late running.

The 2011-20 Strategy recommends 3 holding roads for volumes up to around 180 mtpa with a fourth road triggered once volumes exceed this. Current growth takes terminal capacity to approximately 207 mtpa, which would clearly provide the trigger for the fourth road.

Since the preparation of the 2011-2020 Strategy, the opportunity has been identified to accommodate a fifth track at Hexham, which was previously not considered as an option.

Previous analysis by ARTC has suggested that the scope of resequencing required due to equipment failure is relatively identifiable and will not increase significantly due to greater volume, since the probability of two streams failing simultaneously is statistically low.

However, the number of trains entering the network out of sequence increases disproportionately as volumes grow, since both train numbers, and the probability of them being out of sequence, increase. The number of trains out of sequence has been estimated to increase by 55% as a result of the 15% increase in volume in going from 180 mtpa to 207 mtpa.

The assumption has been that train controllers will be able to use the Nundah and Minimbah – Maitland third tracks to resequence trains. While this is true, a fifth track at Hexham would be valuable in giving both more options and capacity for resequencing. Unfortunately, disruption and mitigation solutions of this nature are inherently difficult to model and quantify since the benefits are very circumstance specific. However, given that the option for a fifth track is now available and the incremental cost is relatively modest, a decision has now been taken to proceed with the five track option to help minimise the effects of disruption, which clearly have a material impact on coal chain performance already.

The HVCCC has also proposed that there should be the ability to hold four trains in parallel before the KCT arrival roads. The T4 design makes allowance for two additional arrival roads for KCT (which would sit between the existing mainline and the T4 track).

ARTC has been requested to develop a scope and cost estimates to provide the HVCCC recommended holding capacity for consideration by the industry, and is currently in Phase 1 of the project.

It is also important to note that congestion on the departure roads due to provisioning, inspections and awaiting paths has an impact on the smooth flow of trains into the dump stations and is another driver of the need to resequence trains. However, the proposed HVCCC solution to this is to eliminate the underlying causes by encouraging the provision of adequate infrastructure off-island for these activities, as discussed below. This is preferable to providing further standing / resequencing capacity on the arrival side.

Provisioning

The Kooragang Island departure roads include a fuelling and provisioning facility on No 3 road owned by PN. This requires trains to be stabled while the locomotives are detached, moved to No 3 road, fuelled and provisioned, and then returned to their train.

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 stations 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.

This causes considerable congestion. The fuelling facility also creates contamination concerns.

In addition, QRN has been leased two 'cripple sidings' that connect off No 1 road. Again, trains stand on the departure tracks while the locomotives are fuelled and serviced.

As the throughput rate of the Kooragang Island facility has progressively increased, so too 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.

One solution would be to provide fuelling facilities on additional, and potentially all, departure roads. However, this would still result in trains occupying departure roads for an extended time, which as volume through the terminal increases, will cause unacceptable congestion. Also, the NCIG terminal has no provisioning facilities, meaning that locomotives would need to shuttle between NCIG and Kooragang for provisioning if the facility remains at Kooragang.

Relocation of fuelling and other provisioning and inspection activities away from the terminal has therefore long been considered the best solution.

ARTC, with industry support, developed a concept for a provisioning centre at Rutherford. This facility was conceived as a multi-user facility offering fuelling, sanding, shunting and some stabling, with the option for a small maintenance centre co-located on the site. ARTC identified a suitable parcel of land that would be available as a by-product of the Minimbah - Maitland third track project.

In parallel with this, Pacific National developed a proposal for a provisioning facility on land it acquired at Greta, while QR National had a concept for a provisioning facility on land it owned at Hexham.

ARTC presented the results of its analysis to industry in May 2010. The industry decided at that time that its preference was to pursue a strategy of provisioning centres being provided by individual operators. Accordingly ARTC has not pursued the Rutherford multi-user facility any further.

ARTC's expectation is that the PN Greta facility will be available by December 2012. At this stage it remains uncertain when the QRN Hexham facility by will be completed. However, in the meantime QRN has set up a provisioning facility at the Ashton mine loader loop and will shortly have a facility at Wambo. PN has also set up provisioning facilities at a number of mine loop locations in the Gunnedah basin. X-Rail is provisioning exclusively at mine loading loops, predominantly at Mt Owen.

The consequence of these developments is that the use of Kooragang Island as a provisioning facility will cease. This will largely eliminate one of the major sources of congestion for departing trains and considerably aid the implementation of a 'dump and go' approach at the terminal.

Empty Train Management

An issue that has received increased focus over the past year is empty train management. This issue is essentially one of what to do with empty trains while they await departure for their next outbound trip. This wait can either be a matter of minutes, or at the extreme, a period of days, particularly when there is a major close-down.

On a day-to-day basis, the key issue is that there is regularly a mismatch between the time a train becomes available for its next trip and the time that that train can depart given path constraints (particularly on the single track sections), load point constraints, coal availability constraints and limitations on which load points a train type / operator can service.

The HVCCC has proposed three projects that would each provide additional capacity and flexibility for holding empty trains. These are:

- *Eight clear departure roads at KCT*. The DS4 development will provide an additional 2 departure roads. Acquisition of no.3 road from PN and some reconfiguration at the dump stations end, would provide the eight tracks. Alternatively, ARTC is investigating the extension of the existing No 3 & 4 Cripple Sidings.

- *Train park-up facility*. A facility that would be able to hold 12 – 15 trains per day is envisaged. ARTC is progressing this on the basis that it would be similar in scale and functionality to the multi-user provisioning facility assessed in 2010, but without the provisioning element.

- *Relief hubs.* Conceptually four train staging hubs of three tracks each. These would be established at locations immediately to the terminal side of the larger mine clusters.

ARTC has been formally requested to develop project concepts for the RCG to consider and has now commenced development of these projects. Preliminary cost estimates for these three projects and the additional holding capacity before KCT are provided under 'Congestion Projects' in Table 8 in Chapter 7.

Hexham – Kooragang Track Capacity Requirement

ARTC has a well established and documented methodology for the capacity analysis used in this and previous Strategies based on selling 75% of practical timetable paths, with the balance consumed by maintenance, surge and cancellations.

