2019 HUNTER VALLEY CORRIDOR CAPACITY STRATEGY

May 2019

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INTRODUCTION

Context

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

In early 2005, ARTC began to release an annual Hunter Valley Corridor Capacity Strategy (HVCCS) setting out how ARTC planned to ensure that rail corridor capacity in the Hunter Valley would stay ahead of coal demand.

This HVCCS is the twelfth of these annual strategies. With the release of the last Strategy the timing was changed from mid calendar year to the start of the calendar year, which better aligns with other coal chain management processes. While the last Strategy was released as the 2017 Hunter Valley Corridor Capacity Strategy (the 2017 Strategy), the opportunity has now been taken to provide greater clarity by changing the Strategy name to align to the coming year. Hence this version is referenced as the "2019 Strategy". It should be noted that the first year of analysis in the 2017 Strategy was 2018 and 2019 is the first year of analysis in this Strategy.

The Hunter Valley rail network (figure 1-1) is an integral part of the world's largest coal export supply chain. It consists of a dedicated double track 'coal line' between Port Waratah and Maitland, a shared double track line (with some significant stretches of third track) from Maitland to Muswellbrook in the upper Hunter Valley, and a shared single track with passing loops from that point north and west.

Nearly all export coal shipped through Newcastle is transported by rail across this network for shipping from Carrington (Port Waratah), or one of the two terminals on Kooragang Island.

In common with the earlier strategies, this Strategy identifies the future constraints on the coal network's capacity, 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 (HVAU). It also identifies those projects that would be required to accommodate prospective volumes that have not yet been the subject of a contractual commitment, though this is a hypothetical scenario only and does not imply that those volumes will be contracted.

For the 2017 Strategy a 'most likely' volume scenario was added to provide a richer level of analysis in the current demand environment. This 2019 Strategy again provides a 'most likely' volume forecast in addition to the usual 'contracted' and 'prospective' scenarios. For this year the most likely and prospective scenarios have been directly provided by producers and supported by the Rail Capacity Group (RCG).

This Strategy identifies a preliminary scope of work to accommodate contracted plus prospective volumes of up to 253 mtpa. This is a small increase in the peak volume compared to the 2017 Strategy. It also identifies a pathway for meeting demand under the most likely scenario, which peaks at 225 mtpa. Contracted volumes do not require any investment for capacity.

For administrative purposes under the HVAU, the network is categorised into three zones, Ports - Bengalla (zone 1), Bengalla - Ulan (zone 2) and Muswellbrook - Narrabri (zone 3). This Strategy sometimes refers to these zones, noting that for simplicity Muswellbrook - Bengalla is sometimes treated as being in zone 2 as it is located on the Ulan line.

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.

HVCCC Master Planning

Capacity analysis in this Strategy takes 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. This broader coal supply chain capacity analysis is undertaken by the Hunter Valley Coal Chain Coordinator (HVCCC).

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

ARTC is strongly supportive of this master planning process. It sees this 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.

The HVCCC also makes an annual declaration of the system capacity of the Hunter Valley coal chain, the Declared Inbound Throughput (DIT). This is the lesser of terminal system capacity and rail system capacity. For 2019, the HVCCC has determined a DIT that is less than track system capacity, that is, track system capacity does not represent a constraint on system throughput. HVCCC has forecast that track system capacity will not constrain currently contracted volumes.

Delivering capacity efficiently

The 2016 and 2017 Strategies included an explicit refocussing of ARTC's forward investment program toward technology and innovation with a view to increasing efficiency and lowering cost on a whole-of-coal-chain basis. Underpinning this approach is the introduction of new processes and technology under the ARTC Network Control Optimisation (ANCO) project to optimise ARTC's network control in the Hunter Valley through enhanced dynamic capability to manage

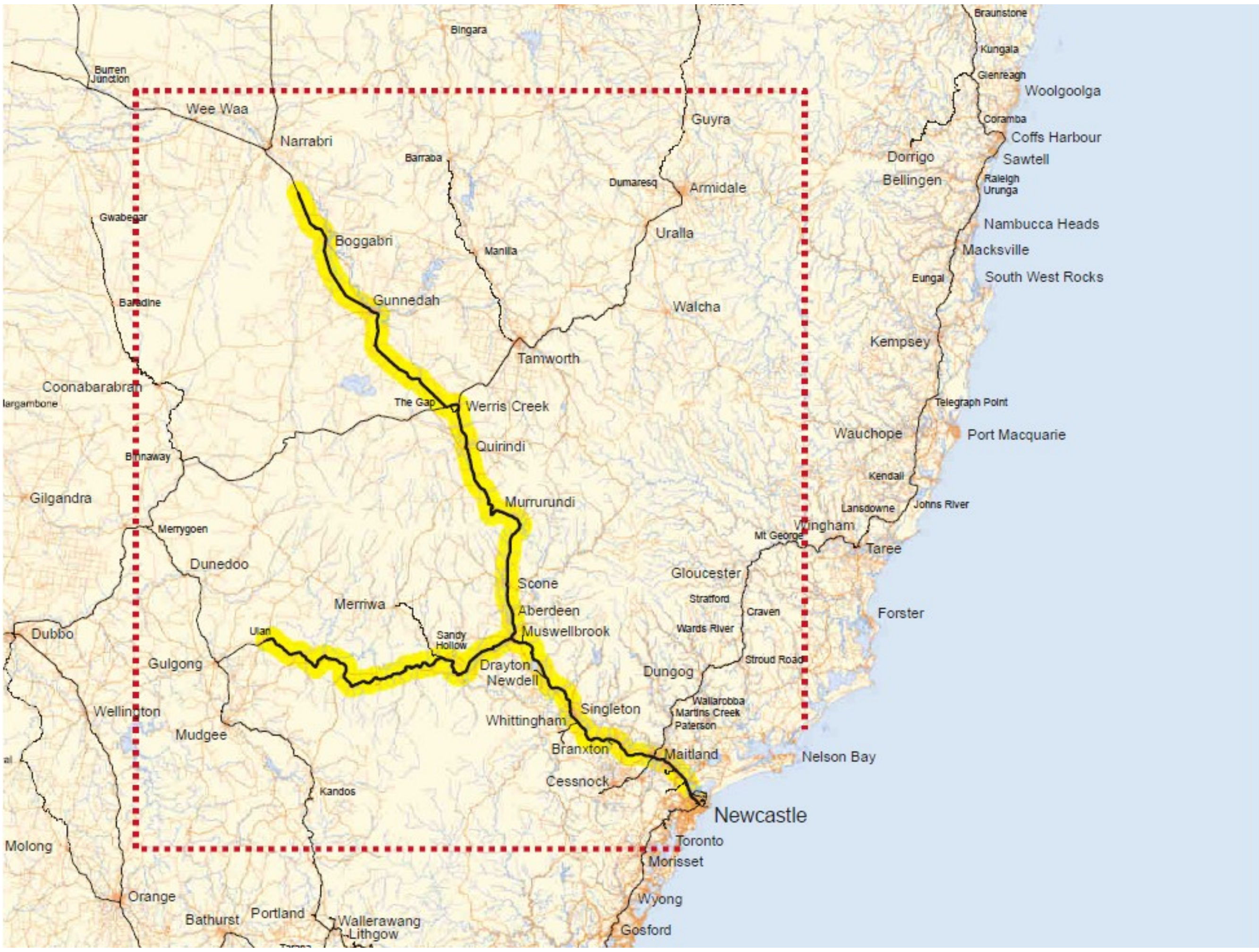

Figure 1-1 - The general location of the Hunter Valley network on the east coast of Australia.

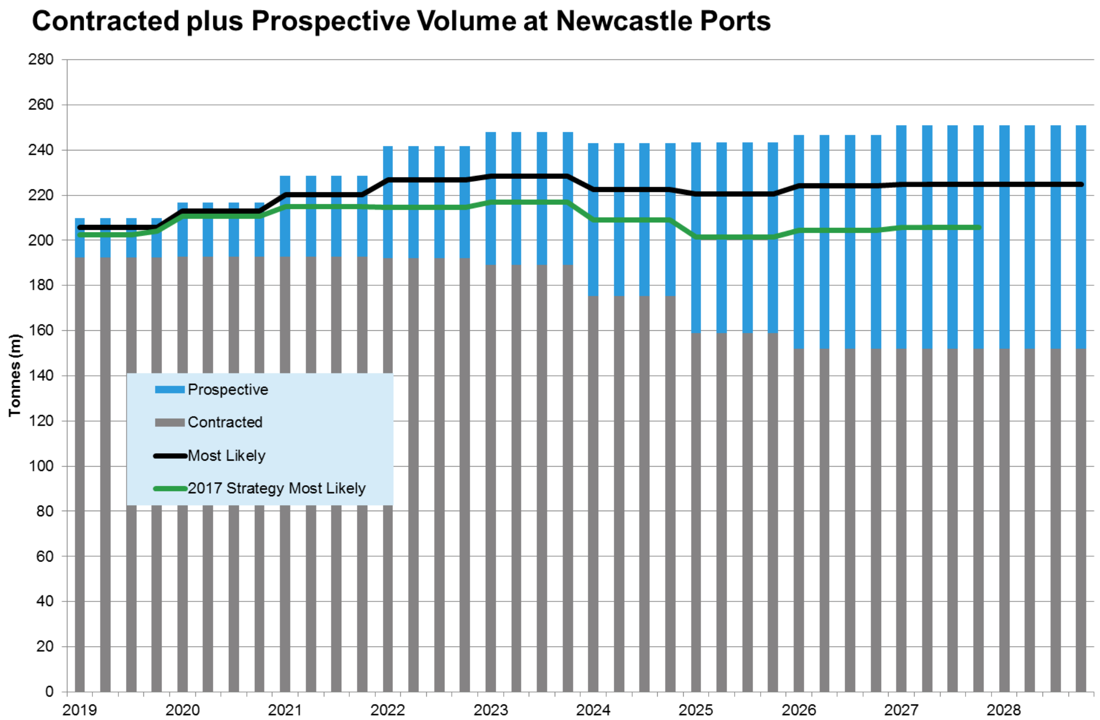

Figure 1-2 - Current Volume Forecasts vs. 2017 Strategy Volume Forecast, Newcastle Terminals (mtpa)

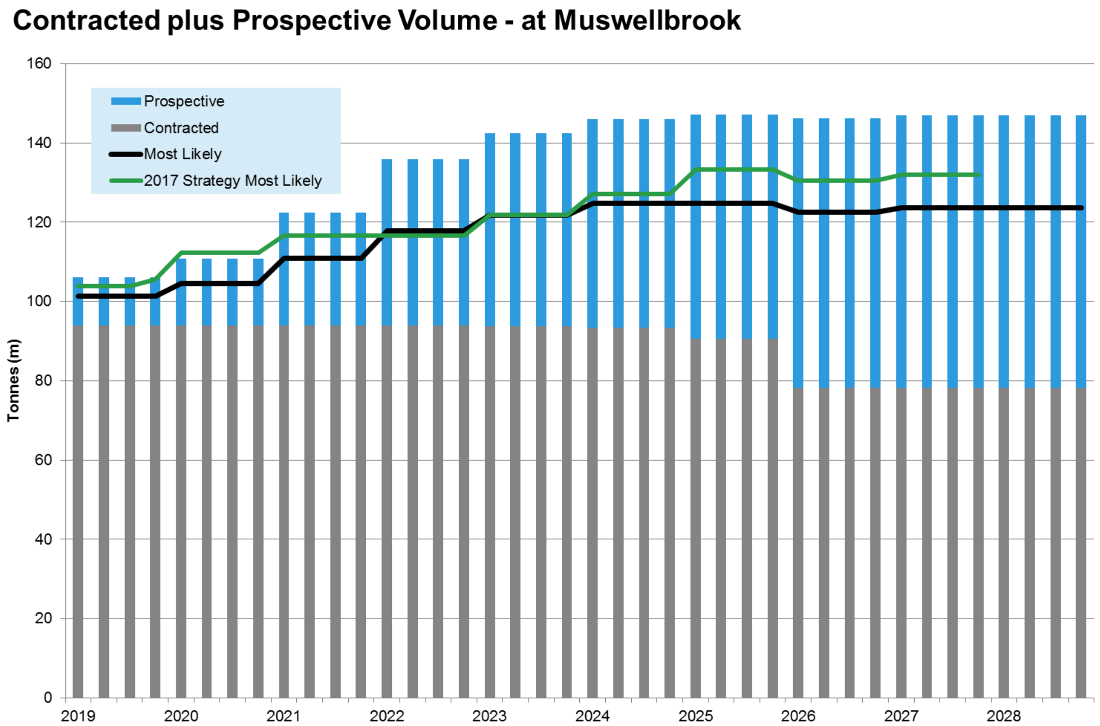

Figure 1-3 - Current Volume Forecasts vs. 2017 Strategy Volume Forecast, Muswellbrook (mtpa)

variation and streamline network wide train management.

This could in future be supplemented by implementation of the Advanced Train Management System (ATMS) which provides communications based safeworking.

While these initiatives offer significant improvements in efficiency, they also have the potential to increase utilisation of existing assets at relatively low cost.

The 2017 Strategy noted that despite the improvement in thermal coal prices the industry remained supportive of a philosophy of delivering capacity at the lowest possible cost. ARTC believes that this remains the preference of the industry.

The focus on technology and innovation therefore continues to align well with a strategy of delivering both increased efficiency and capacity. It recognises though that there remains a level of uncertainty around ATMS

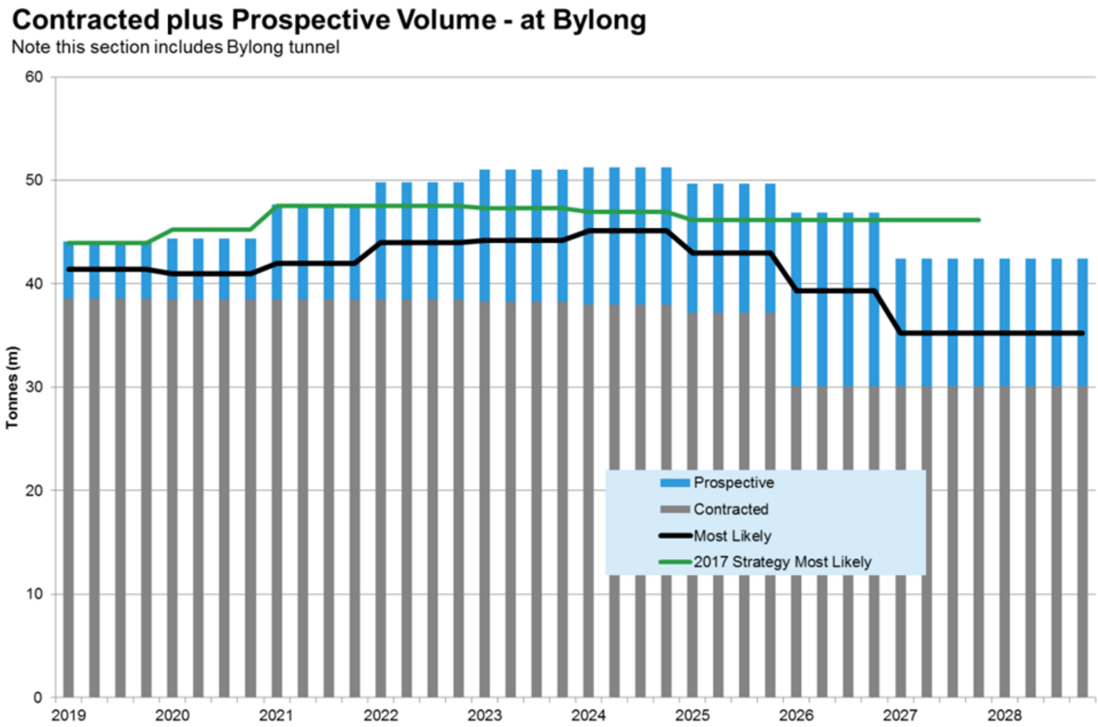

Figure 1-4 - Current Volume Forecasts vs. 2017 Strategy Volume Forecast, Bylong—Mangoola (mtpa)

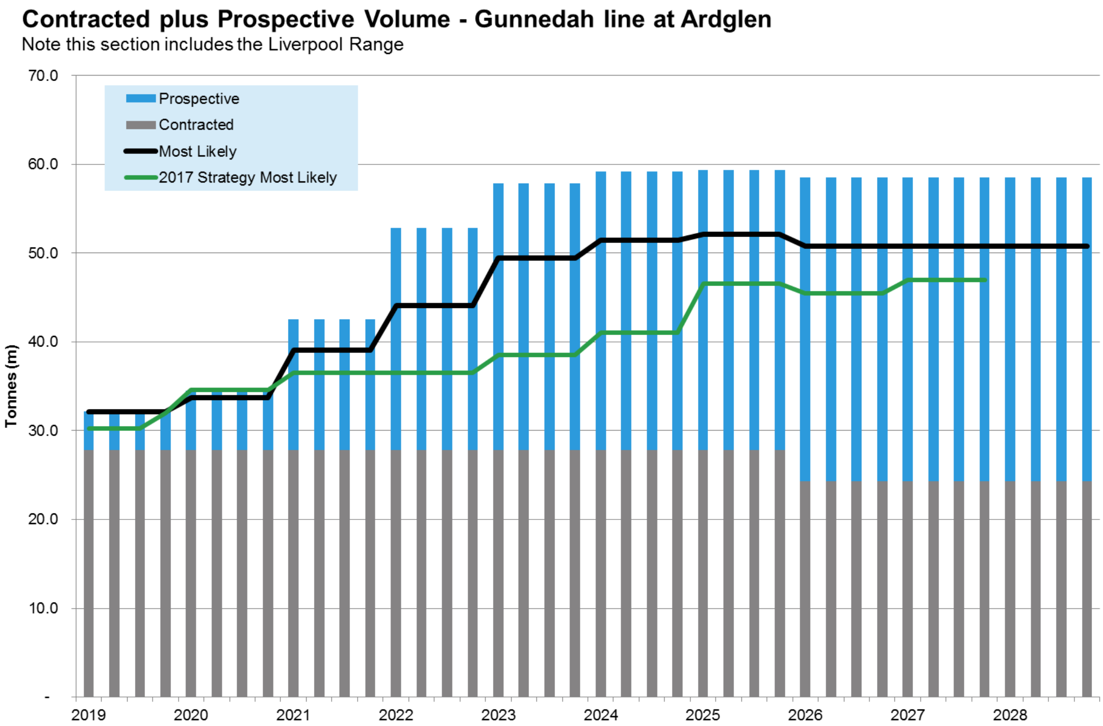

Figure 1-5 - Current Volume Forecast vs. 2017 Strategy Volume Forecast, Werris Creek—Muswellbrook (mtpa)

and accordingly also documents a pathway based on loop investments.

Volume Forecasts

ARTC contracts on a rolling 10 year "evergreen" basis. Contracted export coal volumes were 193.5 mtpa in Q4 2018. They are essentially stable at approximately this level until export volumes start to decline in 2024, falling to 152 mtpa in 2026 and holding constant from there.

Access holders chose to not roll-over some volume in the 2014-2016 period. This volume has not been replaced by new volume contracts at this point.

Contracted volumes also include up to 10.1 mtpa of domestic coal. This volume is included in all modelling of capacity and utilisation. It includes traffic from the Hunter Valley to Central Coast power stations. This volume declines to 8.8 mtpa in 2021 and to zero in 2026.

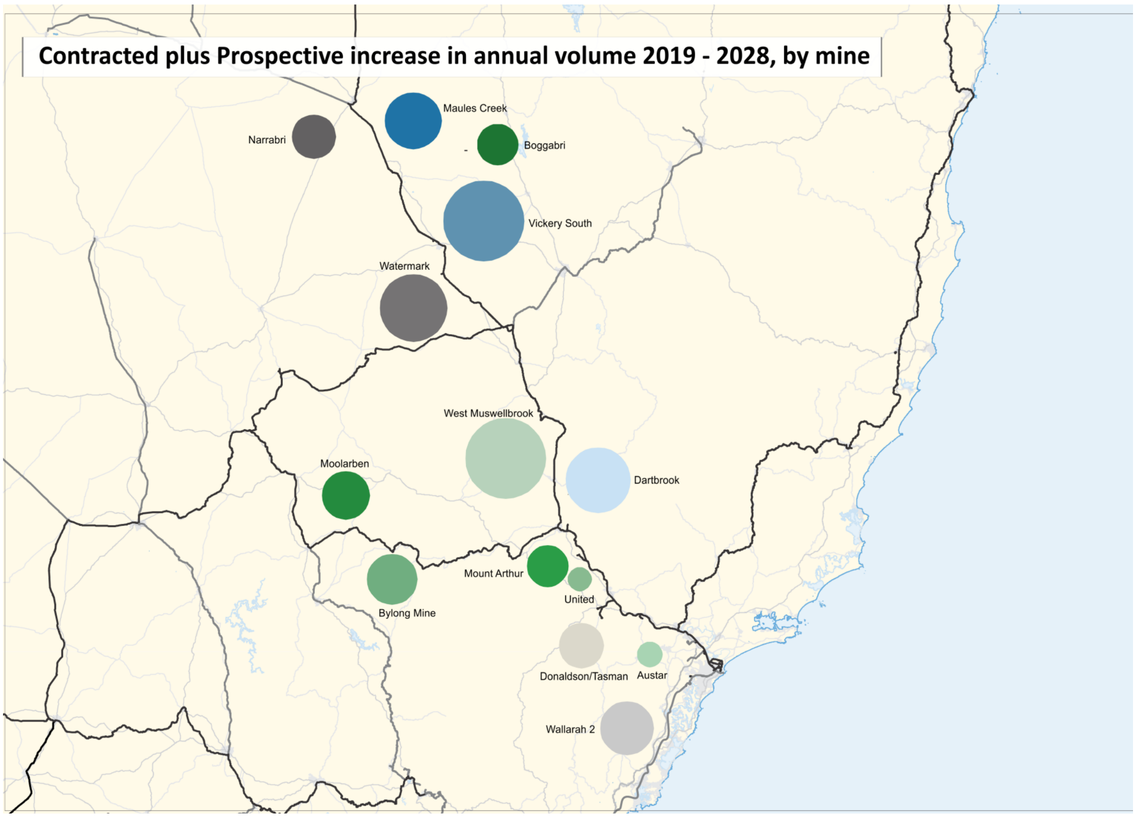

Figure 1-6 - Volume growth forecasts by mine, prospective scenario. Note that growth is represented by diameter

The Capacity Strategies have always set out a ‘prospective’ volume scenario to provide an understanding of the consequences of a high-end volume outcome. Last year the Strategy also included a most likely scenario as a middle ground to help support more detailed capacity planning.

The most likely and prospective scenarios have been sourced from current and potential access holders on the basis that:

- Most likely volume is the volume pathway that access holders consider is their best assessment of future volume; and
- Prospective volume is that which access holders consider is their best assessment of maximum potential volume over and above existing contracts.

Under the provisions of the HVAU, it is a matter for the RCG to determine the prospective volumes that are to be used for the purposes of this Strategy. The RCG comprises representatives of the access holders, along with the HVCCC and rail operators. The three volume scenarios have been reviewed and supported by the RCG .

Also, for the first time, this Strategy introduces a minor technical change whereby capacity is calculated directly from the contracted number of paths rather than the previous method of calculating paths from contracted volumes and assumed train configuration. Under the previous methodology a two per cent allowance was made for short-loading. This is not relevant in the modified method and results in a minor increase in capacity.

Inclusion of a volume in the most likely or prospective scenario does not imply that ARTC believes that the volume will eventuate. Rather, it is used as a guide as to the nature of the projects required in that growth environment.

The most likely and prospective scenarios include some forecasts that sit below currently contracted volumes. As ARTC has a contractual commitment to make the capacity required for that volume available, the strategy is based on the greater of contracted and producer nominated volumes. In practice it is possible that some un-needed contracted volume will be reallocated through the capacity trading system, which will reduce the network capacity requirement. While it is reasonable to assume therefore that actual outcomes will be less than the adopted volume scenarios, it is not possible to predict what the actual outcome will be.

The most likely scenario in this 2019 Strategy is somewhat more optimistic than the 2017 Strategy for volume at the port and from the Gunnedah basin. However, volume from the Ulan line is somewhat lower. Volume at Muswellbrook is broadly similar.

Prospective volumes are somewhat stronger than last year, from 2023 onwards, with the difference being a higher potential volume from both the Gunnedah basin and Upper Hunter.

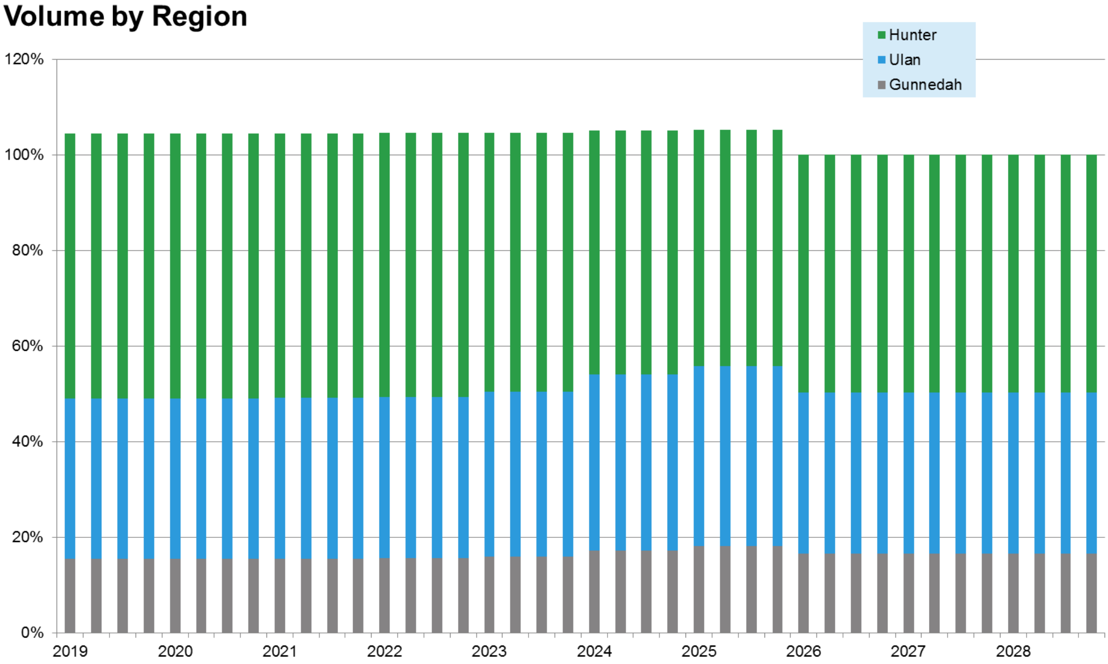

Figure 1-7 - Percentage of Trains by Sub-Network by Year, prospective scenario. Note that total train numbers are calculated as trains from each of the three zones as a proportion of all trains arriving at the port. The total number of trains exceeds 100% up to Q4 2025 due to domestic coal.

Figures 1-2 to 1-5 show the three volume scenarios. The most likely scenario is shown for both this Strategy (black line) and the 2017 Strategy (green line) to allow comparison. Volume is shown at the Newcastle terminals, at Muswellbrook, for the Bylong – Mangoola section (which is the majority of the Ulan line), and Werris Creek – Muswellbrook (which is representative of most of the Gunnedah basin line). Figure 1-6 shows net growth under the prospective scenario geographically, while figure 1-7 shows train numbers by zone. These figures highlight the ongoing transition of volume from south of Muswellbrook to the north and west.

There is also a small but notable volume of traffic from the Western and Southern coal fields exported through Newcastle rather than the traditional Port Kembla export pathway. This volume is generally using paths contracted from the coal fields south of Newcastle and on this basis has been implicitly recognised in the volume forecasts in this Strategy.

How this Strategy has been developed

The development of this Strategy retains the methodology of the 2017 Strategy.

In common with 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 the headway is defined as the time the front of a train enters a section between loops until the time that the rear of the train clears the turnout for the loop at the other end of the section. The longest headway between two loops on an homogenous volume section of network defines the capacity limit for that section. A transaction time is also 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. 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. 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 the ‘double-green’ principle. Under this principle both the next signal and the one after are at green, meaning that the driver theoretically will never see a yellow signal. This ensures that drivers should always be able to drive at full line speed.

After adjusting the capacity to reflect contracted non-coal trains, saleable paths are calculated as a percentage of practical coal paths. This adjustment covers cancellations, maintenance and a variability allowance.

The 2019 DIT assumes an unplanned loss rate of 8.0%, down from the 2018 DIT assumption of 8.3%. This has been adopted for the purposes of the cancellation rate in the adjustment factor calculation. It translates to an uplift rate of 8.7% compared to the 9.1% used in the 2017 Strategy.

Although ARTC's maintenance possession program has been held constant, the increase in the DIT and consequential increase in the target planning rate means that the effective maintenance loss rate increases from 12.1% to 12.3%.

Consistent with the HVAU, the variability buffer has been formalised in the form of the Target Monthly Tolerance Cap (TMTC). A 10% TMTC has historically applied across all three zones based on the stated preferences from the RCG. For 2019 only, a lower TMTC of 8% is proposed to be applied for Zone 3 based on consultation with the RCG and preferences from Zone 3 access holders.

The net effect is that the adjustment factor increases slightly, from 74.3% in the 2017 Strategy to 74.5% for zones 1 and 2 in this Strategy. The increase in the adjustment factor for Zone 3 to 75.9% is larger. This effectively gives a small net increase in theoretical capacity.

The build-up of the Adjustment Factor for this Strategy, and comparison with the assumptions in the 2017 Strategy, is shown in Table 1-1.

The 2016 Strategy described the background to moving from simulated performance as the basis for calculating capacity to actual performance derived from the digital train radio system. This was applied to the Gunnedah basin in 2016 and to the Ulan line in the 2017 Strategy. With this Strategy the use of actual data for headway calculations has been extended to the Muswellbrook - Ports section for the first time.

Adjustment factor	2017 Strategy	2019 Strategy
Cancellations	9.1%	8.7%
Maintenance	12.1%	12.3%
TMTC	10.0%	Zone 1+2: 10.0% Zone 3: 8%
Adjustment Factor	**74.3%**	**Zone 1+2: 74.5% Zone 3: 75.9%**

Table 1-1 - Adjustment Factor (note that the final total is arrived at by multiplication of the percentage rates rather than addition)

In addition, in 2017 the train radio system data was used for the first time to calculate actual rather than theoretical transaction times, where the transaction time accounts for signal clearance time, driver response and acceleration. These times were calculated as:

- the time from when the rear of a train exits the section until the train entering the section from the loop reaches normal actual train speed, less
- the time that a through train takes to cover the same distance.

The train performance and transaction time values adopted in 2017 have been maintained for this Strategy.

When two opposing trains arrive at a loop at around the same time it is necessary for both trains to stop, or at least slow down. One train is held on the mainline before the loop while the other train enters the loop. This can lead to a significant delay for the through train. The effect of these simultaneous arrivals is not picked-up in the process for calculating transaction times from the train location data.

The 2017 Strategy discussed the modelling of an appropriate allowance for this effect, taking into account both the time loss effect of a through train needing to stop and the probability of a simultaneous arrival event occurring. This suggested an appropriate allowance for

simultaneous arrival is in the order of one minute and that for a simultaneous entry loop, which has either a longer length or additional signalling, it saves around 15 seconds of this. These values were adopted as supplements to the actual calculated transaction time in 2017 and have been maintained for this Strategy.

Saleable & Surplus Capacity

At the time ARTC enters into contracts, capacity is assessed based on a set of assumptions. Previous Strategies have noted that the need to constantly update the cancellation and maintenance loss rates to reflect current actual performance could have the unintended consequence that as these change over time it may infer that there is a shortage of capacity even though the capacity existed at the time contracts were entered into and the changes may be external to ARTC. This is compounded by the inevitability of changes to section run times as the train fleet evolves and operational changes are made. Also, the increase in the accuracy and granularity of train performance information made possible by the digital train radio system has led to the resetting of section run times and transaction times, which also feeds through to changes in capacity.

The 2017 Strategy noted that in preparing this 2019 Strategy consideration would be given to mechanisms to address this problem, including basing the adjustment factor on the inputs that applied at the time contracts were entered into.

For the purposes of capacity planning, it is also important to understand likely throughput outcomes compared with the capacity projections at a point in time in the past. ARTC continues to monitor how actual performance compares to underlying assumptions. Where there is a sustainable change in performance, ARTC will consider whether a reset of assumptions is appropriate. Recognising in the Strategy the effect of sustainable changes in performance assists to create appropriate incentives to maximise system performance.

Saleable train path and coal tonnage capacity have in the past been reported in the Recommended Projects & Network Capacity chapter. This chapter has also included:

- An abbreviated 'surplus capacity' table, which showed surplus capacity at key locations under the contracted volume scenario assuming completion of enhancement works recommended for that scenario.
- Maps overlaid with demand and capacity graphs on a line section basis.

The industry has previously indicated that it would like to see both saleable and surplus capacity, or to provide the demand/capacity graphs in higher resolution. However, either of these initiatives would directly disclose contracted volumes by mine, which would breach ARTC's confidentiality obligations.

To improve the depth of information available to the industry, for this 2019 Strategy a new chart has been developed that shows surplus coal path capacity and surplus coal tonnage capacity (assuming current average train size) for each zone. This has been calculated on the most likely scenario assuming delivery of the scope of work recommended to accommodate that volume scenario.

These graphs and figures have been relocated to the line specific chapters to better consolidate the information.

The saleable paths and saleable tonnage tables previously included for the contracted and prospective scenarios have also now been supplemented with equivalent tables for the most likely volume scenario. These remain in the Recommended Projects & Network Capacity chapter.

Monthly Tolerance

The Target Monthly Tolerance Cap (TMTC) is designed to enable the contracted pathing to have a degree of flex to align with the supply and demand variations across the respective zone. This target can also be an input into decisions about enhancement investment and contracting of additional volume. The intention is that ARTC will ensure adequate capacity to allow a peaking in train path demand equal to the TMTC, relative to the average across the year. Historically it has been applied as a standard input across all three zones at 10 per cent.

It is also important to note that the methodology that has been applied in the capacity strategies has been to calculate capacity on a daily basis and apply the variance buffer as a daily ability to peak at 10 per cent above average demand.

In response to requests from access holders in zone 3, ARTC has undertaken some analysis into the variability of path utilisation with a view to reducing the TMTC for zone 3 for calendar year 2019 only. ARTC has consulted with the RCG and has held discussions with affected access holders. Based on this consultation and discussion, the TMTC for zone 3 has been set at 8%. ARTC has also reviewed the variability in path consumption for zone 2, however, no change is proposed to the TMTC for zones 1 and 2.

Transit Times

For any volume and network configuration scenario it is possible to predict a theoretical train transit time between two locations based on the actual train speed and transaction time information and a probability based approach to calculating theoretical loop dwell, escalated by an allowance for congestion delay based on percentage section utilisation.

This Strategy for the first time includes graphs of forecast transit times for each the contracted, most likely and prospective scenarios calculated on this basis. These graphs are included in the relevant Chapters and should allow the industry to develop a broad understanding of likely future cycle time outcomes.

It should be noted that adopting higher utilisation rates as proposed with ANCO and ATMS results in an increase in theoretical dwell and hence transit time as there are more trains for a given population of loops, thus increasing the probability of encountering an opposing movement without any offsetting reduction in the average length of dwell.

Where loops are used to enhance capacity, there is an increase in the probability of encountering an opposing train, but a reduction in the average dwell time at that location, since loops are on average closer together. Whether there is an increase or decrease in transit time in this case will depend on the specific circumstances and balance of these effects.

It should also be noted here that cycle time, including terminal and load point dwell, is a direct function of the number of trains required to move the available coal, divided by the number of train sets available. To the extent that there are surplus train sets in the system, velocity will necessarily slow down. This effect will in many cases be a more important consideration than crossing time on the rail network.

Terminal Capacity

ARTC's understanding of terminal capacity is that nameplate capacity currently sits at 208 mtpa.

Significant growth beyond 208 mtpa had been expected to be met by the PWCS development of Terminal 4 (T4). The T4 project had been on hold since it was granted planning approval on 30 September 2015 and PWCS advised on 31 May 2018 that it would not be proceeding with the development of T4.

The HVCCS has for some years assumed that it would be possible to achieve some incremental capacity through enhancement of existing terminals, up to a nameplate throughput in the order of 235 mtpa. For the purposes of this Strategy it has been assumed that incremental terminal capacity could be available progressively from Q1 2021 if required.

There is no requirement for additional terminal capacity for ARTC contracted volumes.

The most likely scenario would theoretically require incremental enhancement from late 2019. However, in practice it is likely that some contracted volume will not be realised and that capacity trading could facilitate demand being met.

The prospective scenario would potentially exceed the capacity of the terminals even with incremental enhancements. However, it is again likely that trading would allow volumes to be satisfied. The relationship between contracted, most likely and prospective volumes, and potential terminal capacity as assumed for this Strategy, is shown in Figure 1-8.

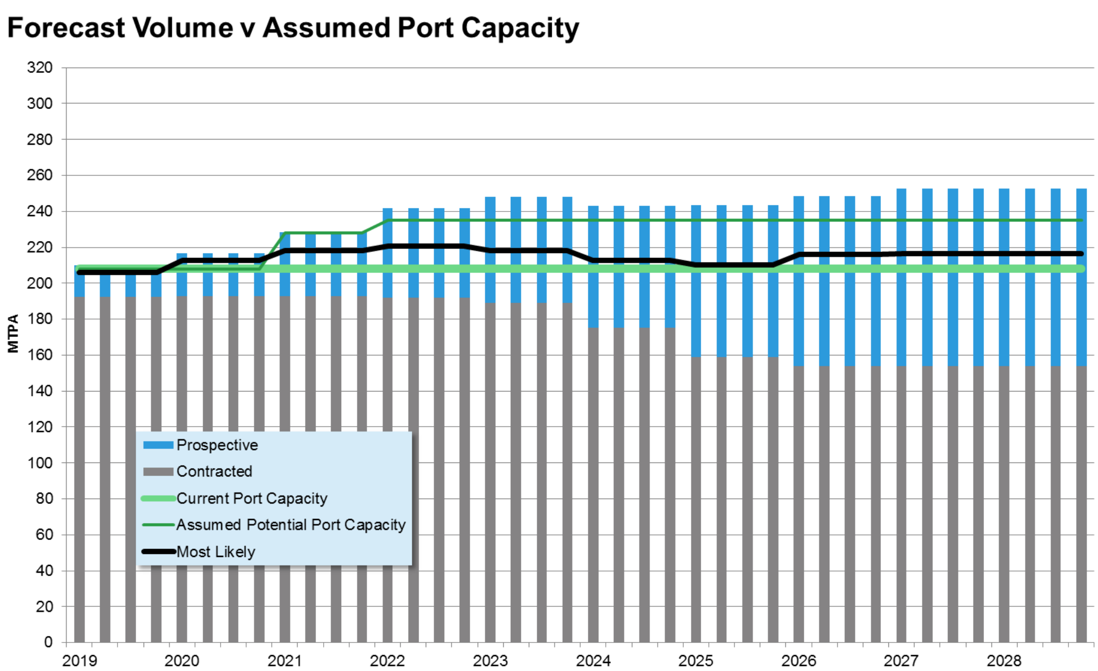

Figure 1-8 - Forecast volume at Newcastle Port compared to assumed port capacity (mtpa)

2

OPERATIONS AND SYSTEM OPPORTUNITIES

Context

Operational and system opportunities have become increasingly important as the coal chain focusses on optimising efficiency and capacity within the constraints of the existing infrastructure. Increasing efficiency provides the platform for the Hunter Valley to maximise its competitive advantage within the global export coal market.

The Hunter Valley coal chain is built around the need to feed coal into the export terminals owned by Port Waratah Coal Services (PWCS) and Newcastle Coal Infrastructure Group (NCIG). These two terminals run to different operational modes. PWCS, which provides approximately 65% of export capacity, utilises a pull based system assembling discrete cargoes to meet vessel arrivals. NCIG, responsible for the remaining 35% of export capacity, operates largely on a push based system with a large percentage of its stockpiling capability allocated to dedicated storage for individual customers.

Operational planning and live-run disruption coordination is undertaken by the HVCCC. The daily schedule is constructed by the HVCCC to achieve coal deliveries in accordance with the Cargo Assembly Plan (CAP). Execution of the plan is optimised through real time decision making undertaken in accordance with principles and protocols agreed by the industry.

ARTC is actively engaged with the HVCCC, rail operators and other supply chain partners in working together to review planning and operational processes to reduce waste and to identify opportunities to improve operational performance.

Rail operations

At 2019 contracted volumes and train sizes, an average of around 66 loaded trains need to be operated each day of the year, or one train every 22 minutes. Capacity planning makes provision for this number of trains to peak at up to 87 per day, though in practice capacity exists for this to peak at even higher rates.

The coal chain is supported by a captive rail fleet operated by four above-rail operators: Pacific National (PN); Aurizon; Genesee & Wyoming Australia (GWA) and; Southern Shorthaul Railroad (SSR).

While rail operations are dominated by coal arriving from the north, coal also arrives at the terminals from a number of smaller mines to the south of Newcastle and from mines in the Lithgow and Southern Highlands areas. This traffic operates on the Sydney Trains network as far as Broadmeadow. There is also a volume of coal supplied to the Eraring and Vales Point power stations south of Newcastle. There are no identified capacity issues for this coal on the short section of the ARTC network which it traverses outside the port areas, and accordingly this Strategy does not discuss the network between the port terminals and Islington Junction (where the Hunter Valley adjoins the Sydney network).

Although there are no identified capacity issues, the timetabling requirements of trains accessing the Sydney network provides operational challenges that have the potential to impact on the Southern coal trains as they work in with the variability of the unloading events at the Newcastle coal terminals.

Coal transport over the network includes the supply to domestic power generation facilities in the Hunter Valley and to the south of Newcastle.

Train size

ARTC contracts on the basis of a contractual entitlement to paths (base path usage or BPU). Tranches of paths are associated with a nominated train configuration, giving an implied contractual volume.

Average train size as contracted with ARTC in 2018 is 8,295 tonnes.

Weighted average delivered coal volume per train was approximately 7,860 net tonnes in 2017 and 8,254 net tonnes in 2018. This compares to a figure of approximately 8,091 net tonnes in 2016.

The decline in average actual train size from 2016 to 2017 reflects the continuation of the increase in the proportion of coal coming from the Gunnedah basin, ongoing diversion of some coal from the Port Kembla coal terminal to Newcastle and a temporary increase in the number of trains from the Austar colliery. These traffics use a smaller than average train size, in particular the Austar coal trains. The increase in average train weight from 2017 to 2018 reflects a reversal of some of these effects.

Figure 2-1 shows the historical growth in average train size and the current contracted train sizes at the Newcastle terminals for the period forecast in the Strategy. While the Strategy is based on the contracted train sizes, ARTC expects that in practice there will be a continuing increase in average train size, though probably not to the same extent as the growth achieved in earlier years.

Train Length

Train length in the Hunter Valley is limited to 1,543 metres. This length recognises the constraints of departure roads (particularly at KCT), the Hexham Holding Roads, Ulan line loop lengths, balloon loop constraints, and standing distances between signals and level crossings.

The length limit to the Gunnedah basin is 1,329 m, with North Coast line trains operating to a similar length. Trains to the Austar mine and to locations south of Newcastle operate with substantially shorter consists.

Operators continue to be interested in introducing longer trains into the system with a view to increasing operating efficiency and ARTC recognises increasing train length as a potentially effective mechanism to increase capacity when implemented in a systematic manner.

However, ARTC is cautious about permitting the introduction of 'overlength' trains on the network (i.e. trains that are longer than the corridor standard) without thorough assessment and change management being enacted which may include infrastructure and supporting systems alterations. While a longer individual train would deliver an increase in capacity per path, but without other supporting infrastructure investment, the de facto priority it gives these trains, the constraints on where they can cross other overlength trains, and the limitations they place on the system generally, means that they are likely to lead to a net reduction in system capacity. ARTC does not anticipate allowing increased train length on single track lines in the absence of appropriate enhancements.

Longer trains also potentially require greater braking distance. This can trigger a requirement for signalling alterations or impose speed restrictions, which can have significant cost and / or capacity implications.

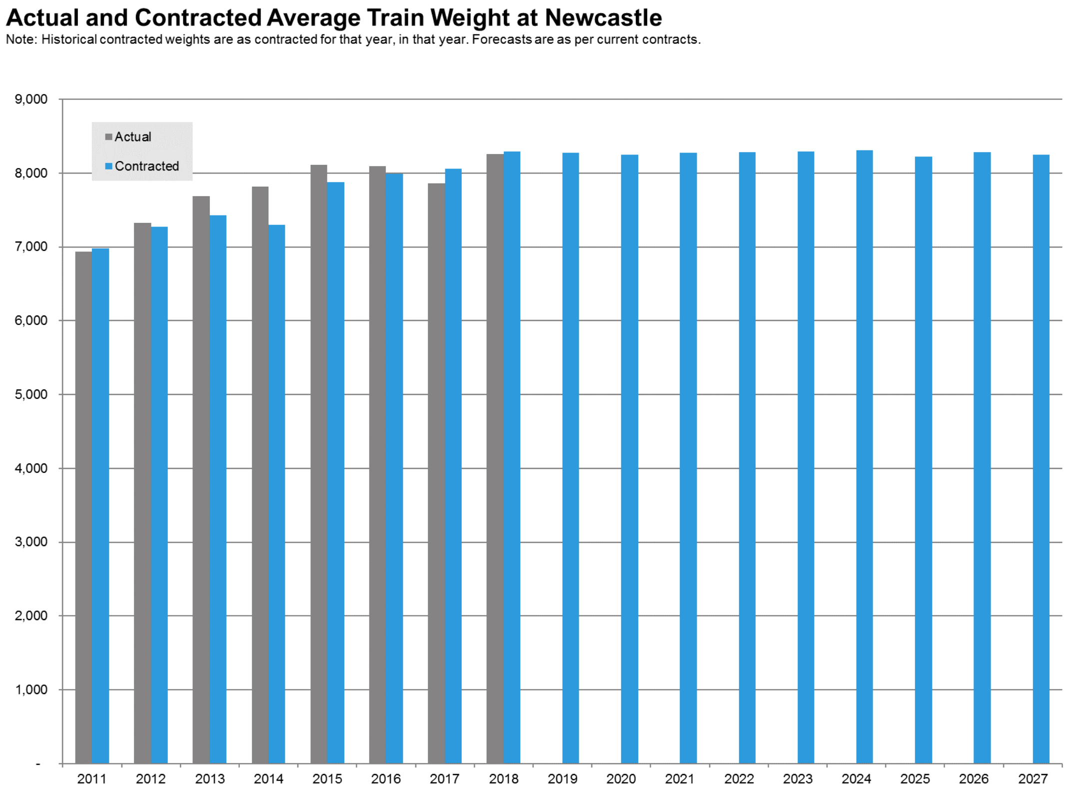

Figure 2-1 - Average Train Capacity under Contracted Volumes (tonnes)

ARTC is continuing to review options for longer trains, and is currently undertaking engineering investigations. Further modelling will be required to validate capacity impacts and opportunities. Subject to the findings of the engineering investigations, ARTC will develop business case assessments of the costs and benefits of providing necessary infrastructure enhancements.

ATMS would assist in increasing train lengths in some situations. Due to the elimination of some signalling system safety overlaps, ATMS will increase the available standing space in some loops. ATMS also significantly simplifies and reduces the cost of loop extensions.

Axle load

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 North Coast line to Stratford and the lines south of Vales Point are only rated for 25 tonne axle loads (100 tonne wagons). The privately-owned railway to Austar can only accommodate 19 tonne axle loads (76 tonne wagons).

From time to time the question of going to higher axle loads, such as 32.5 tonnes, arises. There is no engineering constraint on running such higher axle loads on the existing track structure, and indeed some wagons operate at above 30 tal when the coal is particularly dense. Individual axles can also be significantly above 30 tal when the coal is distributed unevenly within the wagon.

From a system capacity perspective though, an increase in axle load offers limited benefit unless the outline gauge is increased, since there is no significant improvement in tonnes per metre of train length. There would be a small benefit from being able to build slightly longer wagons with less capacity lost due to bogies, but this would be offset by the longer wagon needing to be slightly narrower to remain within the structure clearance.

At the same time, assuming operators built longer wagons to take advantage of the higher axle load, maintenance costs would increase. Risk would also increase as dense coal and unevenly loaded wagons would bring the maximum actual axle loads closer to the theoretical limits of the track. Higher axle loads could also potentially increase track failures, such as rail breaks, and formation failures, increasing the frequency of disruption in the absence of increased maintenance intervention. Formation issues would require detailed consideration.

Given these considerations the position adopted in the past has been to retain 30 tal as the nominal axle load limit. However, ARTC is open to reviewing this if the industry supports the work to analyse a higher axle load.

Train speed

Trains made up of ‘120 tonne’ (30 tonne axle load) wagons are generally restricted to 60 km/h loaded and 80 km/h empty, though locomotives of up to 30 tonne axle load are permitted to run at 80 km/h.

However, engineering analysis has identified that due to formation issues it is not possible to give a blanket approval to operate higher axle load locomotives above 60 km/h to the Gunnedah basin. Accordingly, trains with locomotives weighing more than 134 tonnes are limited to 60 km/h north of Muswellbrook.

There is potential to improve cycle times, and to improve capacity on the single-track sections, by increasing empty train speed to 100 km/h. This requires further analysis and risk assessment, and engagement with operators, which will be undertaken in the coming period.

There are also opportunities to improve capacity by increasing train speeds in targeted locations. These opportunities are discussed in the relevant sections.

Clearances

The Hunter Valley generally conforms to rollingstock outline plate B, which allows up to 3050 mm width and 4270 mm height.

A detailed study was undertaken in 2002 that looked at the option of introducing a North American rollingstock outline to the Hunter Valley, which would allow a higher weight per metre of train length thereby increasing network capacity. However, this study identified that aside from a large number of location specific impediments (including the Ulan line and Ardglen tunnels), a major impediment was the track centres on the multiple track sections. These were mostly built to 3430 mm or 3660 mm, and despite more generous standards being adopted over time, the majority of the main lines remained at around 3660 mm to 3740 mm track centres. A typical North American vehicle would require a minimum of 3940 mm.

While new works are built to a horizontal clearance standard that is consistent with the wider rollingstock, a large proportion of the network remains below this standard and it would require extensive works to accommodate it. Prima facie this does not, therefore, represent a cost-effective pathway to higher volume.

The other strategic clearance issue is horizontal clearances for container double stacking. As a general principle ARTC aspires to achieve double stack clearances, which requires a horizontal structure clearance of 7100 mm. ARTC’s default position is to require any new structures to be built to this clearance.

However, the double stack requirement is directed at interstate container operations. Interstate container trains do not operate across the Hunter Valley network, other than the short section between Broadmeadow and Maitland. This section is precluded from double-stack operations by the overhead wiring south of Broadmeadow. Accordingly, ARTC exempts the Hunter Valley, extending to Narrabri and Narromine, and the NSW North Coast line, from its double stack clearance requirement.