This analysis is well suited to mainline operations, but struggles to adequately illuminate the requirements as trains feed into the terminals, which is primarily driven by the ability of a stacker stream to process trains. To address this, a complimentary analysis methodology has been developed based on the capacity required to feed dump stations at their maximum achievable flow rate. This recognises that the dump station / stacker stream is the highest cost element of the coal chain and consequently to maximise the capacity of the chain as a whole it is desirable to ensure that the stacker stream is operating at peak utilisation.

This required peak utilisation rate can easily be calculated as the maximum achievable discharge rate (in tonnes/hour) divided by average train size. With current and planned belt speeds (which dictate the discharge rate), this peak discharge rate in trains / hour, and the associated train headway, is shown in Figure 15.

Each time the stacker needs to be moved there is a delay to unloading due to the need to run-out the coal and reposition the stacker. This occurs between every train unless two following trains have coal for the same stockpile. Assuming the repositioning process takes on average 20 minutes and that it essentially occurs after every train, this gives a 24 hour throughput capacity of approximately 16 trains at current average train size. This translates into 24 hours train demand and average headway as shown in Figure 16.

These two calculations indicate that on completion of NCIG Stage 2 and KCT DS4:

- The fastest possible rate of train demand, which can only be sustained for around 90 minutes, is 5 trains / hour onto Kooragang Island and 5.7 trains / hour on the section of track shared by Kooragang and Carrington trains.
- This translates into 12.0 minute and 10.5 minute headways respectively.
- Allowing for the effect of stacker repositioning, the fastest rate is 94 trains / day into Kooragang and 108 including Carrington.
- This represents headways of 15.3 and 13.4 minutes respectively.

Expanding volume for one dump station at T4, assuming a belt speed of 10,000 tpa as per the T4 Initial Report, indicates that:

- The fastest rate of train throughput onto Kooragang is 6.4 trains / hour and adding Carrington brings this to 7.1 trains / hour.
- This represents headways of 9.4 minutes and 8.5 minutes respectively.
- As a maximum daily rate this is 118 trains for Kooragang and 131 including Carrington.
- This is headways of 12.2 minutes and 11.0 minutes respectively.

These metrics, together with T4 following construction of the second dump station, can be summarised as shown in Table 6.

	NCIG Stage 2 & KCT DS4	T4—DS1	T4—DS2
1 hr peak rate			
Hexham—Sandgate			
Trains	5.7	7.1	8.5
Headway (minutes)	10.5	8.5	7.1
Sandgate—Kooragang			
Trains	5.0	6.4	7.8
Headway (minutes)	12.0	9.4	7.7
24 hr peak rate			
Hexham—Sandgate			
Trains	108	131	155
Headway (minutes)	13.4	11.0	9.3
Sandgate—Kooragang			
Trains	94	118	141
Headway (minutes)	15.3	12.2	10.2

Table 6 - Headway metrics

The current signalling headway is approximately 7.5 minutes. Hence, all of these rates of throughput, other than between the Hexham holding roads and the junction at Sandgate for the Carrington trains with the second T4 dump station, are within the capacity of the current signalling system assuming trains approximately maintain line speed.

Maintaining line speed should be possible subject to there being adequate arrival road capacity. To the extent that there is insufficient arrival road capacity there are two risks:

- Trains need to queue to access the arrival roads, which immediately eats into the headway and / or blocks access to other terminals.