Operational Improvement Initiatives

ARTC continues to focus on driving an ever-increasing value proposition for Hunter Valley customers, supply chain peers and other stakeholders to sustain and grow long term supply chain competitiveness through operational improvement initiatives.

These initiatives are to improve operational performance aligned with capacity assumptions and include:

- Optimising asset performance through an integrated whole of asset lifecycle strategy and the improved use of reliability and condition monitoring data to improve decision making.
- Increasing synergy between the track maintenance and network control functions through integrated coordination activities, both intra week and day, with the outcome being increased effectiveness in maintenance activities and with improved train flow on the network. The integration focuses on the pre-week/day combined planning processes and coordination across multiple teams in live operations to coordinate safe and efficient track access for maintenance activities while improving overall train flow on the day for our customers on a more reliable network.
- Improved response to failures on the network.
- Reviewing the Master Train Plan to ensure that section run times and transaction times reflect actual average performance while ensuring that the plan recognises variations from the average.
- Focused monitoring and management of the operational constraints around the Ardglen bank, Bylong tunnel and Muswellbrook areas to ensure that train flow is optimised.
- Effective integration of the coal / non-coal train programming with a focus on being able to deliver and implement processes that recognise the different performance characteristics of the traffics and more efficiently assimilate the network tasks to enable increased operational control.
- Increasing real time cooperation and coordination with rail haulage providers to synchronise resourcing and network activities.

With the support of the RCG, ARTC is working to improve response times to failures on the network by implementing consistent, repeatable processes when responding to an asset breakdown/issue. The project will also deliver visibility of response times to measure ongoing performance. Improved response times reduces impacts and preserves capacity. The project is expected to be completed by mid 2019. The scope of the project includes:

- ◊ Review the network incident response plans and procedures and conditions under the Operator Sub-Agreement (OSA) to understand mutual obligations and authorities, common causes of asset breakdowns and as-is response with assumptions on future responses.
- ◊ Establish measures for tracking and reporting of response to breakdown performance.
- ◊ Workshop with key stakeholders to develop location specific tactics that enable repeatable, embedded and faster response times and report/monitor the principles and processes developed.
- ◊ Develop Change Management plans (where required).

- Another improvement project aims to improve train running performance through identified minor network enhancements following interviews with rail operator staff. These enhancements are small scale improvements that would provide improved visibility to the train crew and allow them the opportunity to maintain higher speed through key locations on the network. These initiatives will be prioritised, tested and scoped for inclusion into the ARTC 2019/20 Corridor Capital program or within Customer enhancement projects after business cases for operating expenditure are approved. This approach from ARTC creates a mechanism whereby these ideas can be collected, consolidated and assessed for benefits, resulting in increased input from rail operators and Network Control staff into the drive for enhanced network performance, particularly in zones 2 and 3. Endorsement of the prioritised list of opportunities is expected to be completed in 2019.
- Further work may also be undertaken to review and improve the Muswellbrook junction train flow whereby measures could be introduced to reduce congestion of trains leading into and through this key location. Peaking and troughing in train flow

Likely system architecture for ANCO / ATMS

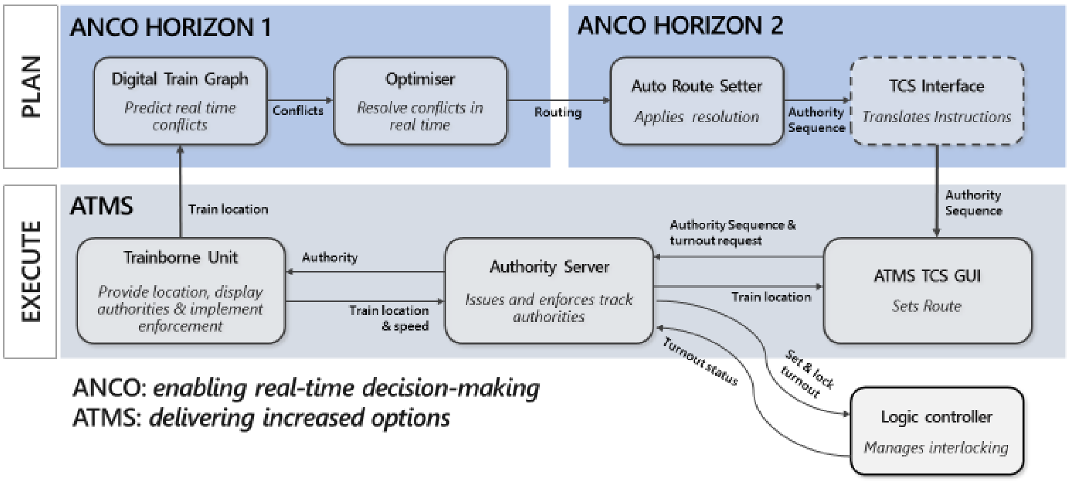

Figure 2-2 - Likely system architecture for ANCO / ATMS

results in the junction at times becoming a bottleneck and reduced overall utilisation of this key network junction. This project will increase opportunities to reduce train dwell and improve train flow on the single line sections to the west of Muswellbrook.

ANCO & ATMS

While operational improvement initiatives will enhance ARTC's ability to provide efficient product delivery and opportunities for additional throughput or maintenance, the largest improvement opportunities lie in the day to day train control decision making processes. It is a challenge for train control to dynamically consider alternative scenarios and assess the potential flow-on impacts so as to deliver maximum performance for the supply chain as a whole. This arises from limited real time, overall network visibility and a lack of tools to assist with short-term planning. To address this gap and deliver a step change in supply chain performance, ARTC has embarked on two significant projects, ANCO and ATMS.

The ANCO project is ARTC's initiative to introduce new processes and technology to improve train control in the Hunter Valley. ANCO aims to deliver a more synergistic and coordinated approach to decision making. Underpinning this project will be real time data feeds across organisations (including train forecast times based on live operational information) and the capacity to manage disruption through scenario testing.

ARTC has selected the GE Transportation 'Movement Planner' product as the centrepiece of implementation of the Horizon 1 of the ANCO Project. Movement Planner will allow the introduction of digital train planning in Network Control Centre North (NCCN), replacing the paper-based train graphs currently in use.

The product is in use on other rail networks in both the US and Australia, who have reported increased visibility of network operations, higher speeds, less train dwell time, improved forecasting and increased network capacity. The ANCO project aims to realise similar outcomes.

The 'Network Viewer' and 'Network Optimizer' modules of Movement Planner predict and resolve real time train conflicts respectively. They will be implemented progressively for the Hunter Valley network, commencing with the areas west of Muswellbrook.

By increasing the efficiency of both train planning and execution, ANCO will enable improved utilisation of the available track capacity, reduced cycle times and a supply chain which is more responsive to customers' dynamic needs.

The current approved scope will deliver:

- Dynamic pathing: Provision of a detailed daily rail schedule reflecting all occupations, including track maintenance.
- Disruption prediction: Monitoring of potential disruption in live run and using dynamic pathing to adjust the plan to minimise time and throughput losses.

Potential future stages, ANCO Horizon II, will add:

- Train management execution: Automatic route setting and clearing, and issuing of movement authorities, allowing train controllers to focus on train flow.
- Infrastructure monitoring: Continuous monitoring of track infrastructure health to maximise

availability.

Dynamic pathing is of particular significance for the determination of track capacity. As discussed elsewhere in this Strategy, ARTC applies principles in determining capacity that make allowance for variations and unknowns. In particular, the 65% utilisation factor on single track is intended to deal with issues like uncertainty around actual train performance, temporary speed restrictions and manual decision making in the execution of crosses as well as the natural constraints on the efficiency with which train crosses can be timetabled. Dynamic pathing will enable these factors to be considered and optimised dynamically, effectively eliminating the need for additional contingency in the train plan. This creates potential for higher utilisation of available track capacity.

Ultimately, the key benefit of ANCO is that it will allow the daily train plan and live run execution to be optimally aligned with system and customer requirements. This alignment, when combined with the capability of the ATMS system, will allow for management of trains to ensure maximisation of efficiency in train flow.

ANCO Horizon 1 is proceeding in accordance with the implementation plan. All four streams, the Movement Planner software, supporting technology, internal operational readiness, and external operational readiness, are on schedule. The technology platform is in place and Movement Planner software deployed, with integration, configuration and testing progressing well.

The second horizon of ANCO would see the introduction of Auto Route setting capability and suitable integration of the Movement Planner and the train control system. This primarily further streamlines train management and establishes a higher process control maturity across the Hunter Valley network. It is also envisaged this horizon would include the addition of an integrated asset maintenance and operations schedule feed into Movement Planner to enable seamless and continuous combined planning of all ARTC activities.

The second prospective initiative for the Hunter Valley, ATMS, would be highly synergistic with ANCO.

ATMS is a communications based safeworking system that will allow much of the lineside signalling infrastructure to be removed. It provides the control, location accuracy and intervention ability to allow trains to safely operate at closer headways than is possible today.

The key basic principles that ATMS is built on are:

- A robust, reliable, digital communications backbone;
- Minimal field based infrastructure;
- ‘Open’ systems architecture;
- Flexibility and scalability; and
- An ability to support the operation of trains at safe braking distance intervals rather than by the traditional fixed block method of train working.

ATMS will provide significantly upgraded capabilities to the ARTC network, including the Hunter Valley. It will support ARTC’s objectives of improving rail network capacity, operational flexibility, train service availability, transit times, rail safety and system reliability.

Importantly, it will enforce its track movement authorities through its ability to directly apply the train brakes in the event of any projected breach of permitted operations. This eliminates the risk of trains travelling beyond a safe location or overspeeding. It has a target of less than one safety critical failure per 100 years. This is achieved through a combination of the high safety integrity levels of individual elements and cross-checking of vital information between the elements.

The ‘virtual block’ system of working adopted by ATMS means that it will be possible to have two or more trains following each other within a section on single track. To the extent that this occurs, it directly increases utilisation. It is a particular benefit where there is a mix of trains with different speed characteristics and frequent instances of trains being overtaken.

ATMS also provides full contextual information to network controllers and train drivers. This will give much greater network visibility and support better decision making.

ATMS provides bidirectional working on all track. This gives flexibility in planning train movements around possessions, allowing track maintenance to happen more quickly with less impact on traffic. Train controllers will also have the ability to allow work on track to commence immediately after the passage of a train and to allow it to continue until shortly before a train arrives at a worksite, thereby giving larger work windows and improving productivity.

The bi-directional capability also gives more options in managing trains of differing priorities or performance, by providing more routing options. This will further increase capacity and reduce delays.

All four major ATMS system components have now completed formal Product Qualification Testing. This is an important milestone which will retire significant technical risk. The project has now formally moved to the system integration testing phase, though extensive system integration testing, including regular on-track testing, has already been conducted as part of the engineering process to mature the ATMS product.

Formal monitored use trials running ATMS in shadow-mode involving Pacific National locomotives and ATMS network controllers have been completed. Final operational trials will be conducted in mid-2019 to gain certification of the safety case for ATMS to be the primary safeworking system from Pt Augusta to Whyalla in late 2019.

The next ATMS project will be to deploy the system from Tarcoola to Kalgoorlie. This has completed Phase 1 Concept, Phase 2 Feasibility, and has now been granted funding to commence Phase 3 Assessment. Commissioning of ATMS on a large scale from Tarcoola to Kalgoorlie will proceed during 2020-2021.

This broader roll-out of the system will help build confidence around its real world deployment before formal consideration is given to potential roll-out in the Hunter Valley.

The combination of ANCO and ATMS has the ability to significantly reduce direct human intervention in train operations. This will increase the predictability and reduce the variability of the rail network, while optimising operations both for efficiency of utilisation of the network and to meet customer requirements.

Figure 2-2 shows diagrammatically the likely future architecture of the ANCO (horizon 1 & 2) and ATMS systems and how they will relate to automation of the train driving function.

These improvements will materially increase the potential rate of utilisation of the track. On the single track sections in particular, it should be possible to lift the effective rate of utilisation from the current 65%.

The key driver of the increased utilisation from ANCO is the improvement in crossing decision making, which will manifest itself in reduced dwell. The utilisation that can be practically achieved will be assessed through analysis of actual dwell compared to dwell pre-ANCO and theoretical efficient dwell.

However, this Strategy assumes that Horizon 1 of ANCO will deliver a five percentage point increase in utilisation, and ARTC is committed to delivering this level of capacity uplift. On this basis the Strategy adopts 70% utilisation for capacity analysis post ANCO Horizon 1.

It assumes a further five percentage point increase from ATMS giving 75% utilisation. It should be noted that as ATMS allows more than one train to be in a section at the same time, the theoretical capacity of the single track becomes greater than 100%.

The modelling also assumes that the improved situational awareness and safety overlay of ATMS will allow trains to operate closer to their theoretical capability and a 2.5% improvement in average train speed has been assumed to be achieved post-ATMS.

Train Park-up

Train park-up has long been identified as a challenging issue that may have an investment requirement.

It is expected that ANCO will facilitate greater smoothing of train flows, reducing pressure for trains to stand. This may be further supported by some features of the HVCCC's forthcoming automated cargo assembly planning tool, RACE.

However, as HVCCC highlights in the 2019 System Assumptions document, there is currently a higher number of train sets in use than the theoretical efficient fleet. This leads to an increased requirement for trains to be parked-up over and above the normal train park-up challenges in live run operations and track outages.

3

INCREASING CAPACITY BETWEEN NARRABRI AND MUSWELLBROOK

Context

The Gunnedah Basin line extends for 252 km, from the junction for the Narrabri mine to Muswellbrook in the Upper Hunter Valley.

This single-track line is highly complex. In addition to its coal traffic, it carries passenger trains (NSW Trains services to and from Scone and Moree / Armidale) and a proportionately high level of grain and export container train activity. This non-coal traffic is up to seven trains each way between Narrabri and Scone, and 10 trains each way per day south of Scone.

There are currently four coal origins along the route, at Turrawan, Boggabri, Gunnedah and Werris Creek. The currently closed Dartbrook mine, just north of Muswellbrook, is working toward reopening.

Two major new Gunnedah basin mines are included in the prospective scenario: Vickery South being developed by Whitehaven, and Watermark being developed by Shenhua. Vickery South is assumed to load from a new balloon loop connecting at approximately 499.3 km, between Emerald Hill and Boggabri. Watermark is assumed to load from a new load point north of Breeza, at approximately 443.5 km.

Liverpool Range

The Ardglen bank, crossing the Liverpool Range, is a particular impediment on this corridor. The severe grades on the short section between Chilcotts Creek 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 carries greater train volumes than the rest of the line.

Operational modelling assumes the following principles for the bank engines:

- There will be two sets of bank engines available at all times. Pacific National and Aurizon currently provide one set each.
- A train requiring banking will not have to wait for a bank engine.
- The attachment process will take 10 minutes to complete before the train will recommence its journey.
- Once the train has cleared Ardglen the bank engine will return to Chilcotts Creek in the shadow of a down train so as not to consume any additional network paths.
- Kankool loop will be used for the crossing of the returning bank engines if necessary to avoid delay to a train in the up direction.

ARTC is working with rail operators to actively manage the banking process so as to optimise utilisation of the network and maximise productivity.

Train Performance

As described in the 2016 and 2017 Strategies, ARTC has now adopted actual rather than theoretical performance as a basis for capacity modelling. Section run times developed on this basis were applied to the Gunnedah basin in 2016 and further refined in 2017. Actual transactions times were calculated and applied in the 2017 Strategy.

This 2019 Strategy uses the same train performance as in the 2017 Strategy. However, Aurizon is working toward the use of 6000 class locomotives on all of its Gunnedah train sets. These have a 23 tonne axle load, allowing them to operate at 80 km/h in the Down direction, the same as PN. Once fully embedded, train performance may be reviewed as part of capacity reviews.

There are also a number of locations along the corridor where changes to maximum permissible train speeds could potentially increase capacity.

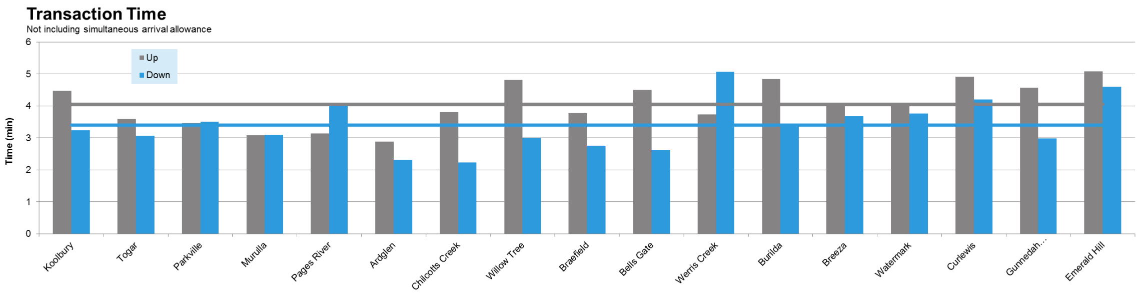

Figure 3-1 - Actual transaction times

North of Braefield at 386.0 km there is a 60 km/h limit on the Down that relates to sighting distance at the Sullings Lane level crossing. There may be low cost options that would allow this to be increased, which would improve the section time for Braefield - Bells Gate, which is one of the more capacity constrained sections.

Through Werris Creek there is a mainline turnout that constrains speed to 25 km/h in the Down direction and 35 km/h on the Up. It may be possible to undertake some minor reconfiguration to lift speeds through Werris Creek, which may defer the need for both the 414 km and 407 km loops.

In Gunnedah, there is the potential to lift train speed in the Down direction from the current limit of 40 km/h. The Down limit was determined in advance of the yard reconfiguration project and was set with a view to optimising the scope of noise walls. The option remains to extend the noise walls. As a first step noise monitoring could be undertaken to confirm actual noise levels compared to the predictions, which will help inform a solution. Lifting the speed limit to 60 km/h, and assuming that Down trains achieve an average of 54 km/h, would add 1.7 mtpa on this capacity limiting section.

Scone is in a similar position with speed limited to 50 km/h in both directions to manage noise. The options here would be the same as for Gunnedah and would potentially increase capacity in advance of Togar North loop construction.

Actual transaction times have not changed from the 2017 Strategy. They are shown in Figure 3-1 for completeness. These times include an allowance for simultaneous train arrival as described in Chapter 1.

During 2014 ARTC undertook some investigations into changing the way information is transmitted using coded track circuits. Coded track circuits are a key part of the signalling systems and a major factor in transaction time. The work identified potential time savings during operations of 40 seconds per coded track circuit . Loops generally have two to four circuits, giving potential savings of 80 to 160 seconds in transaction time. Coded track circuits are used in all loops beyond Werris Creek.

These changes to the coded track circuit logic offer some small incremental capacity increases quickly at low cost and there is also potential for a small reduction in sectional times. On this basis the Gunnedah basin

producers have approved a project to modify the coded track circuits. Only a limited number of loops can be commissioned during each possession and the project will therefore require a progressive roll-out. Loops are being prioritised on the basis of addressing the most capacity constrained sections first.

It is expected that the coded track circuit upgrades will be completed this year and the intention is that transaction times will be recalculated for the 2020 Strategy to accurately reflect the benefit.

Train Lengths

ARTC has an approved train length of up to 1,329 metres in the Gunnedah basin. 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 train length in the absence of track configuration changes to facilitate it.

In 2015 ARTC undertook an analysis of the option of increasing train length to either 1420 m or the zone 1 and 2 standard of 1543 m. The 1420 m option would require 10 loop extensions and the 1543 m option 15 extensions. The cost of extensions was estimated at an order of magnitude of $55 m and $90 m respectively.

While the longer trains increase volume per path, the expectation was that the longer trains would retain the same locomotive configurations. As a result, section run times would increase, which approximately offsets the extra capacity per train. Under the prospective scenario at the time, the 1543 m option was estimated to result in an NPV saving of around $5 m in the scope required to achieve the same tonnage throughput.

While it was concluded that extending train lengths was not the most cost effective solution for increasing capacity, to the extent that it results in more efficient train operations there may be a case for going down this path in the future.

In particular, once ATMS is in place, two loops built to a simultaneous entry configuration would no longer need to be extended, while the cost of the loop extensions would reduce as a result of the simpler signalling works.

Loops & Double Tracking

Progressive lengthening of selected existing passing loops, and constructing additional passing loops, is the default option for accommodating volume growth beyond that provided by the proposed technology projects. The majority of loops are now 1330 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 difficult. Only two loops (Aberdeen and Murrurundi) remain for potential extension.

Opportunities to insert additional mid-section loops are 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.

Notwithstanding this, concept assessments undertaken in 2012 on projects required to accommodate prospective volumes tended to conclude that a mid-section loop remains the preferred solution. In some cases these new loops will be quite close to existing loops. However, where it is practical to construct a mid-section loop the additional cost associated with building a passing lane does not justify the additional benefit. As a result, passing lanes have

only been recommended where there are physical constraints to a mid-section loop.

Double-track sections remain as the preferred solution on the Liverpool Range as it is not practical to stop trains on either the up or down grade across the range. Bells Gate south extension is preferred to extending Quipolly loop due to the high cost of extending the loop given level crossing and environmental constraints. The length of each of these double track sections is determined by physical constraints.

Chapter 6 provides more detail on those projects that would be required in the prospective scenario.

Investment Pathway

Table 3-1 shows the projects required to address the capacity constraint on each local section as demand requires, for the most likely and prospective scenarios and with and without ATMS. Given progress with ANCO, a no ANCO scenario is considered to be a small risk and is not shown, though the realisation of the capacity benefit will need to be confirmed after it is operational as discussed elsewhere. No loop projects are required or proposed for contracted volumes.

The location of each of the projects is shown in Figure 3-2.

The projects identified assume that there is no change to current actual train performance around Gunnedah, Werris Creek, Braefield or Scone. To the extent that section times reduce as discussed in the train performance section, this would potentially allow loop projects to be deferred.

The timing of projects is the later of when they are required, when they can be delivered and when they will deliver a capacity benefit given constraints elsewhere on the corridor and the earliest projects can be delivered to address those constraints.

It is also important to note that the current best assessment is that it will be possible to deliver ATMS faster than many of the projects in Table 3-1. As such the ATMS pathway delivers the biggest increment of capacity sooner than the no-ATMS solution.

Figure 3-3 shows the preferred investment pathway to meet the most likely volume forecast scenario, graphically. Figure 3-4 shows the investment pathway to meet the prospective volume forecast scenario. Both figures show pathways with and without ATMS.

Note that this graph shows volume at Muswellbrook plus the surplus capacity on the most capacity limiting section of the corridor. Hence, capacity can increase independent of capacity enhancement projects if the volume increment is on the port side of the capacity limiting section.

The signal logic change, being the change to the coded track circuits, is assumed to be available for Q3 2019. In practice, the sequencing of the delivery program is to address the most capacity constrained sections first and this is expected to deliver the capacity benefit sooner,

Required by timing[1]	Most Likely with ANCO (no ATMS)	Most Likely with ANCO / ATMS	Prospective with ANCO (no ATMS)	Prospective with ANCO / ATMS
Collygra	Q3 2023	-	Q3 2023	Q3 2023
486 km loop	Q3 2023	-	Q3 2023	Q1 2024
South Gunnedah loop	Q3 2021	Q3 2021	Q3 2021	Q3 2021
Breeza north extension	-	-	Q1 2024	-
Burilda north extension	Q1 2024	-	Q1 2024	Q1 2024
414 km loop (Werris Creek North)	Q3 2023	Q1 2024	Q3 2023	Q3 2023
407 km loop (Werris Creek South)	Q1 2024	-	Q1 2024	-
Bells Gate south extension	Q3 2022	Q3 2022	Q3 2022	Q3 2022
Braefield north extension	Q3 2023	-	Q3 2023	-
Kankool—Ardglen	Q1 2024	-	Q1 2024	Q1 2024
Pages River North extension	Q3 2021	Q3 2021	Q3 2021	Q3 2021
Blandford loop	Q3 2022	Q3 2022	Q3 2022	Q3 2022
Wingen loop	Q3 2021	Q3 2021	Q3 2021	Q3 2021
316 km loop (Parkville South)	Q1 2024	-	Q1 2024	-
Togar North Loop	Q3 2021	Q3 2021	Q3 2021	Q3 2021
Aberdeen	Q3 2023	-	Q3 2023	Q3 2023

Table 3-1 - Project timings under various volume scenarios

Note 1 - Project timing is based on the later of when the project is required, when the project can be delivered and when it adds to capacity given other capacity bottlenecks.

but pending determination of the precise program this has not been assumed. The size of the benefit is location specific and a generic benefit of 60 seconds has been assumed. As already noted, this will be updated once actual train performance data is available.

As discussed in Chapter 2, ANCO is assumed to increase utilisation from 65% to 70%. This is assumed to be able to be realised for Q4 2019 consistent with the ANCO delivery plan.

ATMS has also been assessed as having the theoretical potential to lift utilisation by a further five percentage points, from 70% to 75%. A 2.5% improvement in average train speed has also been assumed. The strategy and achievable timeframe for rollout of ATMS is subject to ongoing review informed by progress in the finalisation of the system safety case and the priority rollout of the system as part of Inland Rail delivery. The current judgement is that Q1 2023 is a plausible target for implementation of ATMS in the Hunter Valley and it has been assumed that the Gunnedah basin would be the first area for deployment.

It is important to emphasise that the scale of benefit from ATMS, and the timeframes for implementation, are somewhat uncertain given the nature of the technology.