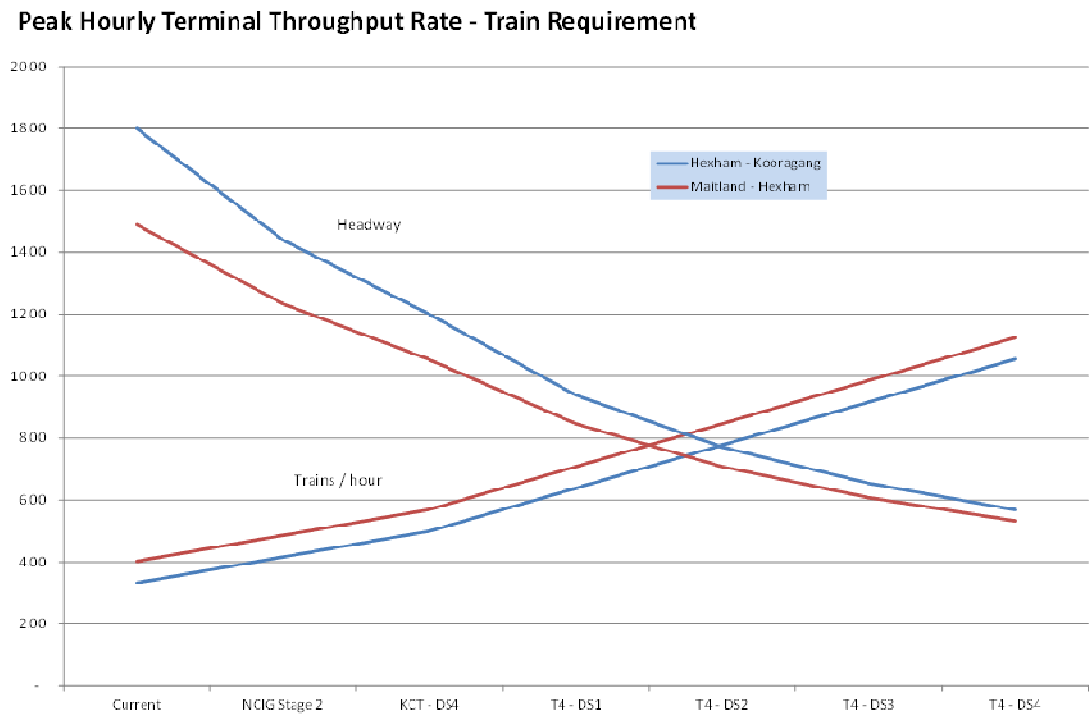

Figure 15 - Peak Hourly Terminal Throughput rate

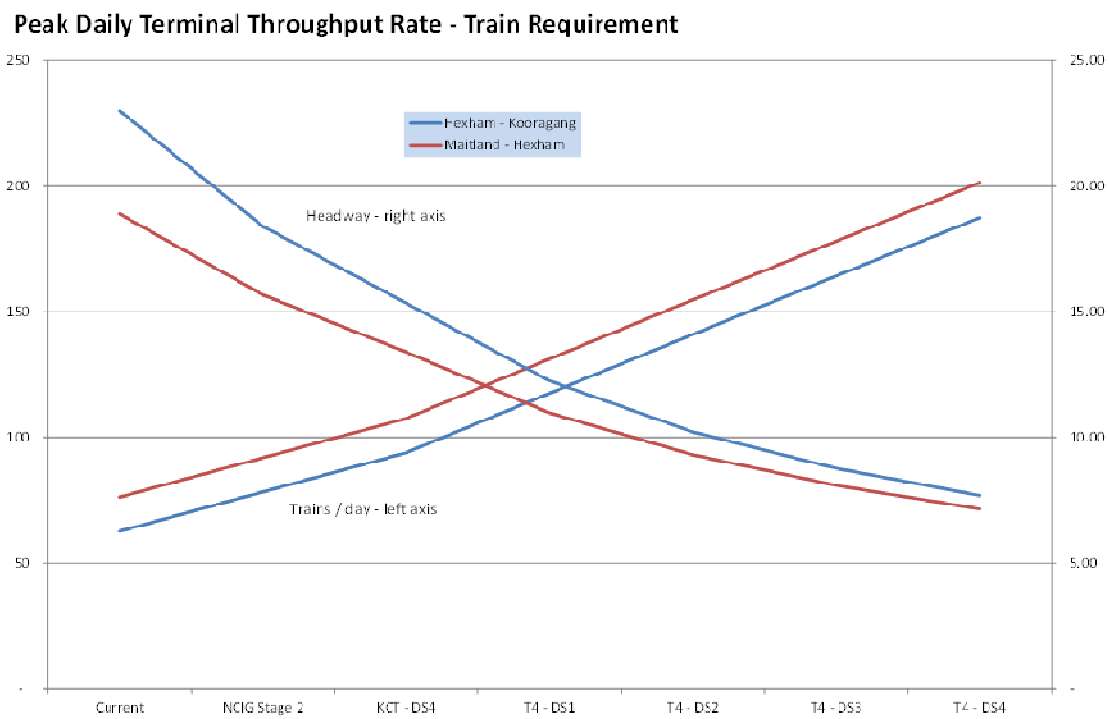

Figure 16 - Peak Daily Terminal Throughput rate

- Two or more stackers require their next train at approximately the same time and it is not possible for them to depart Hexham at sufficiently close headways to avoid a dump station standing idle for a period (up to 7.5 minutes for each overlap of paths). The probability of two dump stations wanting to commence dumping of trains simultaneously is relatively high.

The concept plan for T4 and the NCIG configuration both provide for reasonable levels of arrival capacity. KCT currently has limited arrival capability. The concept plan for T4 makes provision for 2 potential new arrival roads for KCT west of the current dump station tracks. If these two tracks were constructed it would largely mitigate the problems identified.

For the first two dump stations at T4, assuming that the arrival roads at T4 are built as planned and the two additional KCT arrival roads are constructed, capacity on the existing single track between Sandgate and Kooragang Island should be just adequate.

However, the level of intensity of operation will be very high and there is a risk of operational fragility. In this environment ATMS would add significant robustness, both by allowing closer headways and by reducing the probability and consequence of signalling failures.

Moving to the third dump station at T4 would trigger a requirement for an additional Up track between Hexham and the island under conventional signalling. This may not be required with ATMS. ATMS could also theoretically accommodate the volume of a fourth T4 stacker stream, though this scenario would be likely to be highly operationally fragile and it has been assumed that a Hexham – Kooragang third track would be required for the fourth T4 dump station.

Options for the short section between the Hexham holding roads and Sandgate (approximately 1 km) need to be further assessed. The major challenge here is likely to be the level of conflict between loaded Carrington trains and empty trains from Kooragang, and there may be merit in assessing the use of the main lines for loaded Carrington trains.

Under the 2 dump station T4 scenario the peak daily throughput rate would require 9.3 minute headways. This section already achieves significantly better headways assuming trains do not need to stop. On the basis that the Hexham facility has sufficient capacity to manage peaks and troughs without requiring extensive mainline queuing, the current configuration of this section will theoretically be adequate.

However, ARTC has concerns as to whether all of the conditions will be met to ensure that trains do not stop between Hexham and the arrival roads and that in practice the third track between Hexham and Kooragang Island will be necessary to avoid serious congestion. Given the likely long planning and construction timeframe for this project, ARTC will advance the Hexham – Kooragang third track for further initial industry consideration.

ARTC

7

Overview of the recommended projects

A summary of the recommended projects for contracted volumes comparing previous and new proposed delivery timeframes, together with estimated costs, is shown in Table 7. Note that in previous years, cost estimates have been shown in current dollars as at the date of the Strategy. Cost estimates used in this Strategy are forecast escalated values, including contingency based on a 75% probability that the project will cost the estimated value or less.

Proposed delivery dates have been developed based on the 'required by' timing, recognizing the need to manage resource levels, particularly for project commissioning. As a result, some projects are proposed to be delivered in advance of the required timeframe.

Table 8 shows the same detail as Table 7, for the scope of work required for prospective volumes. In Table 8, costs are shown as both unescalated and escalated based on the 'proposed by' delivery dates. The total escalated value of the program is $3,658 m of which $1,093 is for congestion projects.

Again, the proposed delivery dates recognise planning approval and resource constraints. In this case, a number of projects are proposed to be completed after the nominated 'required by' date. This is discussed further in Chapter 8.

Contracted Volume	2011-2020 HV Strategy – Proposed	2012-2021 HV Strategy – Required	2012-2021 HV Strategy – Proposed	Change 2011 Strategy to 2012 Strategy (Proposed)	Estimated Cost ($m, escalated P75)
Maitland—Muswellbrook					
Port Holding Roads (Hexham)	By Q1 2014	ASAP	By Q2 2014	+ 3 months	$139
Minimbah—Maitland 3rd Track	By Q4 2012 (Minimbah - Branxton)	ASAP	By Q4 2012	Nil	$363
	By Q1 2013 (Greta to Farley)	ASAP	By Q1 2013	Nil	
Nundah Bank	By Q1 2013	By Q1 2014	By Q1 2013	Nil	$84
Drayton Jct	By Q2 2013	Maintenance Project	By Q2 2013	Nil	$5
Muswellbrook Junction	By Q1 2014	Deleted	Deleted	n/a	n/a
Ulan Line					
Bylong Tunnel	Interim ASAP	Deleted	Deleted	-	-
Bylong west (390 km)	By Q1 2013	By Q3 2016	By Q2 2013	+ 3 months	$30
Murrumbo west (378 km)	By Q1 2013	By Q3 2017	By Q1 2014	+ 12 months	$40
Widden Creek (353 km)	By Q4 2013	By Q1 2016	By Q2 2014	+ 6 months	$42
Bengalla west	By Q1 2014	By Q3 2015	By Q4 2013	- 3 months	$27
Gunnedah Line					
Pages River	By Q2 2012	By Q2 2013	By Q3 2012	+ 3 months	$24
Chilcott's Creek	By Q3 2012	By Q4 2013	By Q1 2013	+ 6 months	$31
Scone	By Q4 2011	By Q1 2015	By Q2 2013	+18 months	$8
Watermark	By Q2 2013	By Q3 2013	By Q3 2013	+ 3 months	$27
South Gunnedah	By Q2 2013	By Q3 2013	By Q3 2013	+ 3 months	$28
Wingen	New	By Q1 2015	By Q1 2015	n/a	$23

Notes:

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

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.

Table 7 - Recommended Projects, Delivery Schedule and Costs for Prospective Volumes

Prospective Volume	2012-2021 HV Strategy – Required	2012-2021 HV Strategy - Proposed	Estimated Cost ($m) unescalated 2012, P75 order-of-magnitude	Estimated Cost($m) escalated, P75 order-of-magnitude
Port—Maitland				
Hexham - Kooragang 3rd Track	Q1 2020	Q4 2017	$260	$328
Maitland - Muswellbrook				
Farley - Maitland 3rd Track	Q1 2017	Q2 2017	$130	$164
Branxton - Greta 3rd Track	Q1 2017	Q1 2017	$115	$137
Nundah Bank 3rd Track Extension	Q1 2017	Q1 2017	$52	$62
Drayton - Whittingham Bi-Di	Q2 2016	Q2 2016	$85	$101
Minimbah bank Resignalling	Q1 2016	Q1 2016	$21	$24
Muswellbrook - Drayton Resignalling	Q1 2016	Q1 2016	$29	$34
Muswellbrook Junction	Q1 2017	Q1 2017	$67	$81
Ulan Line				
Bengalla West	Q1 2015	Q1 2017	$75	$84
Mangoola west	Q1 2018	Q1 2018	$36	$49
324 km	Q3 2015	Q2 2015	$52	$57
337 km	Q1 2016	Q4 2016	$25	$30
Baerami west	Q1 2018	Q1 2018	$60	$80
Bylong east	Q3 2015	Q4 2016	$98	$113
Coggan Creek west	Q3 2016	Q1 2017	$58	$71
Gulgong	Q3 2016	Q1 2016	$20	$24
Gulgong - Tallawang CTC	Q3 2015	Q2 2015	$14	$16
Gulgong - Tallawang track upgrading	Q3 2015	Q2 2016	$30	$35
Gunnedah Basin Line				
Aberdeen	Q1 2015	Q1 2015	$18	$20
Togar north	Q1 2015	Q1 2015	$51	$56
Parkville south	Q1 2016	Q4 2015	$53	$62
Wingen north	Q1 2017	Q1 2017	$26	$33
Blandford	Q1 2015	Q2 2015	$30	$33
Blandford south	Q1 2018	Q1 2018	$56	$75
Pages River - Pangella	Q1 2017	Q1 2016	$82	$98
Ardglen - Kankool	Q1 2015	Q2 2016	$60	$67
Willow Tree north	Q1 2016	Q1 2016	$36	$42
Braefield north	Q3 2017	Q3 2017	$75	$84
Bells Gate south	Q2 2015	Q2 2015	$40	$45
Werris Creek south	Q1 2017	Q1 2017	$39	$49
Werris Creek bypass	Q1 2015	Q1 2017	$103	$116
Werris Creek north	Q1 2018	Q1 2018	$70	$94
Burilda north	Q1 2016	Q3 2017	$81	$96
Breeza north	Q1 2016	Q1 2016	$38	$45
486 km	Q1 2015	Q3 2015	$26	$29
Collygra	Q1 2015	Q3 2015	$26	$29
Congestion Projects				
Holding Roads ahead of KCT Arrivals		Q3 2017	$146	$189
Two Additional Departure Roads		Q2 2015	$52	$59
Train Parkup		Q3 2017	$312	$406
Down Relief Hubs		Q4 2017	$333	$439

Notes:

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

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.

Table 8 - Recommended Projects, Delivery Schedule and Costs for Prospective Volumes

8

Network capacity with revised project scope and timing

Net surplus capacity by sector (that is, track path capacity less path demand) based on the project timings proposed in this Strategy for contracted volumes, and using the calculation methodology set out in Chapter 1, is shown in Table 9. Table 10 shows the same net surplus capacity in tonnage terms.

Tables 11 and 12 show the equivalent calculation for prospective volumes, for train numbers and tonnage respectively.

For prospective volumes there are a number of instances where track capacity falls short of demand. (shown red) This has arisen because ARTC will not be able to advance the project through the planning approvals process and construct the project by the 'required by' date.

However, as noted in Chapter 1 the prospective volumes adopted for this Strategy exceed ARTC's expectations of terminal capacity and the volumes are unlikely to be achieved in practice. To the extent that volumes are adjusted to ramp-up in line with terminal capacity , the required by dates will move further into the future and better align with the achievable construction program.

It is also important to note that the change in the adjustment factor arising from the formalisation of the Target Monthly Tolerance Cap and implemented from 2015 has meant a bigger nominal buffer between track capacity and demand. As such, the shortfall in capacity is to some extent a shortfall in the buffer rather than a shortage of actual capacity.