Accordingly, if access holders wish to ensure certainty around the delivery of additional capacity, it is preferable to continue with the design and approvals process for loop projects in parallel with the

Figure 3-2 - Muswellbrook to Narrabri Loops

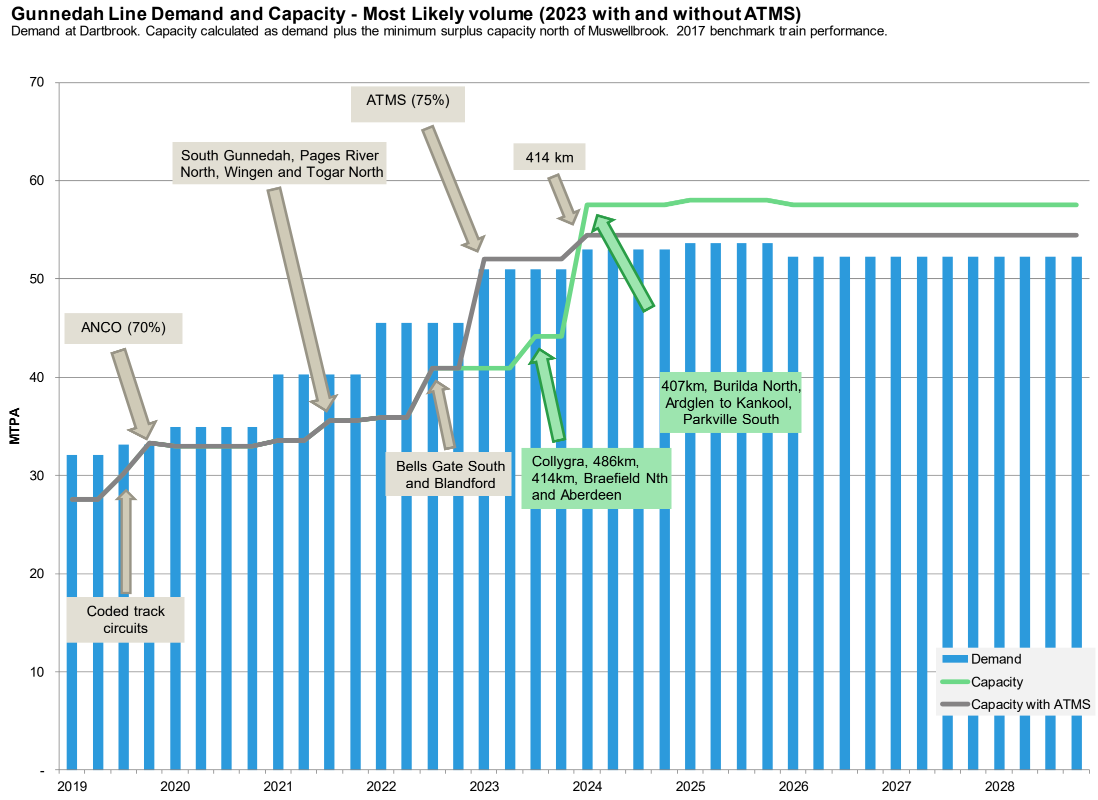

Figure 3-3 - Conceptual pathway for investment to meet the most likely volume scenario.

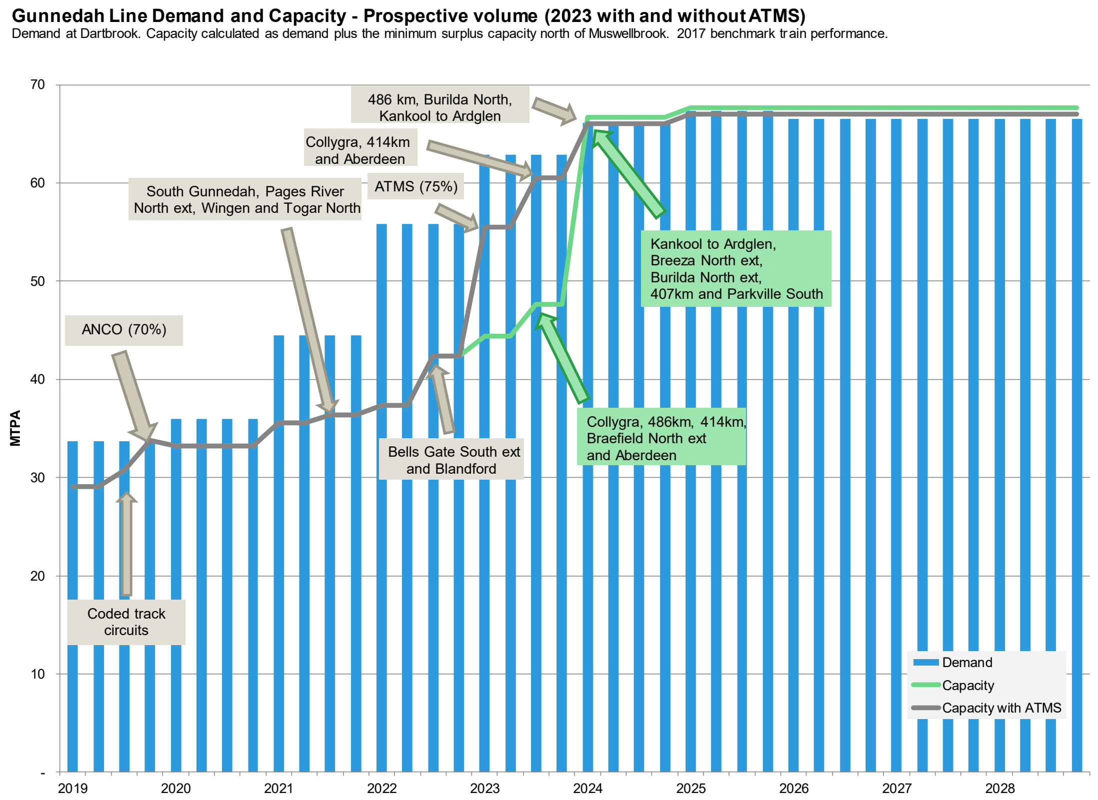

Figure 3-4 - Conceptual pathway for investment to meet the prospective volume scenario.

Note 1—Unlabelled changes in capacity reflect changes in volume on the port side of the capacity limiting section.

implementation of the technology projects. This approach minimises risk and given that the design and approvals processes represent a relatively small proportion of the total project expenditure, mitigate risk at modest cost. In the event that volume grows approximately in line with the forecast, any short-term expenditure on loops would ultimately be of value in expediting construction later in the planning period.

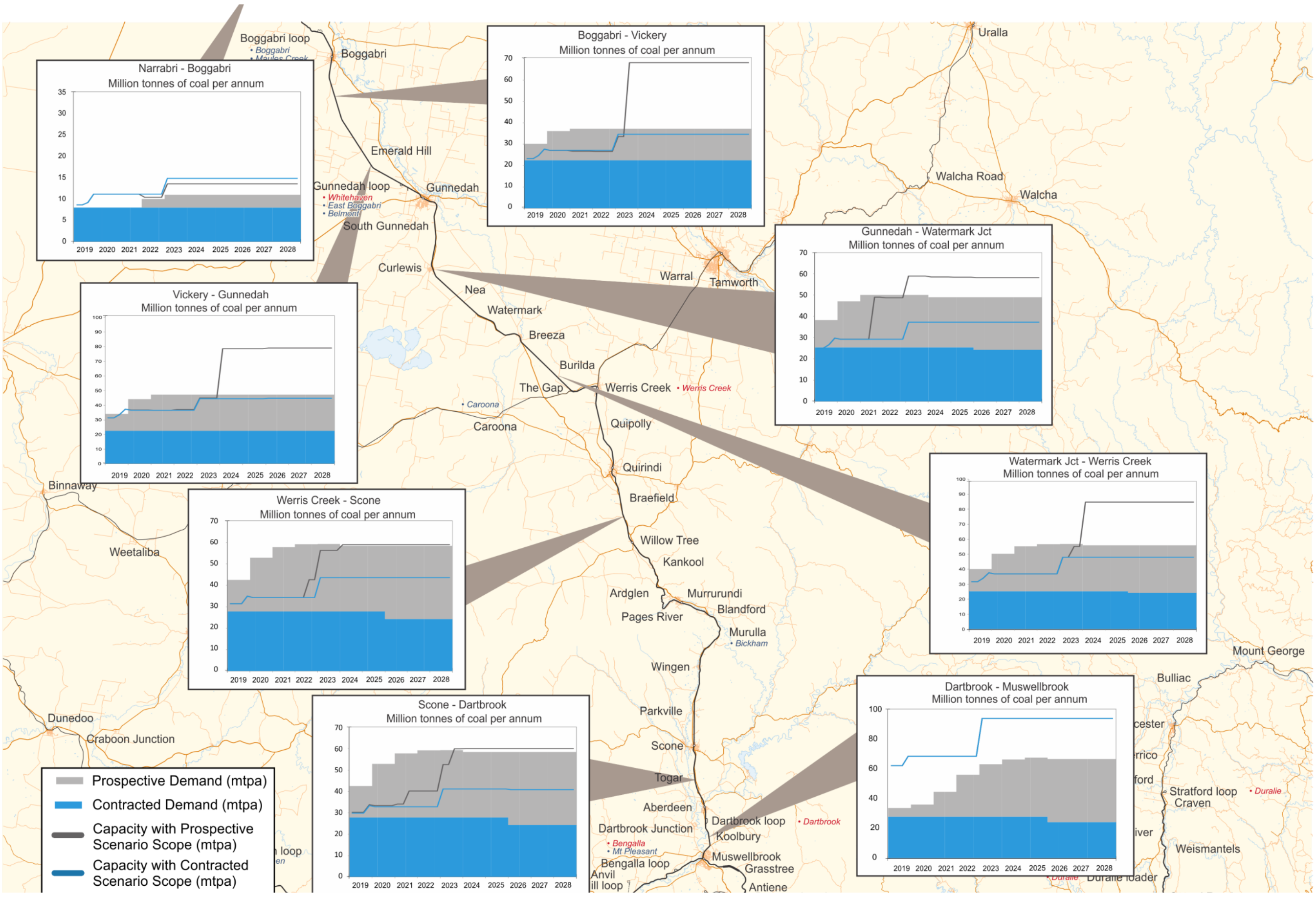

Figure 3-5- Volume and capacity on the Gunnedah basin line.

Gunnedah basin line surplus capacity - most likely scenario (with ATMS)

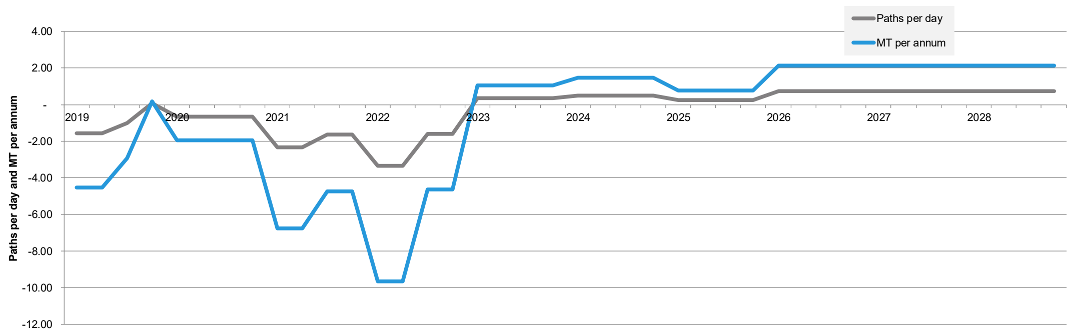

Figure 3-6 - Saleable surplus capacity in paths and tonnes for Zone 3 under the most likely volume and recommended projects scenario with ATMS

Gunnedah basin line surplus capacity - most likely scenario (without ATMS)

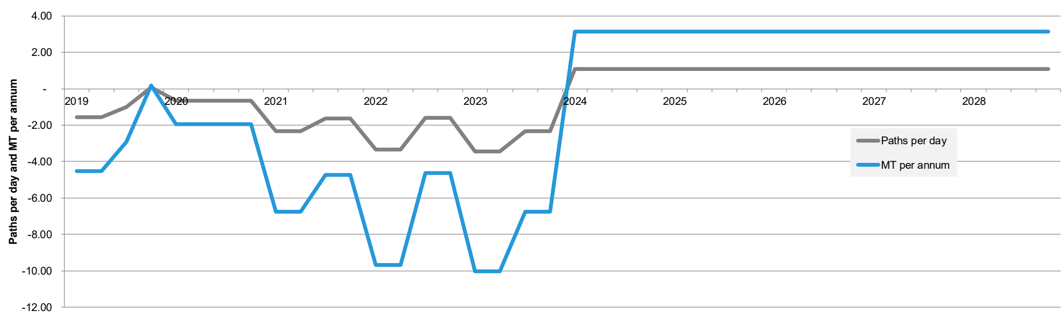

Figure 3-7 - Saleable surplus capacity in paths and tonnes for Zone 3 under the most likely volume and recommended projects without ATMS

Volume & Capacity

Demand and capacity by sector, based on the project timings recommended in this Chapter, and using the calculation methodology set out in Chapter 1, is shown in Figure 3-5. This chart shows both contracted and prospective volumes for the proposed infrastructure scope including ATMS.

As discussed in Chapter 1, a new chart showing forecast surplus capacity, in both paths and tonnes, under the most likely volume and infrastructure scenario with ATMS, is shown in Figure 3-6. A scenario without ATMS is presented in Figure 3-7.

This is calculated as the surplus capacity on the most capacity constrained section, assuming a 8% TMTC for 2019 and 10% for subsequent years, and is effectively the difference between the volume and capacity under the ATMS and no ATMS pathways shown in Figure 3-3.

The most likely volume scenario identified by producers has volume growing faster than capacity enhancement projects can be delivered. Accordingly the 'surplus capacity' chart shows a capacity shortfall until the last required project is delivered, which in this case is ATMS under the ATMS scenario, or the final loops in the non-ATMS scenario.

Tolerance

In previous Strategies it has been noted that the Gunnedah basin line has a highly variable agricultural task and that it may be appropriate to target a lower TMTC and to use peaking capacity opportunistically on days when non-coal freight was low. The 2016 Strategy noted that, depending on the size of the grain harvest and other factors, the available peaking capacity is likely to be sufficient for two or three additional coal trains per day on a majority of days. This will inevitably mean though that there will be days when a coal train set is forced to sit idle due to a lack of paths, but this is potentially a lower cost outcome than additional capacity projects that are only required to meet demand on a minority of days.

As set out in Section 1, following analysis of the variability of path consumption and at the request of zone 3 access holders, ARTC has assumed a reduction of the TMTC for 2019 to 8% for zone 3 only.

Transit Times

As discussed in Chapter 1, the capacity modelling tools have been enhanced to include a transit time calculator. This uses actual train performance and transaction times, together with a probabilistic tool for calculating loop dwell frequency and duration, to forecast the likely average transit time with ATMS.

This is shown in Figure 3-8 for the three volume / infrastructure scenarios. The predicted Muswellbrook - Narrabri mine transit time has been adopted as being illustrative of the likely performance for all load points. A scenario without ATMS is shown in Figure 3-9. Overall transit time is forecast to reduce as the increase in infrastructure more than offsets the increase in train numbers.

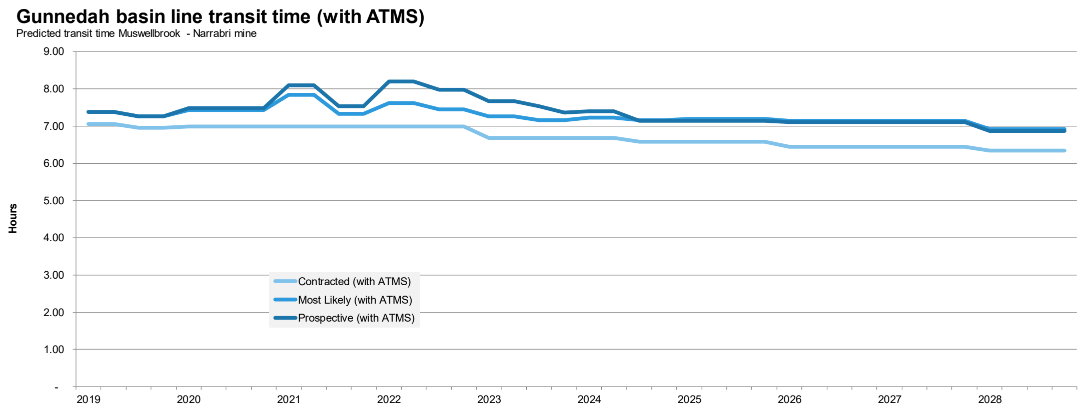

Figure 3-8 - Forecast transit time Muswellbrook - Narrabri mine under contracted, most likely and prospective volume scenarios and works as per Table 3-1 with ATMS

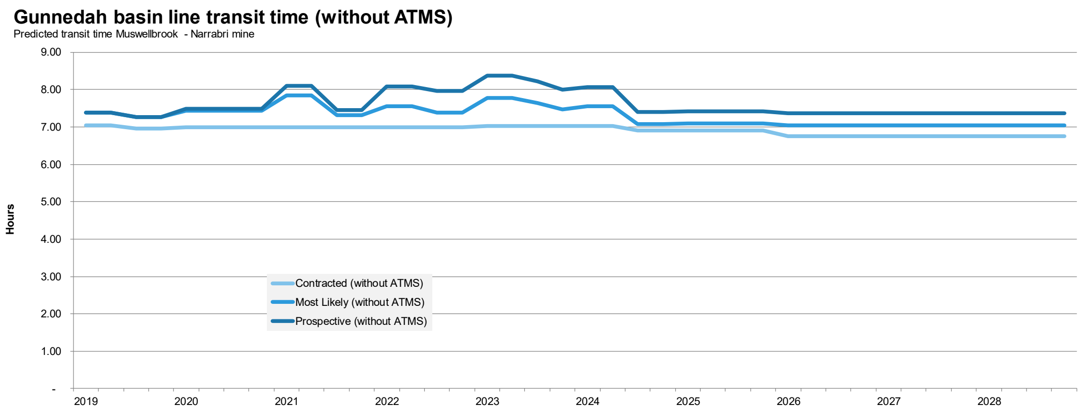

Figure 3-9 - Forecast transit time Muswellbrook - Narrabri mine under contracted, most likely and prospective volume scenarios and works as per Table 3-1 without ATMS.

4

INCREASING CAPACITY BETWEEN ULAN AND MUSWELLBROOK

Context

The Ulan line extends approximately 170 km, from Ulan, west of the dividing range, to Muswellbrook in the upper Hunter Valley.

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

The mines on this sector are clustered either at the start of the line near Muswellbrook (Bengalla, Mt Pleasant, Mangoola) or at the end of the line around Ulan (Ulan, Wilpinjong, Moolarben). This gives rise to a long section in the middle with homogenous demand.

Four new export coal mines are at various stages of the development and approval process, but only the Bylong and West Muswellbrook mines are assumed to be developed in the timeframe of this Strategy. The Mt Penny and Ferndale mines are assumed to not be in production during this period. The Spur Hill mine, which was previously identified as a potential mine connecting to this line, is now considered to be more likely to load through the Drayton load point

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

Train Performance

As noted in Chapter 1, train performance has been held at the benchmark performance adopted in the 2017 Strategy.

Average actual transaction times are consistent with the 2017 Strategy. For completeness they are shown in Figure 4-1.

With the approval by Zone 2 producers of the program to modify the coded track circuit logic these transaction times will change over the course of the next year. Actual transaction times will be reviewed as part of future capacity strategies.

Train Length

Train length on the Ulan line is limited to 1,543 metres, which is the limit for the Hunter Valley as a whole.

Operators continue to be interested in introducing longer trains into the system, including on the Ulan line. This issue is discussed in general in Section 2.

During the year, analysis of the proposition of running overlength trains was undertaken.

HVCCC undertook an analysis of the impact of overlength trains on local capacity using a bespoke simulation model, specifically modelling a 102 wagon train with the assumption that Sandy Hollow and Kerrabee loops could not accommodate the long train .

The conclusion of the HVCCC modelling was:

"From the results we would estimate that by running 3 longer trains that the capacity of the single track Ulan line would decrease by approximately 3% as measured against the base case (where there are zero long trains). That is, although there is an improvement in the tonnes delivered per path with the longer trains, the reduction in available paths through the network outweighs the larger payload size. This holds true for all cases with two or more long trains on the network. The throughput achieved in the model, with a single long train in the fleet, was a 0.5% improvement over the base case. "

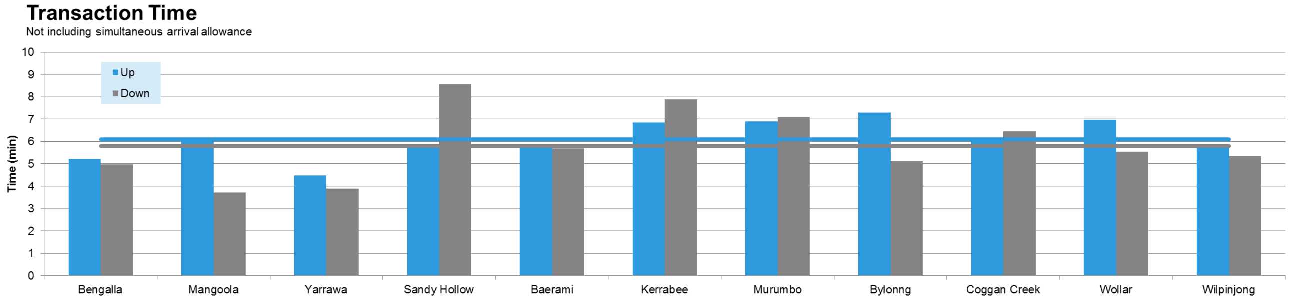

Figure 4-1 - Actual transaction times

The HVCCC calculation of the capacity effect with incremental increases in the fleet of overlength trains is shown in figure 4-2. Note that this output relies on various assumptions and methodological approaches that are too extensive to outline in this Strategy .

One important point to note in regard to the HVCCC modelling: though is that it did not make any allowance for the effect of the longer trains on section time. The 102 long trains would use existing locomotive configurations, which would mean train speed would decrease due to a lower power to weight ratio, with a flow-on effect on section times and a further reduction in capacity.

ARTC analysis of this proposal using the capacity models that are the basis of this Strategy, identified that the critical issue would be transaction time at Kerrabee, which is at one end of the capacity limiting section.

Testing the effect of the increased transit time identified a net reduction in capacity (that is the increase in capacity per path offset by the reduction in the number of saleable paths) of 3.5% for one long train increasing to 32.2% if all trains were overlength. The effect would be expected to be approximately linear between these two outcomes or an approximate 2.5% reduction in capacity for each overlength path per day. This result is very similar to the HVCCC simulated outcome. The ARTC analysis also did not take account of any increase in section time due to lower power to weight ratios.

Moving forward, the options would be to extend Sandy Hollow and Kerrabee to at least 1660 metres to allow the 102 wagon train without a negative impact on capacity, or to extend a further 6 loops (ie, extend a total of eight) to a minimum length of 1745 metres, which would allow a 108 wagon train. These options would increase capacity by 6.3% and 12.5% respectively, less the effect of slower section times due to the lower power to weight ratio. Consideration would also need to be given to the viability of trains of these lengths given other constraints elsewhere in the Hunter Valley network including terminal track lengths and signalling constraints.

ARTC will undertake further analysis of the cost and benefit of longer trains in the coming period.

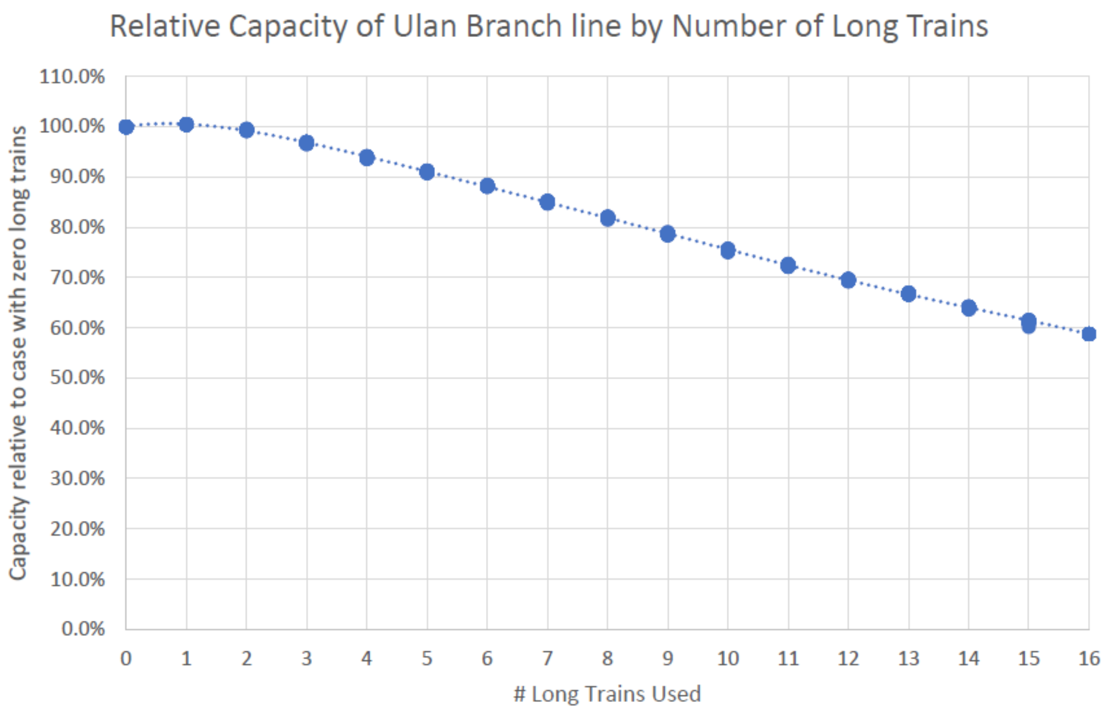

Figure 4-2 - Relationship between the number of longer trains and capacity on the Ulan line

Bylong Tunnel

Although the Ulan line was only built in 1982, it used works from the original uncompleted construction of the line that commenced in 1915. This included the Bylong tunnel, which was built to a relatively small outline that was consistent with the practices of the day, but which creates ventilation concerns in a modern environment.