	2012				2013				2014				2015				2016				2017			
Narrabri - Boggabri	5.8	4.0	4.0	4.0	4.0	4.0	3.7	3.7	3.8	3.8	3.6	3.6	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Boggabri - Gunnedah	8.5	6.6	6.3	6.2	5.9	4.7	2.9	2.6	2.0	2.0	1.8	1.8	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Gunnedah - Watermark Jct	4.8	2.9	2.5	2.4	2.1	1.0	6.5	6.3	5.7	5.7	5.5	5.5	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Watermark Jct - Caroona Jct	4.9	3.0	2.6	2.5	2.2	1.1	8.4	8.2	7.6	7.6	7.4	7.4	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Caroona Jct - Werris Creek	8.8	6.8	6.5	6.4	6.1	5.0	3.1	2.9	2.3	2.3	2.1	2.1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Werris Creek - Scone	2.8	0.9	3.5	3.3	4.8	3.7	1.8	1.5	1.1	1.1	0.9	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Scone - Dartbrook	6.9	5.0	4.6	4.5	4.2	3.1	1.2	1.0	0.5	0.5	0.3	0.3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Dartbrook - Muswellbrook	24.5	22.6	22.3	22.2	21.9	20.8	18.9	18.7	18.2	18.2	18.0	18.0	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
Cobbora - Ulan	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.4	4.4	2.8	2.8	2.4	2.4	1.9	1.9	1.9	1.9	1.3	1.3
Ulan - Moolarben	16.2	16.2	16.2	16.2	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	13.7	13.7	12.2	12.2	11.7	11.7	11.2	11.2	11.2	11.2	10.7	10.7
Moolarben - Wilpingjong	14.0	14.0	14.0	14.0	12.4	12.4	12.4	12.4	11.2	11.2	11.2	11.2	10.2	10.2	8.7	8.7	8.2	8.2	7.7	7.7	7.7	7.7	7.2	7.2
Wilpingjong - Bylong	6.5	6.5	6.5	6.5	4.8	6.4	6.4	6.4	5.3	5.3	5.3	5.3	4.3	4.3	2.8	2.8	2.1	2.1	1.6	1.6	1.6	1.6	1.0	1.0
Bylong - Ferndale	5.2	5.2	5.2	5.2	3.5	3.5	3.5	3.5	2.4	3.7	3.7	3.7	2.9	2.9	1.3	1.3	0.6	0.6	0.2	0.2	0.2	0.2	0.2	0.2
Ferndale - Mangoola	12.6	12.6	12.6	12.6	11.0	11.0	11.0	11.0	9.8	9.8	9.8	9.8	8.7	8.7	7.1	7.1	6.4	6.4	5.9	5.9	5.9	5.9	5.4	5.4
Mangoola - Mt Pleasant	9.2	9.2	9.2	9.2	7.4	7.4	7.4	11.7	10.1	10.1	10.1	10.1	8.5	8.5	6.9	6.9	6.5	6.5	6.0	6.0	6.0	6.0	5.4	5.4
Mt Pleasant - Bengalla	9.2	9.2	9.2	9.2	5.5	5.5	5.5	9.7	7.2	7.2	7.2	7.2	5.5	5.5	4.0	4.0	3.5	3.5	3.1	3.1	3.1	3.1	2.5	2.5
Bengalla - Muswellbrook	47.9	47.9	47.7	47.7	43.9	43.9	43.9	50.0	47.5	47.5	47.5	47.5	43.4	43.4	41.9	41.9	41.4	41.4	41.0	41.0	41.0	41.0	40.4	40.4
Muswellbrook - Antiene	29.8	27.9	27.4	27.3	23.1	22.0	20.1	19.9	16.8	16.8	16.6	16.6	13.6	13.6	12.0	12.0	75.6	75.6	75.1	75.1	75.1	75.1	74.5	74.5
Antiene - Drayton	74.8	72.9	72.4	72.3	68.1	67.0	65.1	64.9	61.8	61.8	61.6	61.6	56.3	56.3	54.7	54.7	54.3	54.3	53.8	53.8	53.8	53.8	53.2	53.2
Drayton - Newdell	58.3	56.4	54.8	54.6	50.5	49.4	47.5	47.3	44.6	44.6	43.4	43.4	38.9	38.9	36.3	36.3	35.6	35.6	34.5	34.5	34.5	34.5	33.1	33.1
Newdell - Mt Owen	83.4	81.5	79.5	79.3	73.6	72.4	70.6	70.3	67.4	67.4	66.2	66.2	59.9	59.9	57.3	57.3	56.6	56.6	55.5	55.5	55.5	55.5	54.1	54.1
Mt Owen - Camberwell	17.4	15.5	13.5	13.4	43.6	42.5	40.6	40.4	37.5	37.5	36.2	36.2	31.3	31.3	28.7	28.7	28.0	28.0	26.9	26.9	26.9	26.9	25.6	25.6
Camberwell - Whittingham	51.2	49.3	47.3	47.2	41.5	40.3	38.4	38.2	35.3	35.3	34.0	34.0	29.2	29.2	26.6	26.6	25.9	25.9	24.7	24.7	24.7	24.7	23.4	23.4
Whittingham - Maitland	45.6	43.7	41.4	41.3	34.9	33.8	31.9	31.6	27.1	27.1	25.8	25.8	20.4	20.4	17.8	17.8	56.0	56.0	54.9	54.9	54.9	54.9	53.6	53.6
Maitland - Bloomfield	98.3	96.4	94.1	93.9	87.5	86.3	84.4	84.2	78.7	78.7	77.4	77.4	69.4	69.4	66.8	66.8	64.9	64.9	63.8	63.8	63.8	63.8	62.4	62.4
Bloomfield - Sandgate	97.2	95.3	93.0	92.9	86.3	85.2	83.3	83.1	77.0	77.0	75.7	75.7	67.7	67.7	65.1	65.1	63.1	63.1	62.0	62.0	62.0	62.0	60.6	60.6

Table 9 - Net Capacity (paths) by sector for contracted volume

	2012				2013				2014				2015				2016				2017			
Narrabri - Boggabri	12.5	8.6	8.6	8.6	8.7	8.7	8.1	8.1	8.2	8.2	7.8	7.8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Boggabri - Gunnedah	18.0	14.0	13.3	13.2	12.6	10.2	6.2	5.7	4.4	4.4	4.0	4.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Gunnedah - Watermark Jct	10.1	6.1	5.4	5.2	4.6	2.2	14.0	13.5	12.3	12.3	11.9	11.9	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Watermark Jct - Caroona Jct	10.3	6.3	5.6	5.4	4.8	2.4	18.1	17.6	16.4	16.4	16.0	16.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Caroona Jct - Werris Creek	18.6	14.6	13.9	13.7	13.1	10.7	6.7	6.2	5.0	5.0	4.6	4.6	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Werris Creek - Scone	5.7	1.9	7.1	6.9	9.8	7.6	3.7	3.2	2.2	2.2	1.8	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Scone - Dartbrook	13.7	10.1	9.5	9.3	8.7	6.5	2.6	2.1	1.1	1.1	0.7	0.7	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Dartbrook - Muswellbrook	49.1	46.2	45.4	45.5	45.0	43.0	39.5	39.0	38.6	38.6	38.2	38.2	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Cobbora - Ulan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.9	6.6	6.6	5.3	5.3	5.3	5.3	3.7	3.7
Ulan - Moolarben	49.3	49.3	49.3	49.3	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	41.8	41.8	36.3	36.3	34.7	34.7	33.2	33.2	33.2	33.2	31.4	31.4
Moolarben - Wilpingjong	39.9	39.9	39.9	39.9	35.6	35.6	35.6	35.6	31.9	31.9	31.9	31.9	29.0	29.0	24.6	24.6	23.2	23.2	21.9	21.9	21.9	21.9	20.3	20.3
Wilpingjong - Bylong	18.3	18.3	18.3	18.3	13.7	18.2	18.2	18.2	14.9	14.9	14.9	14.9	12.3	12.3	7.8	7.8	5.8	5.8	4.5	4.5	4.5	4.5	2.9	2.9
Bylong - Ferndale	14.7	14.7	14.7	14.7	10.0	10.0	10.0	10.0	6.7	10.6	10.6	10.6	8.2	8.2	3.8	3.8	1.8	1.8	0.5	0.5	0.5	0.5	0.5	0.5
Ferndale - Mangoola	35.8	35.8	35.8	35.8	31.3	31.3	31.3	31.3	27.8	27.8	27.8	27.8	24.5	24.5	20.1	20.1	18.1	18.1	16.8	16.8	16.8	16.8	15.2	15.2
Mangoola - Mt Pleasant	26.4	26.4	26.4	26.4	21.4	21.4	21.4	33.6	29.0	29.0	29.0	29.0	24.4	24.4	19.8	19.8	18.5	18.5	17.2	17.2	17.2	17.2	15.5	15.5
Mt Pleasant - Bengalla	26.4	26.4	26.4	26.4	16.0	16.0	16.0	28.2	20.8	20.8	20.8	20.8	16.0	16.0	11.5	11.5	10.2	10.2	8.8	8.8	8.8	8.8	7.2	7.2
Bengalla - Muswellbrook	138.6	138.6	138.1	138.1	127.8	127.8	127.8	145.8	137.8	137.8	137.8	137.8	126.1	126.1	121.3	121.3	119.7	119.7	118.3	118.3	118.3	118.3	116.6	116.6
Muswellbrook - Antiene	79.2	72.8	71.3	71.1	61.5	58.0	52.4	51.8	44.2	44.2	43.7	43.7	35.8	35.8	31.8	31.8	199.3	199.3	198.3	198.3	198.3	198.3	197.0	197.0
Antiene - Drayton	198.9	190.4	188.6	188.4	181.2	176.9	169.9	169.1	162.4	162.4	161.8	161.8	148.0	148.0	144.3	144.3	143.1	143.1	142.0	142.0	142.0	142.0	140.6	140.6
Drayton - Newdell	157.3	149.8	144.9	144.7	135.6	131.8	125.5	124.7	118.2	118.2	114.7	114.7	103.0	103.0	95.1	95.1	92.2	92.2	89.4	89.4	89.4	89.4	86.0	86.0
Newdell - Mt Owen	224.4	216.8	211.2	211.0	198.0	194.1	187.5	186.8	179.3	179.3	175.7	175.7	159.1	159.1	150.9	150.9	147.7	147.7	144.9	144.9	144.9	144.9	141.4	141.4
Mt Owen - Camberwell	47.4	41.7	36.3	36.0	118.4	114.8	108.9	108.2	100.4	100.4	96.9	96.9	83.9	83.9	76.3	76.3	73.8	73.8	70.9	70.9	70.9	70.9	67.3	67.3
Camberwell - Whittingham	139.2	132.7	127.1	126.8	112.4	108.8	103.0	102.3	94.6	94.6	91.1	91.1	78.1	78.1	70.5	70.5	68.1	68.1	65.2	65.2	65.2	65.2	61.6	61.6
Whittingham - Maitland	125.7	119.4	112.9	112.6	95.7	92.3	86.5	85.9	73.7	73.7	70.1	70.1	55.6	55.6	48.1	48.1	150.3	150.3	147.3	147.3	147.3	147.3	143.6	143.6
Maitland - Bloomfield	260.2	253.5	247.4	247.1	232.5	228.8	222.6	221.9	206.5	206.5	203.0	203.0	184.0	184.0	176.0	176.0	169.6	169.6	166.7	166.7	166.7	166.7	163.3	163.3
Bloomfield - Sandgate	258.2	251.4	245.3	245.1	230.1	226.4	220.2	219.5	202.8	202.8	199.3	199.3	180.0	180.0	172.1	172.1	165.5	165.5	162.6	162.6	162.6	162.6	159.1	159.1