Specifically, there are two potential issues: the work health and safety of drivers due to the gasses and particulates from diesel emissions, and; the effect on diesel engines from heat emissions.

Detailed air quality monitoring undertaken in 2011 and 2012 found that the pollution emissions were consistently well below recommended safe thresholds and on this basis the purge time (ie the time between the drivers cab exiting the tunnel and the time the next drivers cab is able to enter the tunnel) was reduced from an arbitrary 30 minutes to 20 minutes.

The results suggested that this purge time was likely to be able to be further reduced. However, as the 20 minute purge time was adequate for the then expected volumes, no further analysis was conducted. In the current demand environment it would be appropriate to undertake further study, and such a project is now underway.

In regard to the heat issue, past locomotive problems that have been experienced have been able to be managed through maintenance and in some cases modification of air intakes. As this is not a safety issue it has been assumed that if any persistent problems appear with a reduced purge time, it is likely that they can be managed, including by real time air temperature monitoring noting that tunnel air temperatures are heavily influenced by ambient air temperature and wind conditions.

The purge time that needs to be achieved depends on the volume and investment scenario. The required time may be as low as 16 minutes but depending on the outcome of the achievable utilisation rates with ANCO and ATMS it may not need to go this low. The further analysis now being undertaken will provide more clarity around the context for setting an appropriate purge time.

In the event that it is not possible to reduce the purge time with the current tunnel configuration, there are essentially two options—construction of mechanical ventilations systems such as fans and doors, or operating the tunnel section at higher utilisation rates than are tolerated elsewhere, which will mean higher levels of congestion, delay and variability, and decreased plan robustness.

Investment Pathway

Table 4-1 shows the projects required to address the capacity constraint on each local section as demand requires, for the most likely and prospective scenarios and with and without ATMS. Given progress with ANCO, a no-ANCO scenario is considered to be a small risk and has not been assessed. No projects are required or proposed for contracted volumes beyond the technology initiatives.

The location of each of the loop projects is shown in Figure 4-3.

Project Name	Most Likely with ANCO (no ATMS)[1]	Most Likely with ANCO / ATMS[1]	Prospective with ANCO (no ATMS)[1]	Prospective with ANCO / ATMS[1]
Coggan Creek west extension	-	-	Q4 2022	-
Murrumbo west extension	-	-	Q4 2022	-
Widden Creek loop	Q4 2021	-	Q4 2021	-
Mt Pleasant loop	-	-	Q4 2022	-

Table 4-1 - Project timings under various demand scenarios

Note 1—Project timing is based on the later of when the project is required, when the project can be delivered and when it adds to capacity given other capacity constraints.

The projects identified assume that there is no change to current actual train performance.

It is also assumed that the rail connection to the Mount Pleasant mine moves from its current location west of Bengalla junction to the east of that junction in Q1 2022 as per Modification 4 to the Mount Pleasant development approval.

Figure 4-4 shows the preferred investment pathway to meet the most likely volume forecast scenario. Figure 4-5 shows the pathway to meet the prospective forecast scenario. Both show pathways with and without ATMS.

Note that these graphs show volume at Muswellbrook plus the surplus capacity on the most capacity limiting section of the corridor. Hence, capacity can increase independent of capacity enhancement projects if the volume increment is on the port side of the capacity limiting section.

The signal logic change, being the change to the coded track circuits, is likely to be able to be implemented within a year, giving a modest uplift in capacity, assumed to be in Q3 2019. The size of the benefit is location specific and varies between 60 and 180 seconds depending on the configuration. While the capacity uplift is nominally in Q3 2019, the program will target the most capacity limited sections first, subject to practical delivery constraints, so the actual capacity benefit is likely to be earlier than shown.

As discussed in Chapter 2, ANCO will offer a range of systemic improvements that will allow utilisation to be lifted from 65% to 70%. This is assumed to be able to be realised for Q4 2019 consistent with the ANCO delivery plan.

ATMS has also been assessed as having the theoretical potential to lift utilisation by a further five percentage points, which would take utilisation from 70% to 75%. A 2.5% improvement in average train speed has also been assumed.

The strategy and achievable timeframe for rollout of ATMS is the subject of ongoing review informed by progress in the finalisation of the system safety case and the prioritisation of rollout of the system in the context of Inland Rail delivery. The current judgement is that Q1 2023 is a plausible target for implementation of ATMS in the Hunter Valley and it has been assumed that the Ulan line would follow the Gunnedah basin line with a lag in the order of six months, giving an implementation time of Q3 2023.

It is important to emphasise that the scale of benefit from ATMS, and the timeframes for implementation, are somewhat uncertain given the nature of the technology.

Accordingly, if access holders wish to ensure certainty around the delivery of additional capacity, it is preferable to continue with the design and approvals process for loop projects in parallel with the implementation of the technology projects. This approach minimises risk and given that the design and approvals processes represent a relatively small proportion of the total project expenditure, mitigate risk at modest cost. In the event that volume grows approximately in line with the forecast, any short-term expenditure on loops would ultimately be of value in expediting construction later in the planning period.

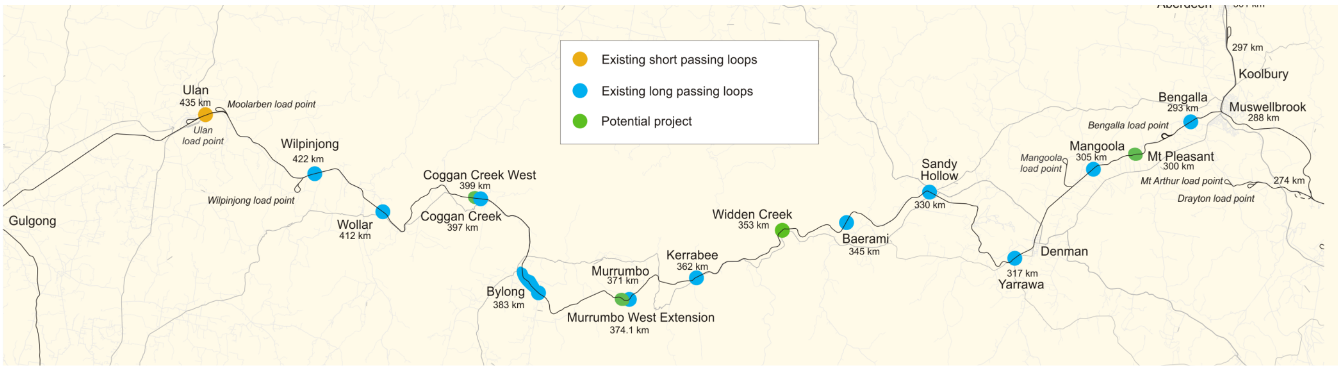

Figure 4-3 - Ulan Loops

Volume & Capacity

Demand and capacity by sector, based on the project timings recommended in this Chapter, and using the calculation methodology set out in Chapter 1, is shown in Figure 4-6. This chart shows both contracted and prospective volumes for the proposed infrastructure scope including ATMS.

As discussed in Chapter 1, a new chart showing forecast surplus capacity, in both paths and tonnes, under the most likely volume and infrastructure scenario

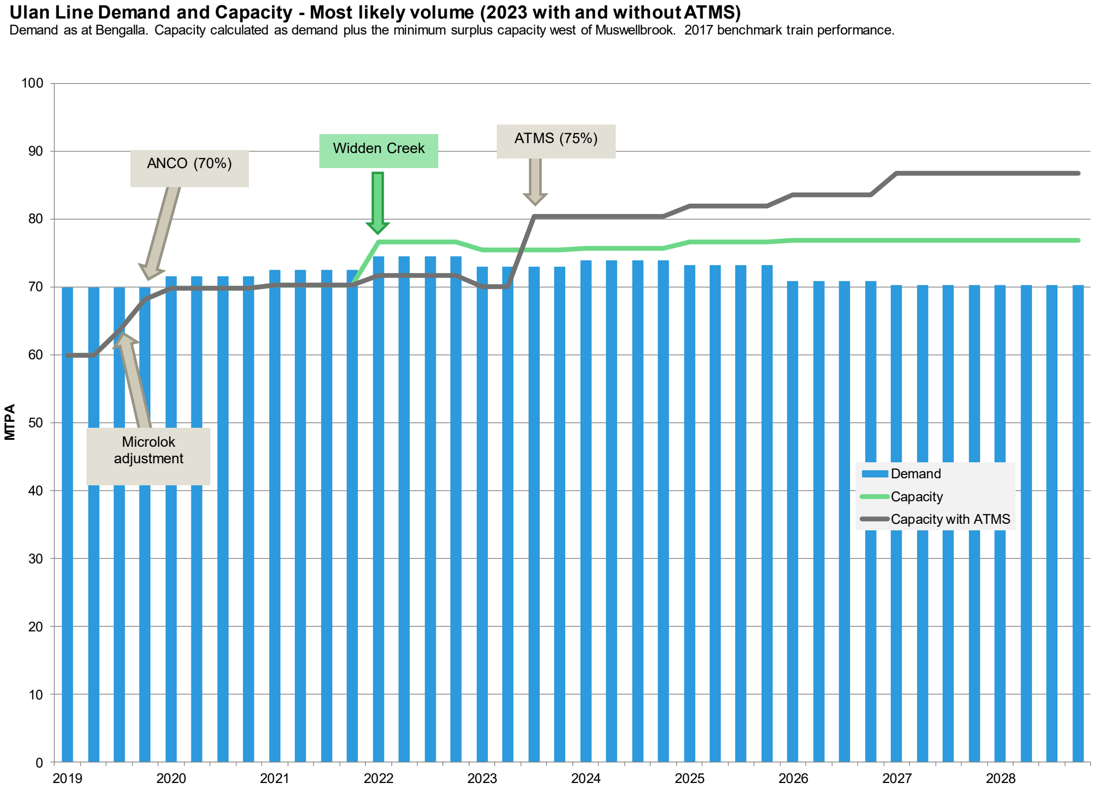

Figure 4-4 - Conceptual pathway for investment to meet Most Likely volume scenario.

Note 1—Unlabelled changes in capacity reflect changes in volume on the port side of the capacity limiting section.

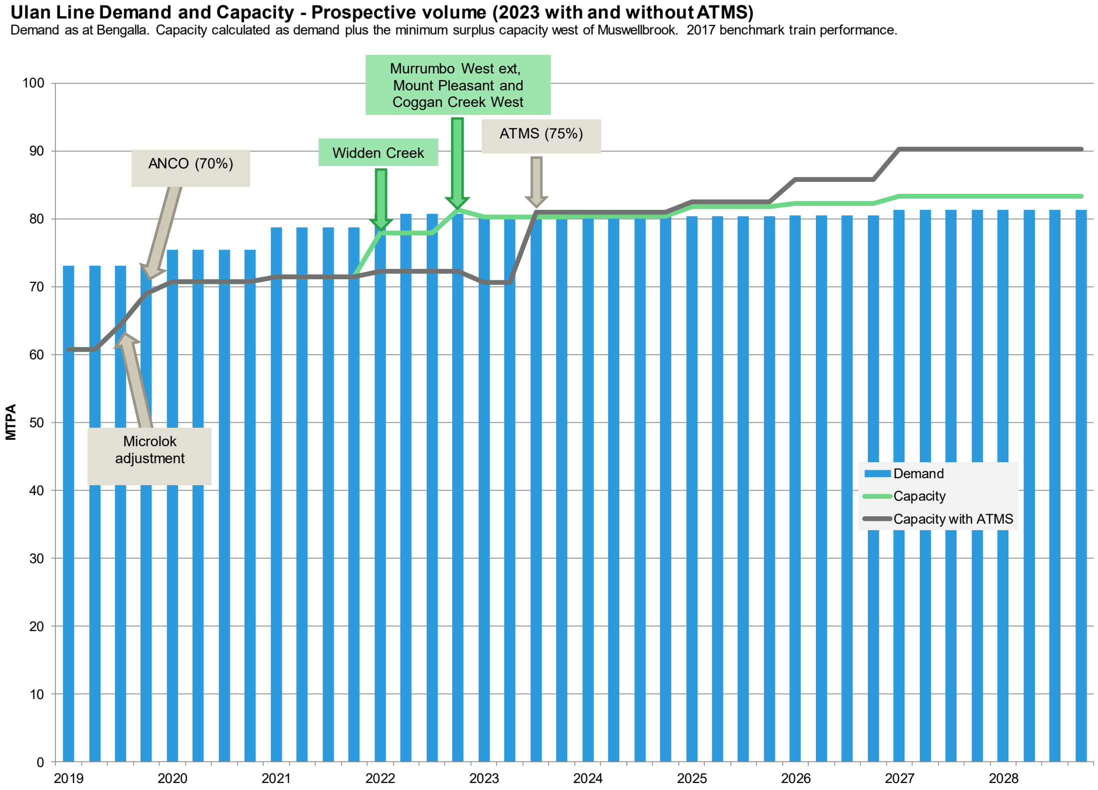

Figure 4-5 - Conceptual pathway for investment to meet the Prospective volume scenario.
Note 1—Unlabelled changes in capacity reflect changes in volume on the port side of the capacity limiting section.

with ATMS, is shown in figure 4-7. Figure 4-8 shows the same analysis without ATMS. The graphs are calculated as the surplus capacity on the most capacity constrained section, assuming a 10% TMTC and are equivalent to the difference between demand and capacity as shown in Figure 4-4.

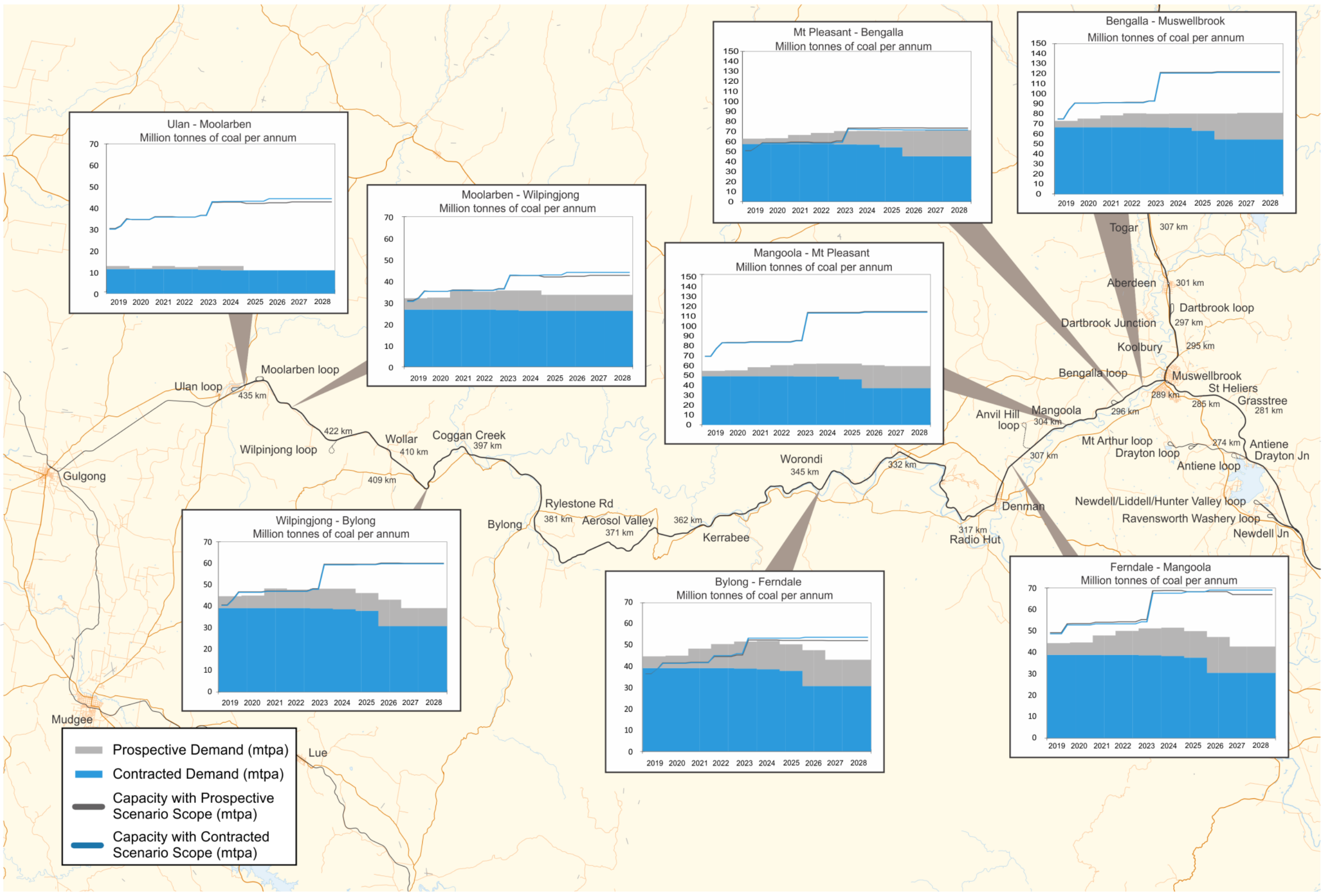

Figure 4-6 - Volume and capacity on the Ulan line

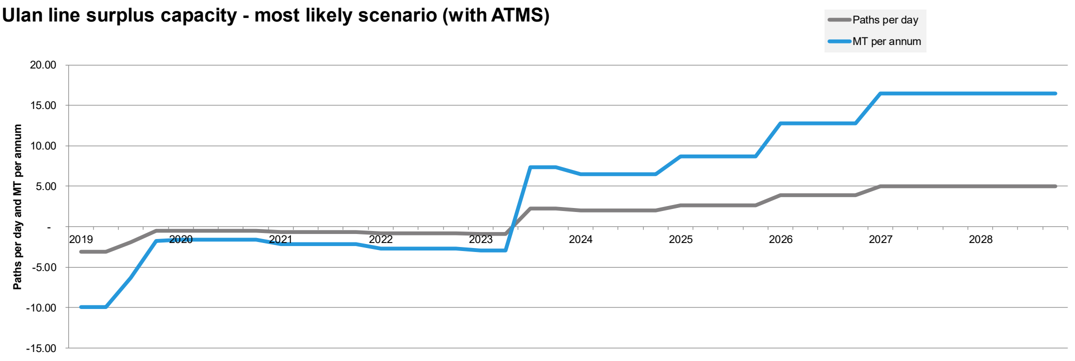

Figure 4-7 - Saleable surplus capacity in paths and tonnes for Zone 2 under the most likely volume and recommended projects scenario with ATMS

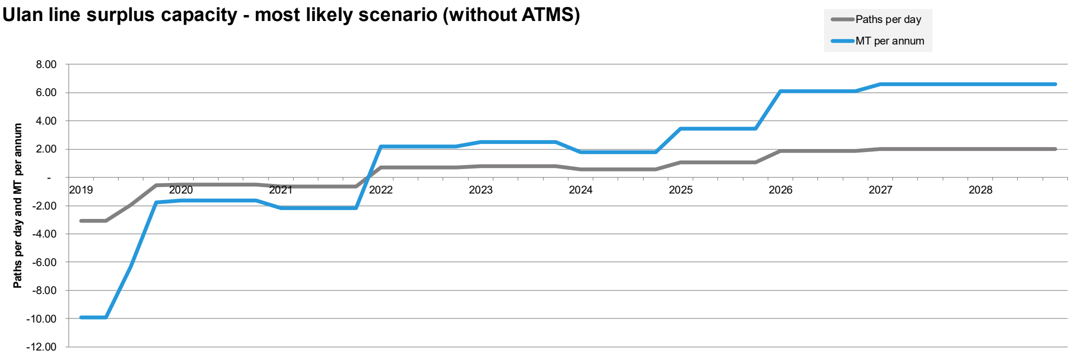

Figure 4-8 - Saleable surplus capacity in paths and tonnes for Zone 2 under the most likely volume and recommended projects without ATMS

Under both scenarios the volumes are expected to increase faster than capacity can be provided, which results in the small negative surplus capacity in the years leading up to the delivery of Widden Creek Loop in Q1 2022 under the 'without ATMS' scenario or ATMS in 2023.

Transit Times

As discussed in Chapter 1, the capacity modelling tools have been enhanced to include a transit time calculator. This uses actual train performance and transaction times, together with a probabilistic tool for calculating loop dwell time, to forecast the likely average transit time.

This is shown in figure 4-9 for the three volume / infrastructure scenarios with ATMS. The predicted Muswellbrook - Ulan mine transit time has been adopted as being illustrative of the likely performance for all load points. A scenario without ATMS is provided in Figure 4-10.

Transit time improves over time as demand declines.

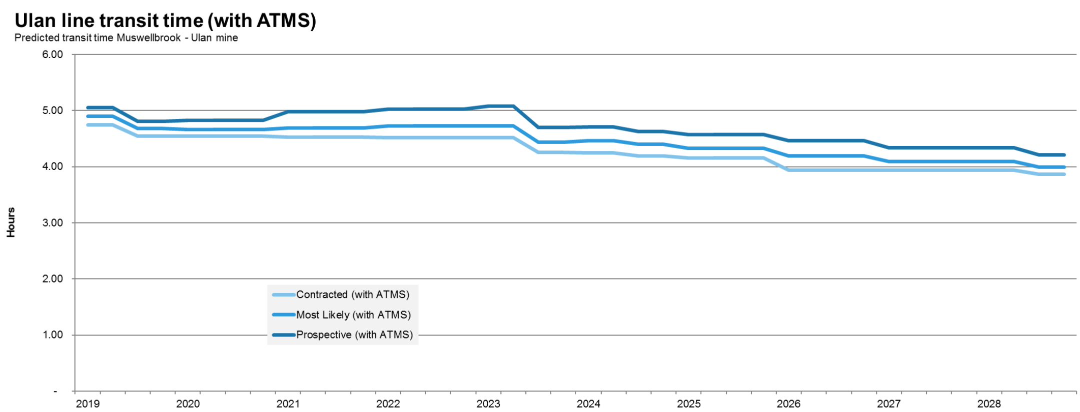

Figure 4-9 - Forecast transit time Muswellbrook - Ulan mine under contracted, most likely and prospective volume scenarios and works as per Table 4-1 with ATMS

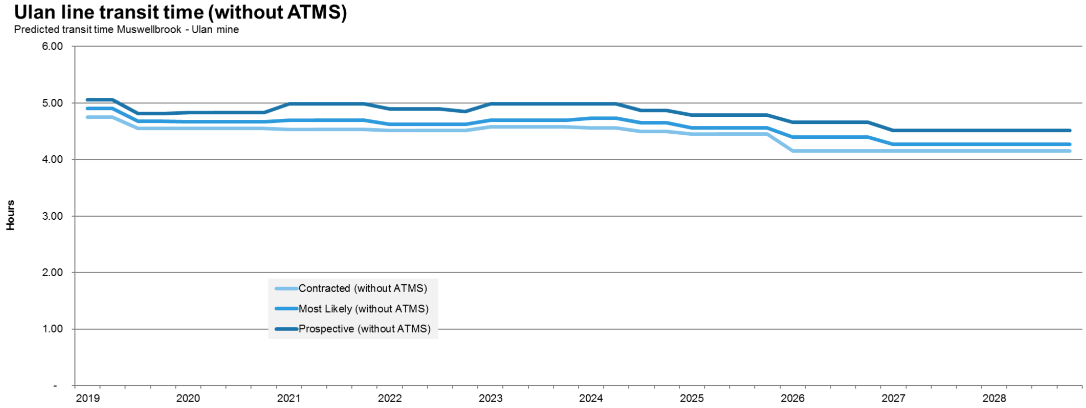

Figure 4-10 - Forecast transit time Muswellbrook - Ulan mine under contracted, most likely and prospective volume scenarios and works as per Table 4-1 without ATMS.

5

INCREASING CAPACITY BETWEEN MUSWELLBROOK AND THE TERMINALS

Context

The Muswellbrook—Terminals section is the core of the Hunter Valley network. A majority of the coal mines in the Hunter Valley connect to this part of the network, which includes a number of branches of varying length. All of the corridor is at least double track with significant sections of triple track and dedicated double track for coal from Maitland to Hexham.

Although this section has all of the non-coal freight and passenger trains from the Gunnedah and Ulan lines, plus an additional daily Muswellbrook passenger service, the volume of coal means that coal dominates operations across this corridor. The passenger services, which get priority and run down the coal services, create a disproportionate loss of capacity, particularly in the loaded direction. However, there is sufficient capacity on the corridor and flexibility created by the three track

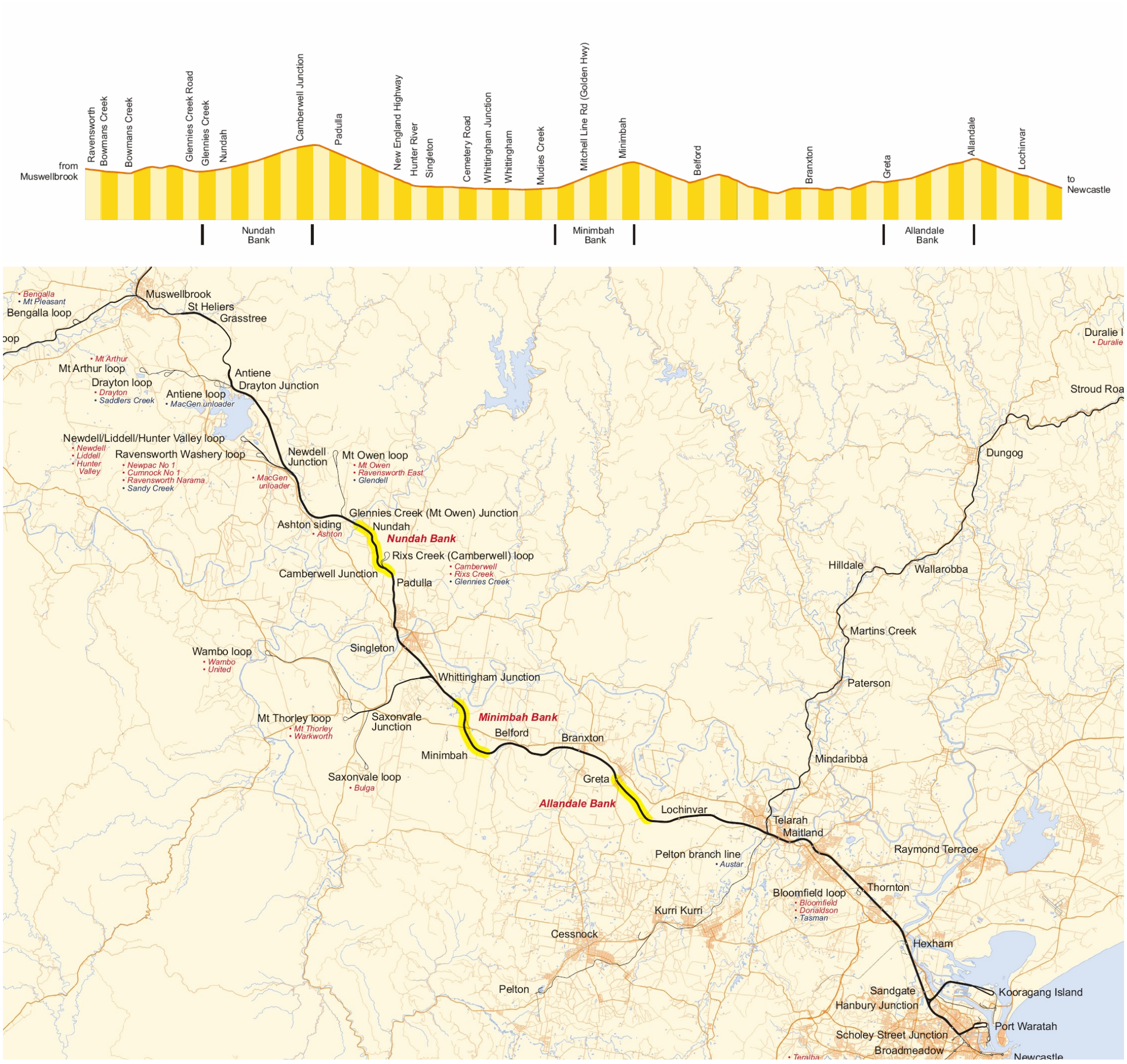

Figure 5-1 - The Nundah, Minimbah and Allandale Banks.

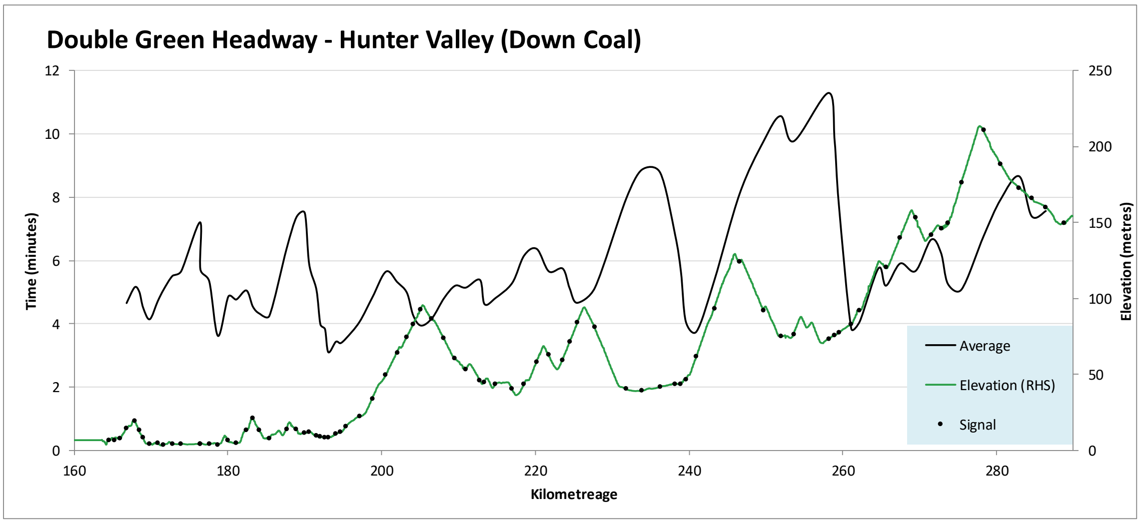

Figure 5-2 - Down direction signal headways

sections, that the shadow effect of the passenger services has a relatively limited effect.

The major issues affecting the line between Muswellbrook and the terminals are headways, junctions, the continuous flow of trains, and efficient flows into the terminals.

Headways

Headways are fundamentally a function of signal spacing and design. Drivers should ideally only ever see a green signal on double track, 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 pulsating yellow indication.

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 5-1). 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 then requires a third track to achieve the required capacity. All three of the major banks are on three track sections.

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[1] once volume exceeds around an average of 84 paths per day, or 245 mtpa at current average train weights.

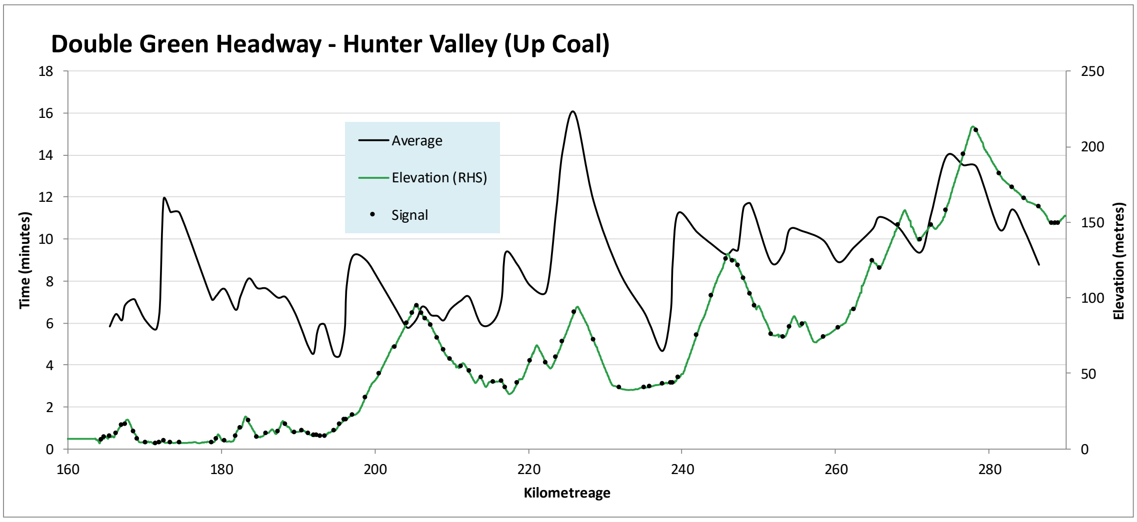

Figure 5-3 - Up direction signal headways (not adjusted for three–track sections)

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

While this principle has been adopted in the signalling design for new works, there have not as yet been any projects directed specifically at reducing signal spacing.

For this 2019 Strategy actual train performance between Muswellbrook and the ports has been calculated for the first time. Figures 5-2 and 5-3 show the double green headway for the Down and Up directions, respectively.

This actual train data has largely validated previous theoretical calculations.

Effective headway is at around 8 to 10 minutes in both directions south of Minimbah, though the data has identified a short peak of around 12 minutes approaching Hexham. Note that Figure 5-3 does not adjust headways for the three-track sections, which approximately halve the Up headway. Headway increases further up the valley with spacing as high as 14 minutes in the vicinity of Drayton Junction in the Up direction.

Adoption of this actual train performance data has had some minor effects on estimated capacity, but has not led to the identification of any capacity constraints.

It should also be noted that in a live operating environment, all trains will ideally operate at consistent speeds and achieve the section run time. To the extent that they do not it results in drivers encountering yellow signals, which causes them to slow, creating a cascading effect on following trains that will cause a loss of capacity.

Current contracted volumes do not trigger a requirement for any headway projects. In the event that ATMS proceeds on this section it will fundamentally alter the operating environment with trains able to operate at the minimum safe distance in all circumstances, which can be as low as four minutes. On Minimbah and Nundah banks though it will still be desirable to avoid two trains being on the bank on the same track at the same time, which means that on these sections ATMS would deliver a minimal reduction in headway compared to the current fixed signalling.

It has been assumed that for the purposes of the scope of work for prospective volumes that ATMS will proceed and negate the need for any signalling projects. ATMS is assumed to be delivered by Q1 2024.

Junctions

There are numerous junctions on the Hunter Valley rail network where train conflicts at the at-grade interfaces impact on capacity (figure 5-4).

Replacement of the low speed, high maintenance turnouts around Maitland has now been completed, with the last two replaced in early 2018. This upgrade was

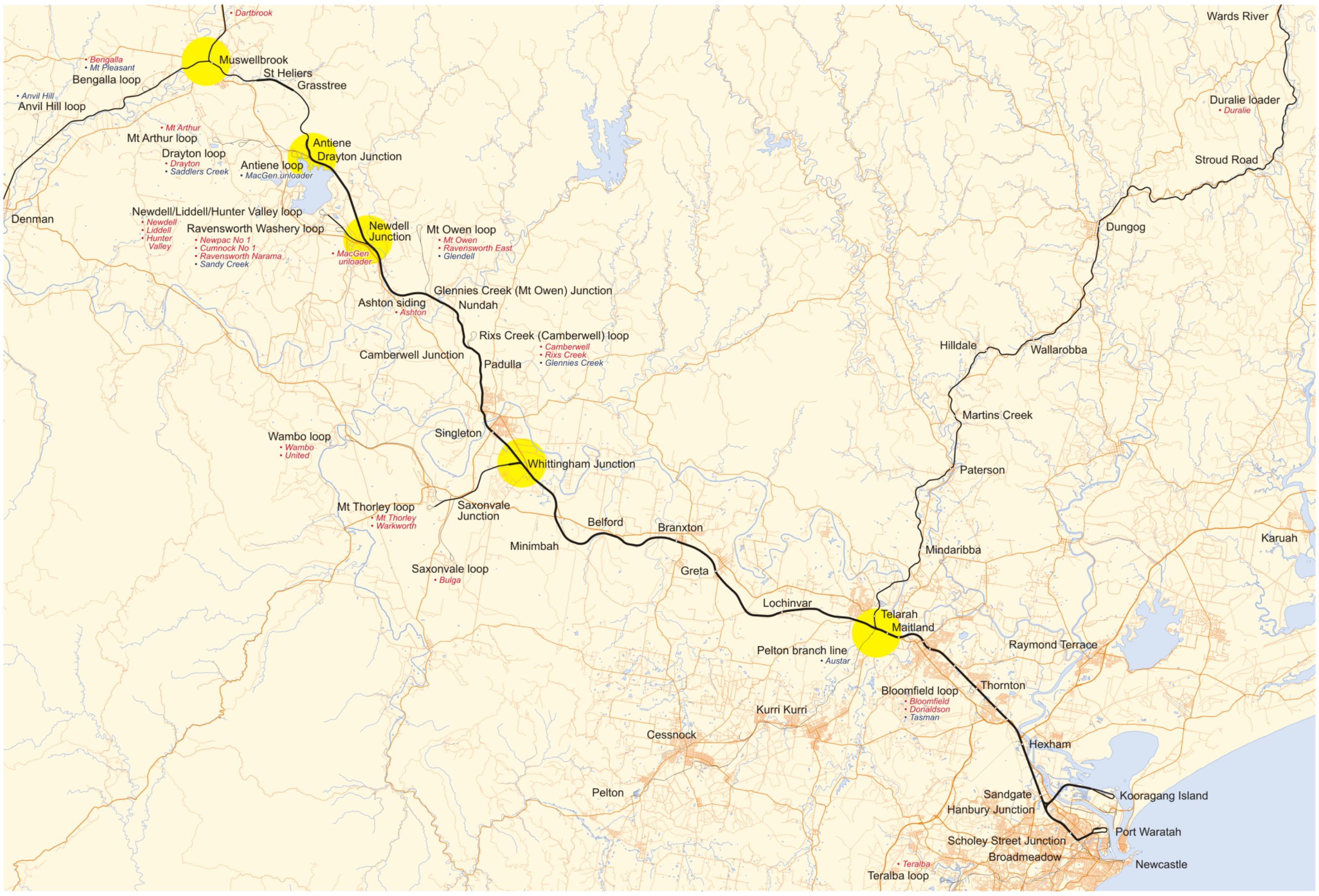

Figure 5-4 - Maitland, Whittingham, Newdell, Drayton and Muswellbrook Junctions

undertaken to reduce the future maintenance task and increase reliability and did not have any significant effect on train speeds through the junction.

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 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 highly efficient.

Camberwell Junction was upgraded to high speed turnouts in conjunction with the Nundah bank third track project, though the speed on the balloon loop limits the practical speed.

Mt Owen Junction has slow speed turnouts. However, the limited volume from Mt Owen means that its junction does not have a significant impact on capacity.

Ravensworth loop, which was previously integrated into the Newdell loop, was separated in 2013 and given a new junction with high-speed turnouts and a holding loop.

Newdell and Drayton Junctions have been upgraded with high-speed, low maintenance turnouts. While this was primarily maintenance driven, the speed upgrade means that these junctions are highly efficient.

Muswellbrook junction stands apart from the other junctions due to the need to sequence trains onto two single track lines and the significant number of trains from both lines, which means a large number of conflicting movements at the at-grade junction.

While a level of congestion at Muswellbrook is present under contracted volumes, it is tolerable based on theoretical analysis assuming a level of intelligent design in the live run train plan.

Recent analysis of actual train arrivals at Muswellbrook though suggests that in reality the operating practices are generating considerable pressure at the junction. The pattern of departure of trains from the port terminals shows that there are frequent instances of multiple trains for one line being released onto the network at separations that are inconsistent with the loop spacing on the single track lines. This necessarily means that trains have to queue at Muswellbrook waiting for a path. This effect does not occur in the Up direction since trains traversing the single track lines are naturally well spaced as they approach the junction.

This issue is purely an operational one and is being addressed through the Muswellbrook Junction train flow project discussed in Chapter 2.

Work done to date on potential infrastructure solutions has identified significant construction and environmental challenges that would suggest that any infrastructure solution is only worth pursuing once volume growth, and hence congestion, approach a level where an infrastructure solution is unavoidable.

In the medium term, prospective volume growth from both the Ulan and Gunnedah basin lines could mean that such a solution may be necessary.

The best physical solution identified is a third track heading east from Muswellbrook, which offers the best operational outcome and value for money given the constraints.

The recently identified need to replace the Hunter River / Muscle Creek bridges on the Ulan line immediately west of Muswellbrook does create an opportunity to cost effectively create double track between Muswellbrook and Bengalla. If and when there is an emerging need to further consider an infrastructure solution, the options will be further assessed to determine best value for money.

ARTC has previously assessed the threshold where a solution is required at approximately 45 coal paths/day. This threshold continues to be reached in 2023 under the prospective volume scenario, but doesn't climb above 49 paths per day. Demand does not reach 45 paths per day in the most likely scenario.

ANCO, ATMS and operational discipline, may also be feasible options to support higher throughput with the current configuration, though this will need to be tested.

HVCCC undertook modelling during 2013 that suggested there may be a need for a holding track at Muswellbrook assuming that trains arrive at Muswellbrook off their designated path where there are only a limited number of fixed paths on the Ulan and Gunnedah lines. It was subsequently concluded that in an environment of dynamic management of the network, the need for this investment could be avoided. With ANCO horizon 1 now progressing well, there is reasonable confidence that there will be no need for a holding track at this location with current volume forecasts and operational planning assumptions.

This junction will remain a focus for ARTC, both strategically and operationally, to ensure that traffic flows from the two single lines are integrated efficiently onto the double track spine south of Muswellbrook.

Continuous Train Flow

A key issue for efficiency at the terminals 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.

This was the primary driver of the decision to build the Minimbah—Maitland third track, and flexibility to achieve continuous flow has also been enhanced by the construction of the Hexham holding roads.

No further tightening of train flow requirements has been identified as necessary to support current volume forecasts. However, ANCO is expected to provide significantly enhanced ability to plan and control the arrival pattern of trains, which will give greater confidence around the ability of the system to optimise utilisation of the dump stations.

Terminals

The Hunter Valley coal industry is 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), much 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 Port Waratah precinct, with extensive rail facilities servicing a variety of activities. This includes steel products, containerised product for both third party logistics and mineral concentrate export in addition to bulk export grain for both GrainCorp and Newcastle Agri Terminal loader. 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

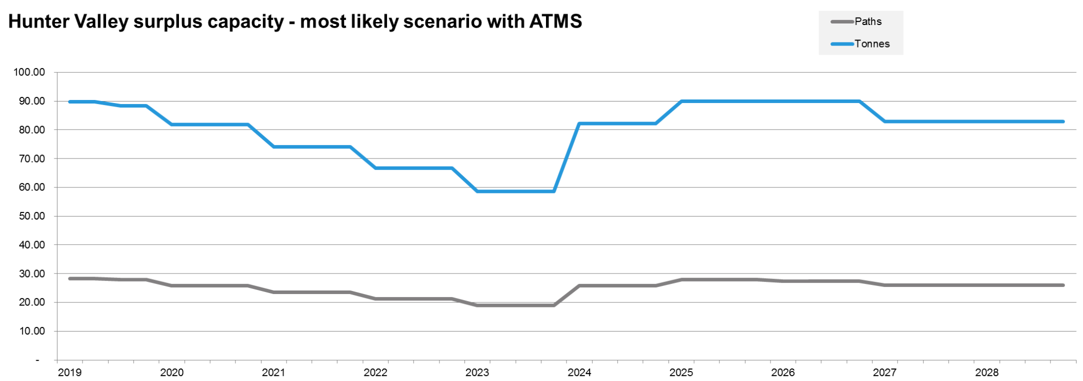

Figure 5-5 - Saleable surplus capacity for Zone 1 under the most likely volume and recommended projects scenario with ATMS

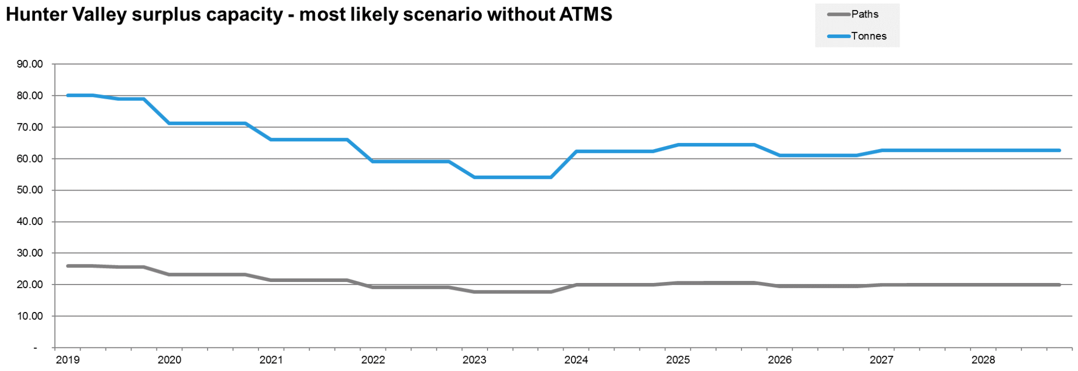

Figure 5-6 - Saleable surplus capacity for Zone 1 under the most likely volume and recommended projects scenario without ATMS

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 Austar services. Only two of the three arrival roads can accommodate 80 wagon and longer trains.

The Carrington facility has an environmental approval limit of 25 mtpa. There is some opportunity to expand this slightly, though there may be environmental challenges in doing so.

PWCS Kooragang Island is better configured for modern rail operations. It now has 9 departure roads for its four dump stations and four fully signalled arrival roads.

Provisioning and inspection activity, which had historically contributed to congestion, has been moved out of the departure roads. Locomotives continue to shuttle between Kooragang and Port Waratah but this has a relatively minor impact on capacity.

PWCS nameplate capacity as a whole is 143 mtpa, while NCIG has nameplate capacity of 66 mtpa. NCIG has three arrival roads for its two dump stations.

All previously identified rail network investments to support current terminal capability have been completed.

Any scope of work required for prospective volumes will be dependent on the details of any incremental enhancements to capacity at KCT or NCIG.

Volume & Capacity

As discussed in Chapter 1, a new chart showing forecast surplus capacity, in both paths and tonnes, under the most likely volume and infrastructure scenario with ATMS, is shown in Figure 5-5. A scenario without ATMS is shown in Figure 5-6.

This is calculated as the surplus capacity on the most capacity constrained section, assuming a 10 per cent TMTC.

Volume and capacity by line sector using the calculation methodology set out in Chapter 1 is shown in figure 5-7. This chart shows both contracted and prospective volumes for the proposed infrastructure scope including ATMS.

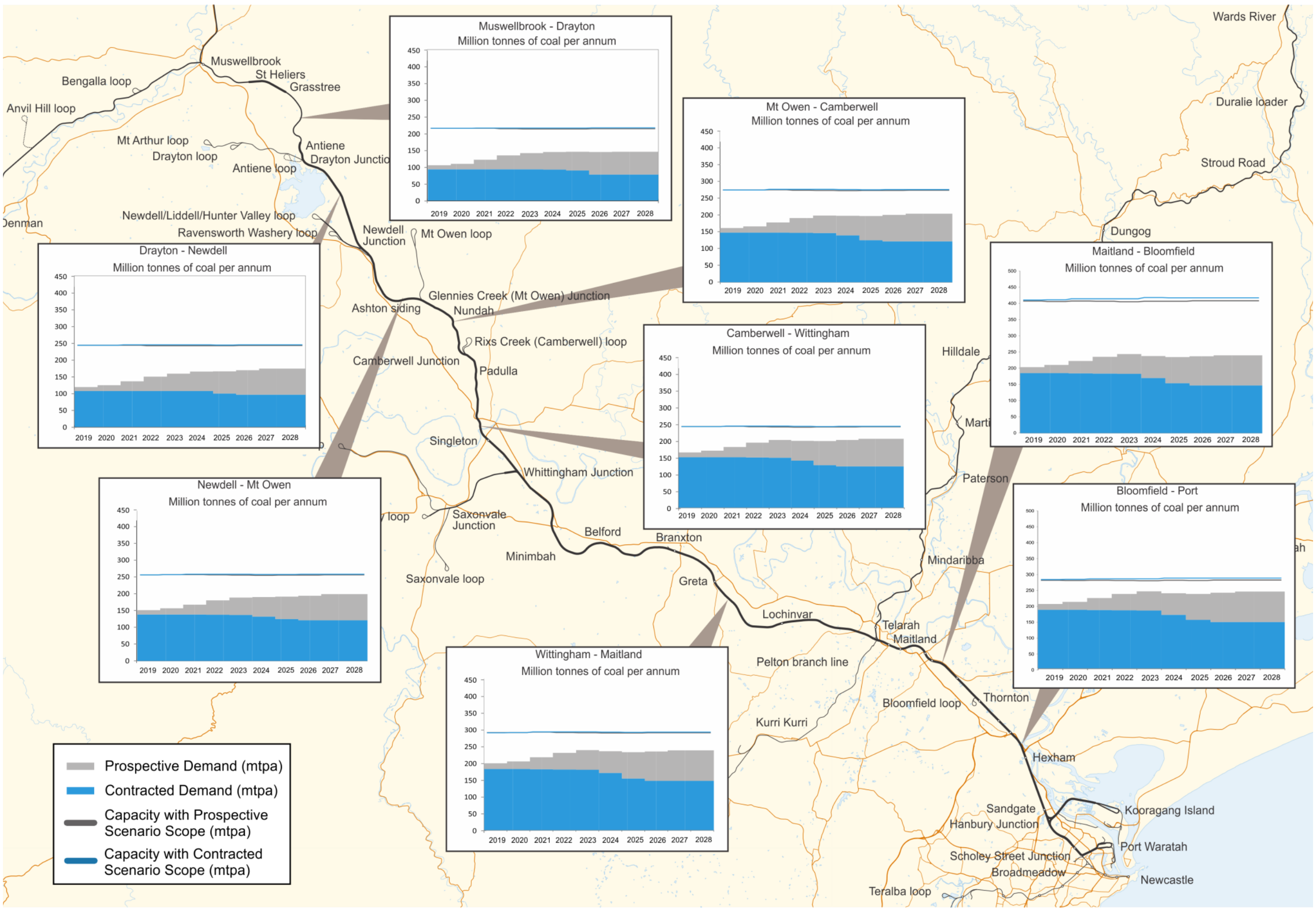

Figure 5-7 - Volume and capacity Muswellbrook—Newcastle

6

PROJECT INFORMATION

Context

Feedback on the 2017 Strategy suggested that it would be helpful for the Strategy to provide additional detail on the projects that are proposed to achieve the capacity outcomes. This section aims to provide that additional detail, though some of the projects required in later years of the prospective scenario are not covered.

ATMS and ANCO are discussed in detail in Chapter 2.