Table 10 - Net Capacity (tonnage) by sector for contracted volume

	2012				2013				2014				2015				2016				2017			
Narrabri - Boggabri	5.8	4.0	4.0	4.0	4.0	4.0	3.7	3.7	3.8	3.8	3.6	3.6	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Boggabri - Gunnedah	8.5	6.6	6.3	6.2	5.9	4.7	2.9	2.6	1.7	1.7	1.6	1.6	-2.3	-2.3	6.7	6.7	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Gunnedah - Watermark Jct	4.8	2.9	2.5	2.4	2.1	1.0	6.5	6.3	5.4	5.4	5.2	5.2	1.9	1.9	1.9	1.9	-0.4	-0.4	-0.4	-0.4	-0.9	-0.9	-0.9	-0.9
Watermark Jct - Caroona Jct	4.9	3.0	2.6	2.5	2.2	1.1	8.4	8.2	7.3	7.3	7.1	7.1	1.2	1.2	1.2	1.2	6.7	6.7	6.7	6.7	6.2	6.2	6.2	6.2
Caroona Jct - Werris Creek	8.8	6.8	6.5	6.4	6.1	5.0	3.1	2.9	2.0	2.0	1.8	1.8	-3.8	-3.8	-3.8	-3.8	-7.9	-7.9	-7.9	-7.9	-1.0	-1.0	-1.0	1.1
Werris Creek - Scone	2.8	0.9	3.5	3.3	4.8	3.7	1.8	1.5	0.8	0.8	0.6	0.6	-4.2	-1.7	-1.7	-1.7	-5.9	-5.9	-5.9	-5.9	-3.3	-3.3	0.7	2.2
Scone - Dartbrook	6.9	5.0	4.6	4.5	4.2	3.1	1.2	1.0	0.2	0.2	0.1	0.1	6.0	6.0	6.0	6.0	7.4	7.4	7.4	7.4	5.6	5.6	5.6	5.6
Dartbrook - Muswellbrook	24.5	22.6	22.3	22.2	21.9	20.8	18.9	18.7	17.9	17.9	17.7	17.7	11.2	11.2	11.2	11.2	7.1	7.1	7.1	7.1	5.2	5.2	5.2	5.2
Cobbora - Ulan	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.4	4.4	2.8	2.8	2.4	2.4	1.9	1.9	1.9	1.9	1.3	1.3
Ulan - Moolarben	16.2	16.2	16.2	16.2	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	13.7	13.7	12.2	12.2	11.7	11.7	11.2	11.2	11.2	11.2	10.7	10.7
Moolarben - Wilpingjong	14.0	14.0	14.0	14.0	12.4	12.4	12.4	12.4	11.2	11.2	11.2	11.2	10.2	10.2	8.7	8.7	6.9	6.9	6.4	6.4	6.4	6.4	5.9	5.9
Wilpingjong - Bylong	6.5	6.5	6.5	6.5	4.8	6.4	6.4	6.4	5.3	5.3	5.3	5.3	3.4	3.4	1.8	1.8	0.0	0.0	-0.5	-0.5	1.0	1.0	0.5	0.5
Bylong - Ferndale	5.2	5.2	5.2	5.2	3.5	3.5	3.5	3.5	2.4	3.7	3.7	3.7	0.7	0.7	-0.9	-0.9	-3.7	-3.7	-4.2	1.0	0.8	0.8	0.2	3.9
Ferndale - Mangoola	12.6	12.6	12.6	12.6	11.0	11.0	11.0	11.0	9.8	9.8	9.8	9.8	6.5	6.5	4.9	4.9	1.3	1.3	0.9	0.9	0.7	0.7	9.2	9.2
Mangoola - Mt Pleasant	9.2	9.2	9.2	9.2	7.4	7.4	7.4	11.7	10.1	10.1	10.1	10.1	6.3	6.3	4.7	4.7	1.4	1.4	0.9	7.0	6.8	6.8	7.7	7.7
Mt Pleasant - Bengalla	9.2	9.2	9.2	9.2	5.5	5.5	5.5	9.7	7.2	7.2	7.2	7.2	3.3	3.3	1.8	1.8	-1.6	-1.6	-2.0	4.0	3.9	3.9	4.8	4.8
Bengalla - Muswellbrook	47.9	47.9	47.7	47.7	43.9	43.9	43.9	50.0	47.5	47.5	47.5	47.5	41.0	41.0	39.5	39.5	36.2	36.2	35.7	35.7	35.5	35.5	35.0	35.0
Muswellbrook - Antiene	29.8	27.9	27.4	27.3	23.1	22.0	20.1	19.9	16.6	16.6	16.4	16.4	6.0	6.0	4.4	4.4	60.9	60.9	60.5	60.5	58.5	58.5	57.9	57.9
Antiene - Drayton	74.8	72.9	72.4	72.3	68.1	67.0	65.1	64.9	61.6	61.6	61.4	61.4	48.6	48.6	47.1	47.1	39.6	39.6	39.1	39.1	37.2	37.2	36.6	36.6
Drayton - Newdell	58.3	56.4	54.8	54.6	50.3	49.2	47.3	47.1	44.2	44.2	42.9	42.9	31.1	31.1	28.5	28.5	20.8	20.8	19.7	19.7	17.7	17.7	16.3	16.3
Newdell - Mt Owen	83.4	81.5	79.5	79.3	73.4	72.3	70.4	70.2	67.0	67.0	65.7	65.7	52.1	52.1	49.5	49.5	40.8	40.8	39.7	39.7	37.7	37.7	36.4	36.4
Mt Owen - Camberwell	17.4	15.5	13.5	13.4	43.4	42.3	40.4	40.2	37.0	37.0	35.7	35.7	23.5	23.5	20.9	20.9	12.3	12.3	11.2	11.2	9.2	9.2	7.8	7.8
Camberwell - Whittingham	51.2	49.3	47.3	47.2	41.3	40.2	38.3	38.0	34.9	34.9	33.6	33.6	21.4	21.4	18.8	18.8	10.1	10.1	9.0	9.0	7.0	7.0	5.7	5.7
Whittingham - Maitland	45.6	43.7	41.4	41.3	34.7	33.6	31.7	31.5	26.6	26.6	25.4	25.4	12.1	12.1	9.5	9.5	37.4	37.4	36.3	36.3	33.2	33.2	31.9	31.9
Maitland - Bloomfield	98.3	96.4	94.1	93.9	87.3	86.2	84.3	84.0	78.2	78.2	77.0	77.0	61.1	61.1	58.5	58.5	46.3	46.3	45.1	45.1	42.1	42.1	40.7	40.7
Bloomfield - Sandgate	97.2	95.3	93.0	92.9	86.2	85.0	83.1	82.9	76.6	76.6	75.3	75.3	59.4	59.4	56.8	56.8	43.3	43.3	42.2	42.2	39.2	39.2	37.8	37.8