Mount Pleasant Loop

Phase 1 of the proposed Mt Pleasant project was endorsed by the ARTC's internal project steering group, the Operational Steering Committee (OSC), in July 2013. Due to the length required for the originally proposed western extension to the Bengalla Loop (approx. 4km) and the associated costs to construct this option a mid-section loop is proposed to increase the capacity of the Bengalla to Mangoola section of the Ulan Line.

The Phase 1 Concept Assessment considered five different options for the Bengalla to Mangoola section including combinations of extensions of both existing loops and the recommended mid-section stand-alone loop. The recommended option involves the construction of a stand-alone loop between 299.100km to 301.270km (2.170km long).

The proposed loop will include simultaneous entry signalling functionality, involve eight culvert extensions and future phases will confirm if the two existing level crossings need to be upgraded or relocated to allow for the loop construction/operation. The recommendation to commence Phase 2 works on the project was not submitted to the RCG due to the project being placed on hold.

Further assessment in the early stages of Phase 2 is required to determine the impact of currently identified risks related to ground conditions, environmental approvals, site access for construction, potential noise impacts to adjacent residents, level crossing upgrades and services relocations.

Current status	Phase 1 completed August 2013
Time to complete	30 months
Cost estimate (unescalated)	$33 m
Cost estimate basis	As at end of Phase 1

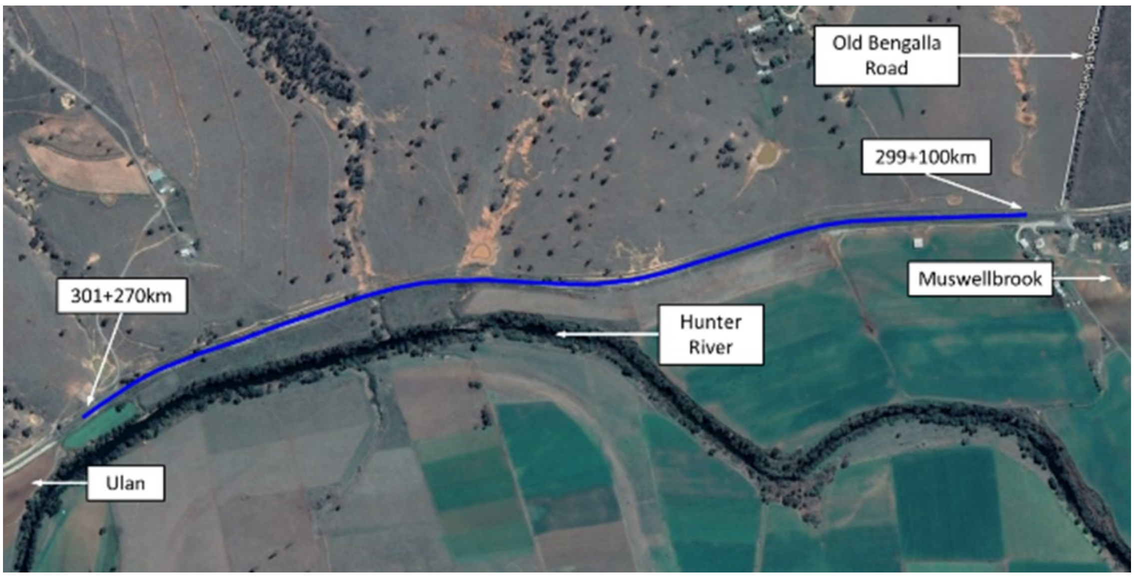

Figure 6-1 - Proposed Mt Pleasant loop

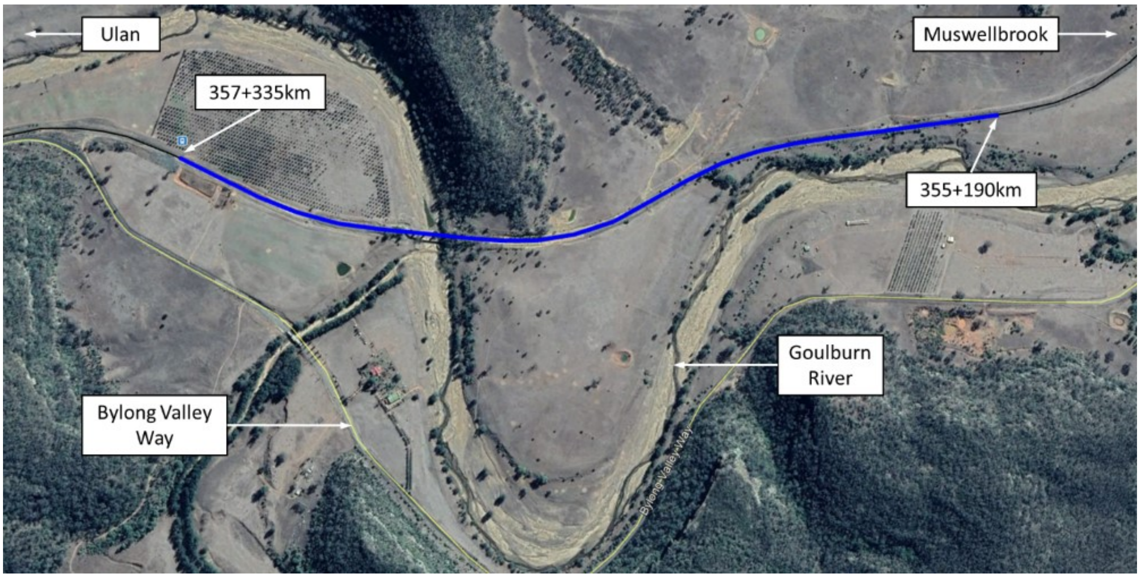

Figure 6-2 - Proposed Widden Creek loop

Widden Creek Loop

Phase 1 of the proposed Widden Creek Crossing Loop was endorsed by OSC on 17 February 2012. The detailed analysis of the options investigated are discussed in the Baerami to Kerrabee (353km Loop) Preliminary Options Report (June 2011) and subsequent Baerami to Kerrabee (353km Loop) Supplementary Options Report (Jan 2012).

The Concept Assessment Report, endorsed by RCG in April 2014, recommended a simultaneous entry crossing loop between 355.190km – 357.335km (2.145 km long). Options to extend either Baerami or Kerrabee loops were considered due to the difficult geography of the section. However, a mid-point loop at Widden Creek was determined to be the least cost option to achieve the capacity objective.

The proposed loop includes a major bridge across the Goulburn River at 356.619 km. The option of building a new bridge wide enough for two tracks, but using one side for a maintenance road initially, was endorsed. However, this bridge is now the subject of potential replacement due to fatigue. In the event that this bridge renewal proceeds it would reduce the future capital bridge replacement cost in the order of $20m. This reduction assumes the need for a change to the current loop concept design and that the loop traffic volume being low enough for the fatigue life on the existing structure to be sufficiently extended to avoid the replacement of the existing bridge, which will need to be confirmed in the next stage.

Current status	Phase 2 completed September 2013
Time to complete	36 months
Cost estimate (unescalated)	$46 m
Cost estimate basis	As at end of Phase 2

Murrumbo West Loop Extension

Phase 1 of the proposed Murrumbo West Loop Extension project was completed in June 2011. The location of the Bylong tunnel precludes the construction of a mid-section loop to increase the capacity of the Murrumbo to Bylong section of the Ulan line. This meant that the considered options for increasing capacity of this section included differing extensions of the end of section loops.

The Phase 1 Concept Assessment considered the loop extensions of both Murrumbo and Bylong and due to the ruling grade of 1:80 on the country side of Bylong Tunnel, and the related additional earthworks costs required to alleviate this grade, the extension of Murrumbo was recommended. The recommended option includes an extension of the existing Murrumbo loop from 371.090km to 374.397km (3.307km long) providing a total loop length of 5.277km.

The proposed loop extension retains simultaneous entry signalling functionality, includes the upgrade of three level crossings, requires the extension of 32 culverts and involves extensive earthworks with retaining structures required to stabilise the existing cutting slopes. Whilst the commencement of Phase 2 works on the project was approved the project was subsequently placed on hold prior to the completion of any substantial works on this phase.

The main benefits of the proposed option are that it provides greater operational flexibility (with the ability to park two trains in the loop), no requirement to grade ease between Bylong Loop and the Tunnel and allows crossing of three trains within the section. The main risks to the planned project schedule are the environmental approval duration, the environmental constraints of the site (indigenous heritage, endangered species, flora & fauna etc) and the required land acquisition. Further work would be completed in the

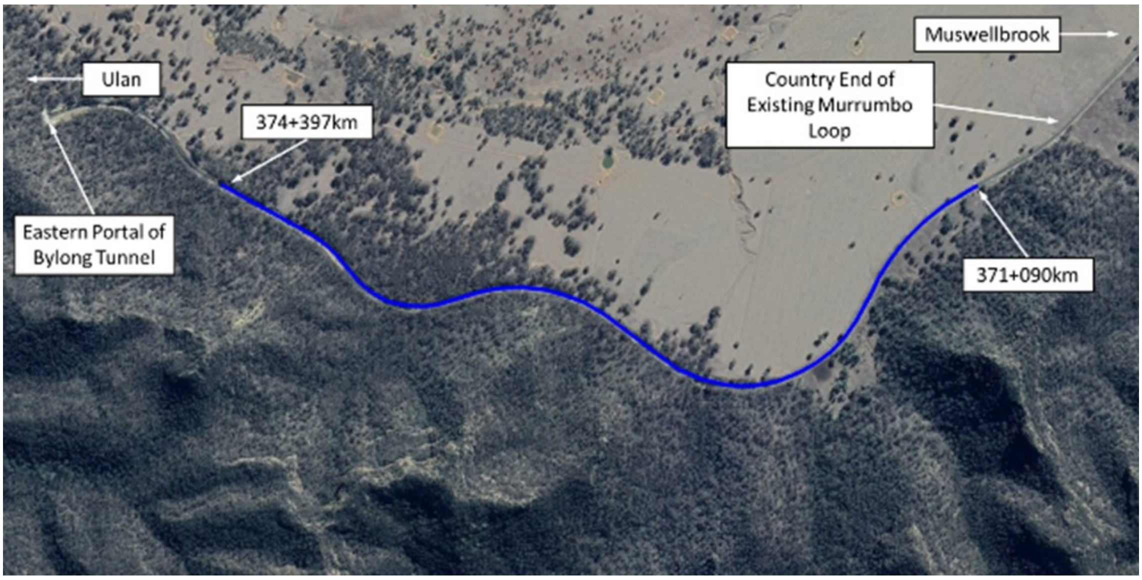

Figure 6-3 - Proposed Murrumbo West loop extension

early stages of Phase 2 to develop mitigation measures for these risks.

Current status	Phase 1 completed June 2011
Time to complete	28 months
Cost estimate (unescalated)	$48 m
Cost estimate basis	As at end of Phase 1

Aberdeen Loop Extension

Phase 1 of the proposed Aberdeen Loop Extension was endorsed by the OSC in November 2012. Three different options were identified and investigated between Koolbury and Togar during Phase 1 of the Aberdeen Loop Extension project.

The completed Concept Assessment recommends an extension of the existing Aberdeen loop towards Koolbury (or Muswellbrook). The concept assessment included a number of investigations including operational modelling, desktop property acquisition investigation, utility searches, geotechnical desktop assessment and environmental desk top searches.

The proposed loop extension alignment requires land acquisition on the Eastern side of the existing corridor and is located between 299.335km and 300.100km (0.765km long). The project was submitted to the RCG in February 2013 with a recommendation to place the project on hold as Phase 2 didn't need to start (based on the then capacity demand forecasts) until August 2015.

The minimisation of property acquisition through the introduction of retaining walls and by modifying the proposed access road has been identified as an opportunity for further investigation in future phases.

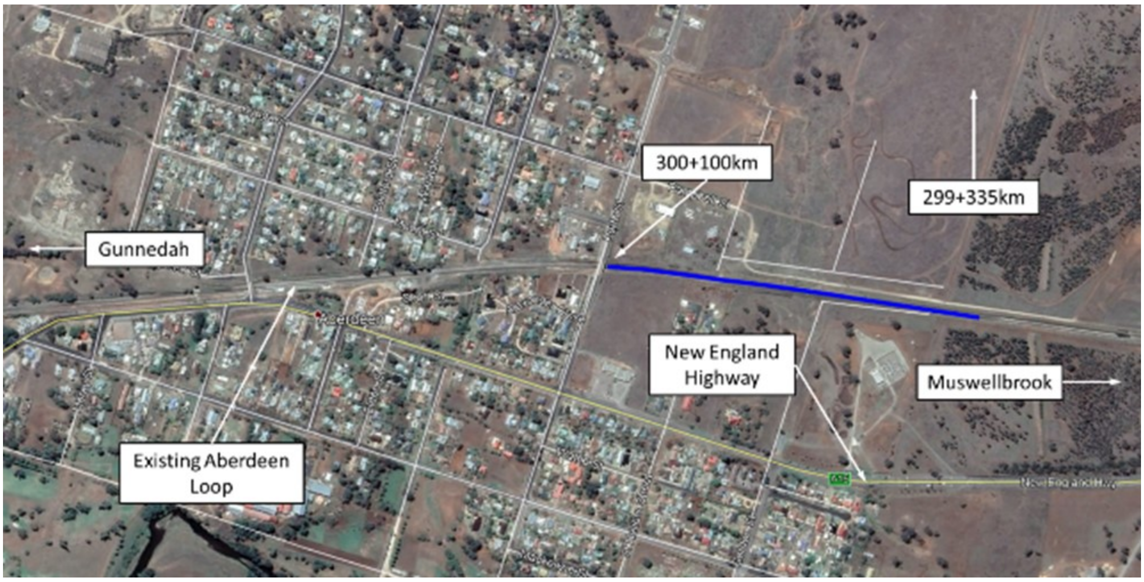

Figure 6-4 - Proposed Aberdeen loop

Current status	Phase 1 completed January 2013
Time to complete	26 months
Cost estimate (unescalated)	$13 m
Cost estimate basis	As at end of Phase 1

Togar North Loop

Phase 1 of the proposed Togar North Loop was endorsed by the OSC on 10 December 2012. Seven options comprising both stand alone loops and loop extensions between Togar and Parkville were investigated during Phase 1 of the Togar North Loop project (311km Loop).

The Concept Assessment Report, endorsed by the RCG in January 2014, recommended a stand alone loop between Togar and Scone that is located as close to Scone as practical. The other considered options were discounted due to site constraints such as level crossings and the increased length of new track required for the alternate options. The stand alone loop at Togar North was determined to be the least cost option to achieve the capacity objective.

Phase 2 of the project was endorsed by the RCG in October 2014 proposing a standalone loop location on the Up side with modified simultaneous entry signalling between 310.345km and 311.957km (1.612km long). Phase 3 works on the project were placed on hold in early 2015.

The proposed loop can be constructed within the current rail corridor land (though leasing will be required for construction). The earthworks includes lime stabilisation to reduce the amount of material that needs to be removed from site while several culverts and minor underbridges require replacement and extensions during the loop construction.

Current status	Phase 2 completed October 2014
Time to complete	29 months
Cost estimate (unescalated)	$23 m
Cost estimate basis	As at end of Phase 2

Wingen Loop

The Parkville to Murulla section of the main north line was initially nominated for duplication. However following further analysis a mid-section loop was determined to be the preferred solution to increasing network capacity in this area.

A Phase 1 Concept Assessment was subsequently undertaken in 2013 which assessed a total of four options. The recommended option from this phase consisted of a stand-alone loop between 325.680km and 327.240km.

The feasibility study for the proposed loop was subsequently completed in 2014. A minor change was proposed to the Phase 1 arrangement with the recommended configuration comprising a standalone loop located on the Down side without simultaneous entry between 325.666km and 327.240km (1.574km long). This option was approved by relevant stakeholders including the RCG for progression into Phase 3 in 2014.

The loop will be constructed on the down side of the existing single line and while the completed concept design does include minor encroachments on adjacent land it is planned for these to be battered into the adjacent land and the existing corridor boundary retained. As typical for the area the majority of the site is located on highly reactive clays that are not considered suitable for re-use. However, further testing will be carried out in the next phase to determine if lime

Figure 6-5 - Proposed Togar North loop

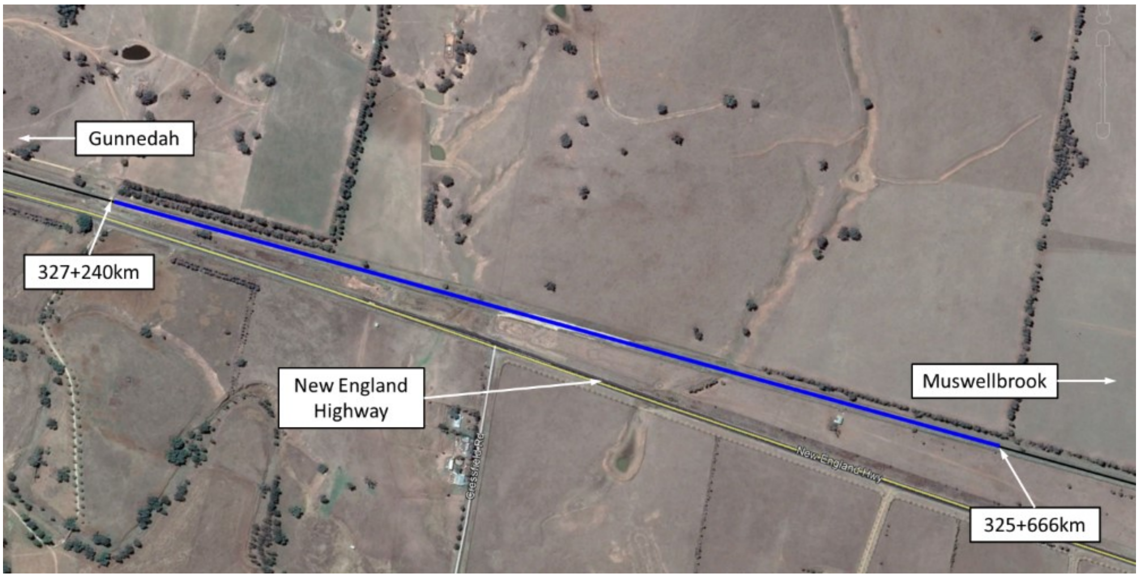

Figure 6-6- Proposed Wingen loop

stabilisation can be used to reduce the required earthworks. An existing passive level crossing located to the north of the loop needs to be upgraded to active protection with F-Type lights and bells as the position of the loop will impact on the existing level crossing sighting distance.

It is noted that a more central option was previously discounted based on the recommended option providing the then required forecast section capacity at a reduced cost. The alternative option is still available for development if the additional capacity offered in this section is required (43.9mtpa vs 34.9mtpa) at an additional cost of approximately $10 m.

Current status	Phase 2 completed September 2014
Time to complete	26 months
Cost estimate (unescalated)	$20 m
Cost estimate basis	As at end of Phase 2

Blandford Loop

Phase 1 of the proposed Blandford Loop was endorsed by the OSC on 17 December 2012. Seventeen initial options were narrowed to eight comprising stand alone loops, passing lanes and loop extensions between Murulla and Pages River during Phase 1 of the Blandford Loop project.

The completed Concept Assessment recommends a stand alone loop constructed on the Up side of the existing track between Murulla and Murrurundi. The assessment included a number of investigations including utility searches, geotechnical desktop assessment and environmental desk top searches. The limits of work for the proposed loop were identified and a signalling arrangement plan was prepared, however no track and civil designs have yet been developed for the project.

The proposed standalone loop includes allowance for simultaneous entry signalling and is located between 346.350km and 348.300km (1.950km long). The recommendation to commence Phase 2 works on the project was not submitted to the RCG due to the project being placed on hold.

The proposed loop position has been recommended based on it minimising the constraints imposed by the adjacent Blandford level crossing, the large cuttings in this area, and to minimise the impacts on the nearby residents of Blandford.

Current status	Phase 1 completed September 2012
Time to complete	39 months
Cost estimate (unescalated)	$38 m
Cost estimate basis	As at end of Phase 1

Pages River North Loop Extension

Phase 2 of the proposed Pages River North Loop Extension was completed as a part of the Liverpool Range Duplication project development in March 2013. The Pages River North Loop Extension was detailed within the completed UHVA Project Feasibility design dated April 2012.

The Project Feasibility Report for the Liverpool Range Duplication project, presented to the RCG in March 2013, recommended a staged approach to the implementation of the duplication to enable capacity increases to be introduced as demand required. The Pages River North loop extension was designated Stage A of the then planned duplication.

Phase 2 of the project proposes a Northern extension of the existing Pages River loop on the Up side between 355.835km and 356.895km (1.060km long).

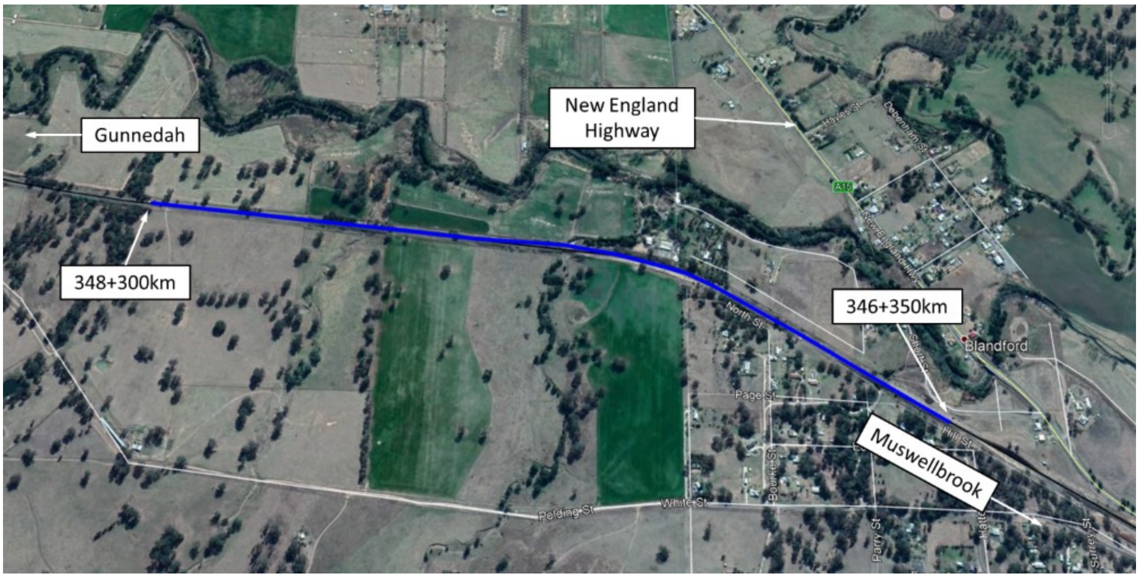

Figure 6-7- Proposed Blandford loop

The proposed loop extension can be constructed within the existing rail corridor (though leasing will be required for construction access). The works include the requirement to extend/modify 3 existing undertrack culverts and a new turnout at the country end of the loop extension. These works are sufficient for the most likely volume scenario with ATMS.

Phase 3 works on the project were not endorsed to commence due to changing capacity demand. However, if the prospective volume scenario or the most likely volume scenario without ATMS is realised then the Phase 3 works, which includes extension to the Ardglen tunnel at approximately 360km, will be required and that scope has been assumed in this Strategy.

Current status	Phase 2 completed March 2013
Time to complete	32 months
Cost estimate (unescalated)	$91 m
Cost estimate basis	Includes Phase 3 works

Ardglen to Kankool Duplication

The Ardglen to Kankool section of the Main North line was nominated for duplication (designated Stage D) as part of the work completed in investigating the increase to the capacity of the Liverpool Range section of the network.

A Phase 1 Concept Assessment for the Liverpool Range Duplication project was completed in December 2010 identifying an outline for a staged design and construction of the option to duplicate the existing alignment based on the then modelled capacity requirements.

The existing Pages River and Chilcotts Creek loops were subsequently delivered in this area and the Liverpool Ranges Duplication project then focussed on the constrained section between these two new loops.

The Liverpool Range Duplication project feasibility study was subsequently completed in March 2013. The

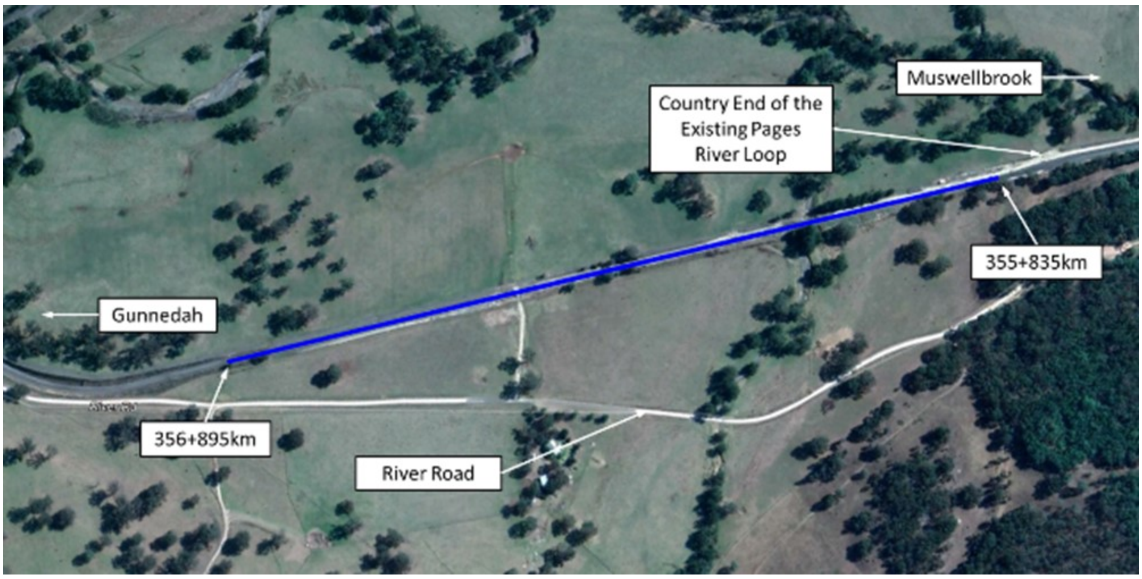

Figure 6-8- Proposed Pages River North loop extension

Figure 6-9- Proposed Ardglen to Kankool duplication

Ardglen to Kankool Duplication was detailed within the completed UHVA Project Feasibility design dated April 2012.