Table 11 - Net Capacity (paths) by sector for prospective volume

	2012				2013				2014				2015				2016				2017			
Narrabri - Boggabri	12.5	8.6	8.6	8.6	8.7	8.7	8.1	8.1	8.2	8.2	7.8	7.8	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Boggabri - Gunnedah	18.0	14.0	13.3	13.2	12.6	10.2	6.2	5.7	3.8	3.8	3.4	3.4	-5.0	-5.0	14.4	14.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Gunnedah - Watermark Jct	10.1	6.1	5.4	5.2	4.6	2.2	14.0	13.5	11.7	11.7	11.3	11.3	4.1	4.1	4.1	4.1	-1.0	-1.0	-1.0	-1.0	-1.9	-1.9	-1.9	-1.9
Watermark Jct - Caroona Jct	10.3	6.3	5.6	5.4	4.8	2.4	18.1	17.6	15.8	15.8	15.4	15.4	2.6	2.6	2.6	2.6	14.5	14.5	14.5	14.5	13.5	13.5	13.5	13.5
Caroona Jct - Werris Creek	18.6	14.6	13.9	13.7	13.1	10.7	6.7	6.2	4.4	4.4	4.0	4.0	-8.2	-8.2	-8.2	-8.2	-17.2	-17.2	-17.2	-17.2	-2.1	-2.1	-2.1	2.3
Werris Creek - Scone	5.7	1.9	7.1	6.9	9.8	7.6	3.7	3.2	1.7	1.7	1.3	1.3	-9.0	-3.7	-3.7	-3.7	-12.6	-12.6	-12.6	-12.6	-7.2	-7.2	1.5	4.8
Scone - Dartbrook	13.7	10.1	9.5	9.3	8.7	6.5	2.6	2.1	0.5	0.5	0.1	0.1	12.8	12.8	12.8	12.8	15.9	15.9	15.9	15.9	12.0	12.0	12.0	12.0
Dartbrook - Muswellbrook	49.1	46.2	45.4	45.5	45.0	43.0	39.5	39.0	38.1	38.1	37.7	37.7	24.0	24.0	24.0	24.0	15.2	15.2	15.2	15.2	11.3	11.3	11.3	11.3
Cobbora - Ulan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.9	7.9	6.6	6.6	5.3	5.3	5.3	5.3	3.7	3.7
Ulan - Moolarben	49.3	49.3	49.3	49.3	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	41.8	41.8	36.3	36.3	34.7	34.7	33.2	33.2	33.2	33.2	31.4	31.4
Moolarben - Wilpingjong	39.9	39.9	39.9	39.9	35.6	35.6	35.6	35.6	31.9	31.9	31.9	31.9	29.0	29.0	24.6	24.6	19.3	19.3	18.0	18.0	18.0	18.0	16.4	16.4
Wilpingjong - Bylong	18.3	18.3	18.3	18.3	13.7	18.2	18.2	18.2	14.9	14.9	14.9	14.9	9.5	9.5	5.1	5.1	0.0	0.0	-1.3	-1.3	2.9	2.9	1.3	1.3
Bylong - Ferndale	14.7	14.7	14.7	14.7	10.0	10.0	10.0	10.0	6.7	10.6	10.6	10.6	1.9	1.9	-2.5	-2.5	-10.4	-10.4	-11.7	2.7	2.2	2.2	0.6	10.9
Ferndale - Mangoola	35.8	35.8	35.8	35.8	31.3	31.3	31.3	31.3	27.8	27.8	27.8	27.8	18.1	18.1	13.7	13.7	3.7	3.7	2.4	2.4	1.9	1.9	25.7	25.7
Mangoola - Mt Pleasant	26.4	26.4	26.4	26.4	21.4	21.4	21.4	33.6	29.0	29.0	29.0	29.0	17.9	17.9	13.4	13.4	3.9	3.9	2.6	19.7	19.2	19.2	21.8	21.8
Mt Pleasant - Bengalla	26.4	26.4	26.4	26.4	16.0	16.0	16.0	28.2	20.8	20.8	20.8	20.8	9.5	9.5	5.0	5.0	-4.4	-4.4	-5.7	11.5	11.0	11.0	13.5	13.5
Bengalla - Muswellbrook	138.6	138.6	138.1	138.1	127.8	127.8	127.8	145.8	137.8	137.8	137.8	137.8	118.5	118.5	113.8	113.8	103.4	103.4	102.1	102.1	101.6	101.6	99.9	99.9
Muswellbrook - Antiene	79.2	72.8	71.3	71.1	61.5	58.0	52.4	51.8	43.4	43.4	42.9	42.9	15.4	15.4	11.4	11.4	155.9	155.9	154.8	154.8	149.0	149.0	147.7	147.7
Antiene - Drayton	198.9	190.4	188.6	188.4	181.2	176.9	169.9	169.1	161.5	161.5	160.8	160.8	125.3	125.3	121.7	121.7	101.3	101.3	100.2	100.2	94.7	94.7	93.3	93.3
Drayton - Newdell	157.3	149.8	144.9	144.7	135.2	131.3	125.0	124.3	116.9	116.9	113.4	113.4	80.8	80.8	73.5	73.5	52.7	52.7	49.9	49.9	44.7	44.7	41.3	41.3
Newdell - Mt Owen	224.4	216.8	211.2	211.0	197.6	193.6	187.1	186.3	178.0	178.0	174.3	174.3	136.2	136.2	128.5	128.5	104.8	104.8	102.0	102.0	96.5	96.5	93.2	93.2
Mt Owen - Camberwell	47.4	41.7	36.3	36.0	117.9	114.3	108.4	107.7	99.2	99.2	95.6	95.6	62.0	62.0	54.8	54.8	31.8	31.8	28.9	28.9	23.6	23.6	20.2	20.2
Camberwell - Whittingham	139.2	132.7	127.1	126.8	111.9	108.4	102.5	101.8	93.3	93.3	89.8	89.8	56.3	56.3	49.1	49.1	26.2	26.2	23.3	23.3	18.1	18.1	14.6	14.6
Whittingham - Maitland	125.7	119.4	112.9	112.6	95.2	91.8	86.1	85.4	72.4	72.4	68.9	68.9	32.6	32.6	25.4	25.4	98.9	98.9	95.9	95.9	87.6	87.6	84.1	84.1
Maitland - Bloomfield	260.2	253.5	247.4	247.1	232.0	228.3	222.2	221.5	205.2	205.2	201.7	201.7	160.3	160.3	152.7	152.7	119.9	119.9	117.0	117.0	108.9	108.9	105.4	105.4
Bloomfield - Sandgate	258.2	251.4	245.3	245.1	229.6	226.0	219.8	219.1	201.5	201.5	198.1	198.1	156.3	156.3	148.7	148.7	112.9	112.9	110.0	110.0	101.8	101.8	98.3	98.3

Table 12 - Net Capacity (tonnage) by sector for prospective volume