Phase 2 of the project proposes a duplication of the existing single track Main North between Ardglen and Kankool on the Up side between 364.600km and 368.786km (4.386km long). The Phase 2 Feasibility Report was submitted to the RCG for progression to Phase 3 in March 2013; however, the next phase of the works on the project were not endorsed to progress at that time.

The duplicated track will be constructed on the up side and is planned to include the mild easing of curves on the existing alignment at several locations as well as extensive retaining structures to allow for the required earthworks to be completed between the high rock cuttings and the adjacent highway.

The environmental approval for this project will be via an Environmental Impact Statement that will represent a key component of the critical path for the project delivery programme.

Current status	Phase 2 completed March 2013
Time to complete	47 months
Cost estimate (unescalated)	$86 m
Cost estimate basis	As at end of Phase 2

Bells Gate South Loop Extension

Phase 1 of the proposed Bells Gate South Loop Extension project was endorsed by the OSC on 26 November 2012. Major constraints with the existing mid-section short Quirindi loop meant that extension of this loop to cater for the design train was deemed unfeasible at that time and options were therefore considered for

Figure 6-10- Proposed Bells Gate South loop extension

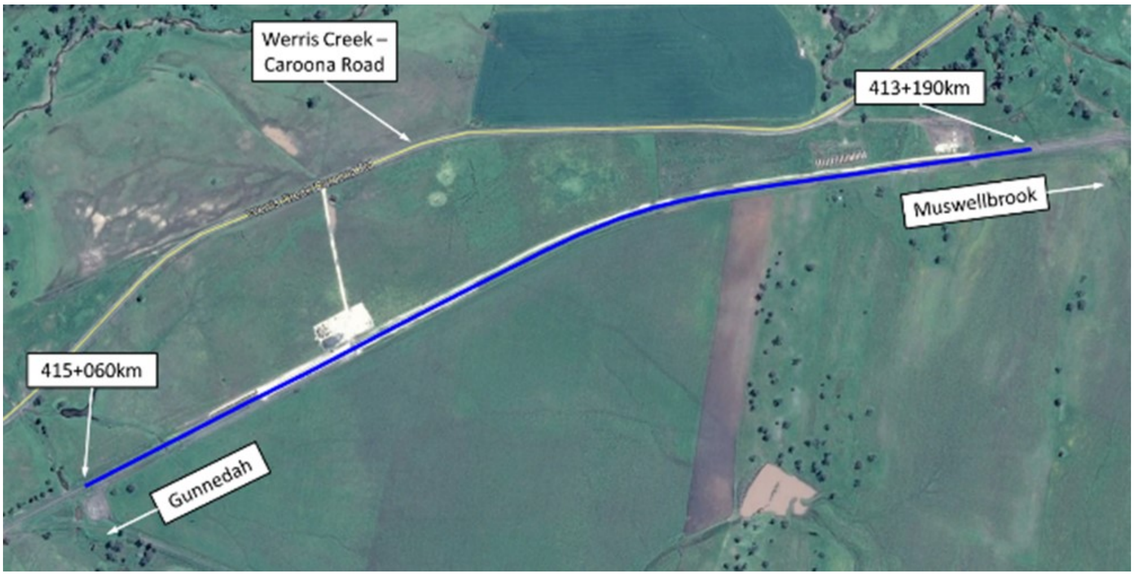

Figure 6-11- Proposed Werris Creek North loop

increasing the capacity of the Braefield to Bells Gate section by extending either of the existing loops at the ends of this section or extending both.

The Phase 1 Concept Assessment considered four differing lengths for the Bells Gate South loop extension. The recommended option includes an extension of the existing Bells Gate loop from 398.290km to 394.800km (3.490km) providing a total loop length of 5.416km.

The proposed loop extension retains simultaneous entry signalling functionality, includes the upgrade of one level crossing to active protection, requires the relocation of 3km of the existing signal cable route and involves extensive earthworks within an area containing very low CBR soils. The recommendation to commence Phase 2 works on the project was not submitted to the RCG due to the project being placed on hold.

Further assessment, based on current forecast volumes, of the option to extend the northern end of the existing Quirindi loop would be included in the early stages of Phase 2 to confirm the most cost effective solution for progression through to the next phase.

Current status	Phase 1 completed January 2013
Time to complete	39 months
Cost estimate (unescalated)	$46 m
Cost estimate basis	As at end of Phase 1

Werris Creek North Loop

Phase 1 of the Werris Creek North Loop was endorsed by the OSC in February 2013 as part of a submission considering the three projects between Bells Gate and Burilda (Werris Creek Bypass, Werris Creek South & Werris Creek North). The detailed analysis of the options investigated are discussed in the Werris Creek Bypass, Bypass Extension South and Bypass Extension North Options Report (March 2013).

The Concept Assessment Report recommended a simultaneous entry crossing loop between 413.190km to 415.060km (1.870km long). Options to by-pass Werris Creek, extend the loops either side and build mid-section loops were considered to increase the capacity of the Bells Gate to Werris Creek to Burilda sections. The Werris Creek North Loop was one of the projects recommended to achieve the previously required capacity objective, along with the Werris Creek South Loop and the Burilda South Loop Extension.

The proposed Werris Creek North loop includes one culvert replacement, another culvert extension and a level crossing upgrade. The scope used as the basis for the delivery estimate included the assumption that approximately 25,000m3 of excess earthworks materials could be permanently stockpiled on site.

Current status	Phase 1 completed March 2013
Time to complete	31 months
Cost estimate (unescalated)	$30 m
Cost estimate basis	As at end of Phase 1

South Gunnedah Loop

An options assessment was undertaken in 2011 with three options investigated around the existing level crossings between 465.885km and 470.520km in the section between Gunnedah and Curlewis. The option selected and approved by the relevant stakeholders including the RCG for progression to Phase 2 Feasibility consisted of a standalone loop between 467.066km and 468.615km.

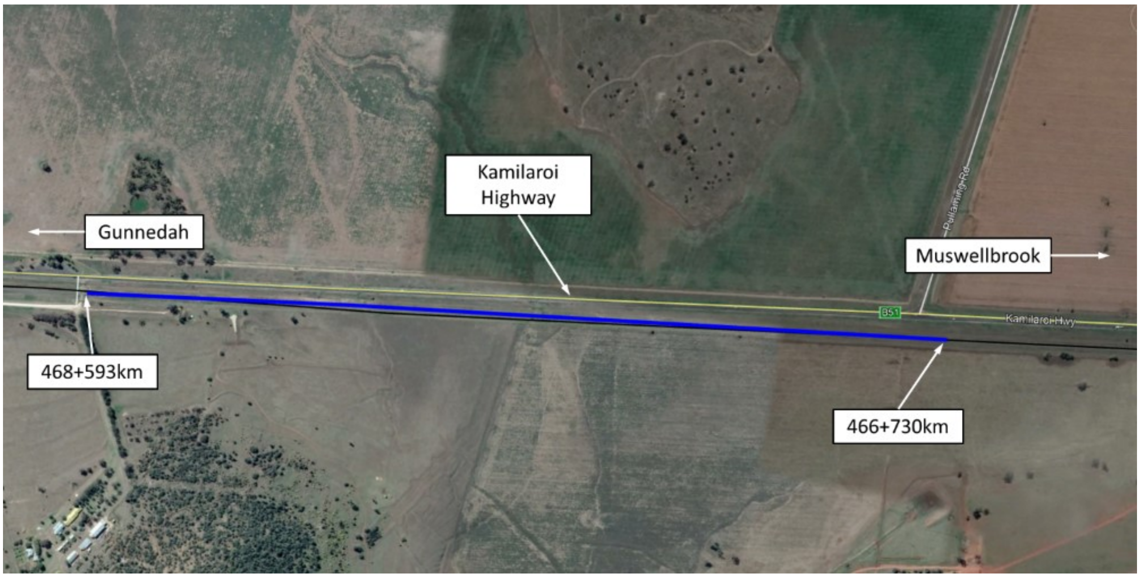

Figure 6-12- Proposed South Gunnedah loop

The Phase 2 - Feasibility and subsequent Phase 3 – Project Assessments were completed during 2011 and 2012 with the investigation works including site surveys, identification of utilities, geotechnical investigations, hydraulic modelling of the local drainage, detailed designs, environmental approval and property negotiations.

During the project development the final loop configuration was confirmed as providing a simultaneous entry signalling system with the loop positioned between 466.730km and 468.593km (1.863km long).

The existing passively protected level crossing at 468.650km will be upgraded to active protection based on an assessment of the revised risk profile for this adjacent crossing.

As the Phase 3 scope was completed in 2012 a number of activities will need to be reviewed to ensure designs and assessments are appropriate and satisfy current standards and legislation prior to commencing construction. These activities include the following:

- Review and update track and civil designs
- Review and update designs associated with the RMS Works Authorisation Deed (WAD)
- Negotiate and execute a new WAD with RMS
- Review and update signalling designs
- Prepare an updated project REF and have this updated document approved
- Negotiate and arrange execution of private property lease for construction compound.

Current status	Phase 3 completed December 2012
Time to complete	24 months
Cost estimate (unescalated)	$25 m
Cost estimate basis	As at end of Phase 3

Figure 6-13- Proposed Collygra loop

Collygra Loop

The Phase 1 Concept Assessment for the proposed Collygra Loop project was endorsed by the OSC in December 2012. Four options were considered during Phase 1 to increase the capacity of the section between Emerald Hill and Boggabri. The recommended option comprises a standalone loop between 504.780km and 506.700km (1.920km long) named the Collygra Loop.

The proposed loop will be located on the Up side of the existing mainline and has been located to minimise the impact on existing infrastructure with modifications required to a single existing underbridge. Provision for simultaneous entry signalling has been included within the concept signalling design.

The recommendation to commence Phase 2 works on the project was not submitted to the RCG due to the project being placed on hold.

Further assessment, in the early stages of Phase 2, will be required to determine access requirements via private property, treatments required to the local foundation materials due to the presence of high plasticity/highly reactive soils and the likely timeframes for the acquisition of land required to deliver this project. These investigations may lead to the adjustment of the loop position as a part of these early Phase 2 works.

Current status	Phase 1 completed December 2012
Time to complete	36 months
Cost estimate (unescalated)	$23 m
Cost estimate basis	As at end of Phase 1

7

MAINTENANCE STRATEGY

Context

In this section ARTC aims to provide high level insight into the asset management process and expected cost exposure for maintenance in the Hunter Valley. It reflects ARTC's major focus on long-term asset reliability improvement.

Changes from Previous Year

Since the 2017 Strategy there have been some changes in terms of the published spend profiles for the maintenance program. While ARTC has a sustaining maintenance strategy approach, these spend profile changes are due to specific demand and asset condition considerations.

The Major Periodic Maintenance (MPM) plan has been adjusted to align with the revised likely tonnage profiles and the planned Sustaining Capital spend profile has been revised based on steel bridge integrity considerations. In the 2017 Strategy these items were identified as potential future changes.

The tonnage profile adopted for the purpose of maintenance plans is an increase on the 2017 Strategy.

Looking forward, the spend profile may need to change to reflect changes in demand, timing of capacity enabling projects and also asset condition considerations.

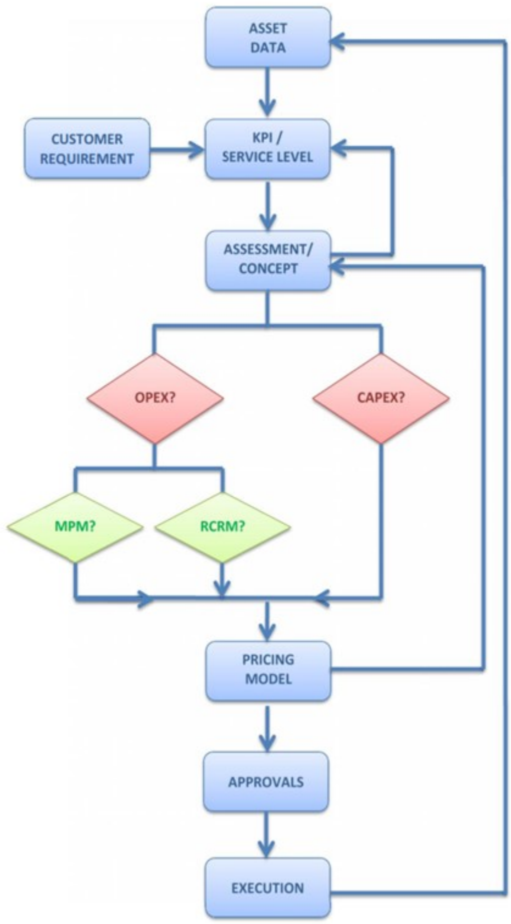

Figure 7-1 - Maintenance Development Process

Maintenance Planning System

The development of the Hunter Valley Corridor Maintenance program is an iterative process using various asset data inputs and analysis methods to arrive at a program of works that is considered to deliver ARTC's customer requirements in the most efficient manner. Figure 7-1 outlines the basis of the process.

Since the 2017 Strategy, ARTC has continued the delivery of various technology and asset management system initiatives which are aimed at improving the understanding of the condition and risk to the network. The notable technology and asset management system initiatives are discussed below with many of these being raised in the 2017 Strategy as multiyear commitments.

This program will enable improvements to the understanding of the asset condition and behaviour of the asset in response to the current maintenance strategy.

Adaptive Innovations

ARTC is at various stages of assessing and implementing a number of technological improvements to support asset condition data collection, asset reliability outcomes and efficient maintenance delivery. These include:

- Use of Instrumented Coal Wagons (ICW's) in Zone 2 for track condition monitoring
- High speed grinding to reduce the overall unit rate of rail grinding delivery
- High speed ultrasonic testing to reduce the network time required to test rail
- Real time bridge health monitoring to remotely monitor and act proactively on significant structural issues
- Use of LIDAR inspections for accurate corridor asset monitoring
- Implementation of points condition monitoring devices to proactively intervene prior to points failures
- Trialling of water proof point machine motors in flood risk areas to reduce operational recovery times.

Asset Management System Initiatives

ARTC has recently committed to significant key improvements of the systems used to develop the annual maintenance program with a view to improving on the processes used to derive the maintenance strategy. The targeted improvements are aimed at extracting further value for money for our customers. Most notably these initiatives include:

- Rationalisation of the individual systems used to manage the asset information and work tracking through the Asset Management Improvement Project (AMIP).
- The development of a Decision Support Platform (DSP) to assess asset condition and support risk-condition based maintenance planning.
- Varying the underlying time-based standards and process that generate work where alternative methods are considered superior.

ASSET MANAGEMENT IMPROVEMENT PROGRAM

To meet the service delivery needs of the rail network, infrastructure assets are required to be safe, reliable and cost effective on an ongoing basis. Asset management processes that optimise maintenance activities and deliver an accurate understanding of asset health, risk and cost provide management and customers with confidence and valuable inputs to decision making.

The Asset Management Improvement Project (AMIP) will build this foundation and deliver value through improved asset assurance function, resource optimisation and defect management on the rail assets. This will provide a more sophisticated asset management framework for ARTC to build robust maintenance plans and enable a deeper level of discussion on risk.

An outcome of the AMIP is the rationalisation of data collection and asset recording including asset attributes, asset condition and asset defect details. Consistent and accurate collection of data allows the basis for more reliable analysis.

Since the 2017 Strategy ARTC has commenced monitoring Mean Time To Repair (MTTR) and Mean Time Between Failure (MTBF) analysis for rail breaks. The AMIP outcomes provide asset data that can be relied upon for the analysis identifying the parameters that impact network reliability. The completion of AMIP will enhance the data for the MTTR and MTBF analysis for rail breaks and the principles will also be applied to other asset types.

DECISION SUPPORT PLATFORM

The AMIP will provide the maturity of asset data that is essential to the success of the Decision Support Platform (DSP).

Through the consolidation of asset information from various sources into a single analytical platform the DSP will inform asset planning decisions that assist in improving network reliability. The system will enable easy access and sharing of asset condition, reliability and asset risk information across the organisation. It will enable active management of emerging conditions through reports, system alerts, and notifications and will provide assurance that work is implemented appropriately.

The system's reliability objectives are to enable, via consolidated use of data, a reduction in rail breaks, a sustained reduction in track misalignments, improvement in bridge condition and monitoring, a reduction in points failures and an improvement in customer value through targeted maintenance improvements.

MAINTENANCE STANDARDS

The majority of the maintenance standards used to manage the asset have been derived using a tonnage or time basis. This time/tonnes basis has historically managed the safety risk across many rail operations worldwide. For example, a turnout will be inspected at a certain interval regardless of other mitigating factors such as age, condition or recent performance.

ARTC is currently reviewing maintenance standards, bringing about active consideration of time and condition-based monitoring requirements. The aim of this work is to intervene and maintain the asset only after a safety, reliability or condition trigger to optimise customer outcomes.

The changes to standards will be implemented in stages over a medium to longer term time horizon. However, recently ARTC has reviewed the frequency at which turnouts are visually inspected across the network. This review has used an approach that ranks turnouts against elements such as condition, age, criticality and failure history to derive an inspection frequency that better addresses the risk at each particular location on the network.

ARTC will work with the industry safety regulator and other subject matter experts as required to ensure that any changes to inspection intervals are undertaken in an adequate, risk controlled manner that does not compromise the safety of the asset.

Maintenance Works Summary

The annual maintenance program is divided into three main areas of expenditure; Routine Corrective and Reactive Maintenance (RCRM), Major Periodic Maintenance (MPM) and Sustaining Capital (capital). The RCRM and MPM programs are considered an operating expense and as such these programs are not subject to the Regulated Asset Base (RAB) treatment, whereas the capital program of works is subject to this treatment in accordance with the HVAU.

The current forecast program of works for both MPM and Capital is presented in the following sections. The graphs highlight an upper and lower confidence limit in terms of the forecast expenditure. This limit diverges over time in line with confidence around the requirement for the works and the cost estimate associated with the works. The graphs include the total Net Tonne Kilometres (NTKs) and the total coal volumes. The trend in maintenance expenditure can be compared to the trend of both historic and future NTK's and coal tonnes.

To provide further context to this forward maintenance spending profile, the previous five years of maintenance expenditure is also shown.

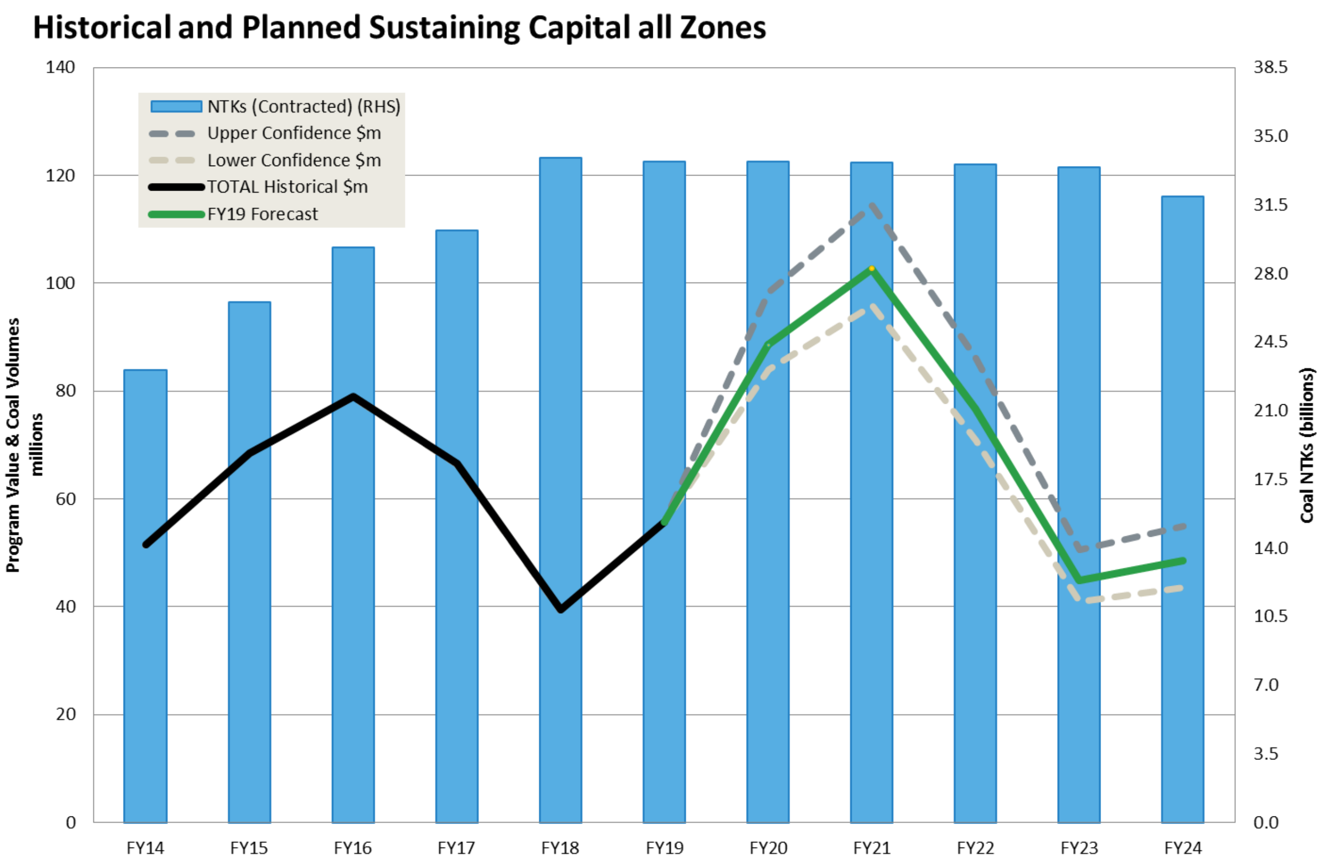

Figure 7-2 - Historical and Planned Corridor Capital

Corridor Capital

The current forecast of the five-year sustaining capital program for all Pricing Zones is shown in Figure 7-2.

This historical spend profile includes the 30 tonne axle load program of works in Zone 3 which concluded at the end of 2017. The peak in future year spend is related to a critical bridge replacement program based on risk and condition and also a significantly increased re-railing program.

The significant activities under the corridor capital program of works and a brief description of the development and asset risk are provided below. These activities typically represent over 50% of the annual corridor capital spend in any given year.

BRIDGE RENEWALS

Most structures on the coal network are of concrete construction. However, there are also steel structures and a masonry structure which while they are adequate for the current operating requirements of the coal network, provide a different risk profile due to age, condition and location on the network.

The bridge renewal program is primarily driven from a safety and risk perspective. Structures are a long-life asset with modern day designs allowing for 100+ year life. A small proportion of significant steel structures in the Hunter Valley are approaching the end of their expected life with maintenance plans for each of these structures reflecting the treatment of safety risks as opposed to significant life extension.

The emergence of significant bridge defects during 2017 has prompted ARTC to carry out bridge assessments and monitoring beyond the standard maintenance scheduled tasks. ARTC has several steel bridges in the Hunter Valley Coal Network that are circa 100 years old. To assess the criticality and risk of these structures a Multi Criteria Analysis (MCA) was conducted, prioritising structures for additional controls. Outcomes of the MCA included:

- 22 structures to be visually inspected and reported on for further recommendations; and
- 6 structures to be fitted with condition monitoring equipment.

The report recommendations have been adopted into the maintenance program and include revised replacement schedules and steel repair programs.

RERAILING

The rerailing program is developed using a model that uses the historical observed rail wear rates for each section of track. By correlating the actual tonnage history over these sections, the model then estimates the amount of rerailing required on the network through the use of forecast volumes to predict future life of the rail. There is a significant amount of rail requiring replacement during the next three years.

Rerailing is essential both to ensure that the rail has adequate structural capacity to carry the specified axle loads and to reduce the risk of rail breaks as defects in the rail propagate over time.

TRACK STRENGTHENING

The track strengthening program generally consists of track reconditioning (replacement of all ballast and subgrade). The identification and development of the scope utilises various sources of information including temporary speed restrictions, amount of tamping effort, geotechnical investigations and local team knowledge. Work scope and method is developed with a view to achieving permanent solutions that can be delivered in a 72 hour closedown.

The majority of the Hunter Valley rail network is built on an earthworks formation which was constructed during the early 1900's. The running of 30 tonne axle load rolling stock would not have been envisaged by design work done during this period. Due to the age and engineering design of these earthworks, some sections do progressively fail and the renewal is performed with a contemporary formation design.

TURNOUT RENEWAL

The turnout renewal program is derived through an assessment of turnout performance, age, location risk and current maintenance effort. The scope of works under this activity generally delivers an upgrading of the existing turnout and underlying formation with any design optimisation performed in the investigation phase of the project.

Turnouts constructed with timber bearers and older style steel work are considered an operational risk to the coal network as this style of turnout is prone to failure and a high maintenance effort. The majority of turnout replacements performed in the Hunter Valley are replacing turnouts of this design with turnouts designed to withstand the demands required of the asset in moving the volumes forecast and achieving standardised turnout types across the network.

Major Periodic Maintenance

The forecast spend profile of the MPM program for all zones is shown in Figure 7-3.

The significant activities under the MPM program of works and a brief description of the development and asset risk are provided below. These activities typically represent over 50% of the annual MPM spend in any given year.

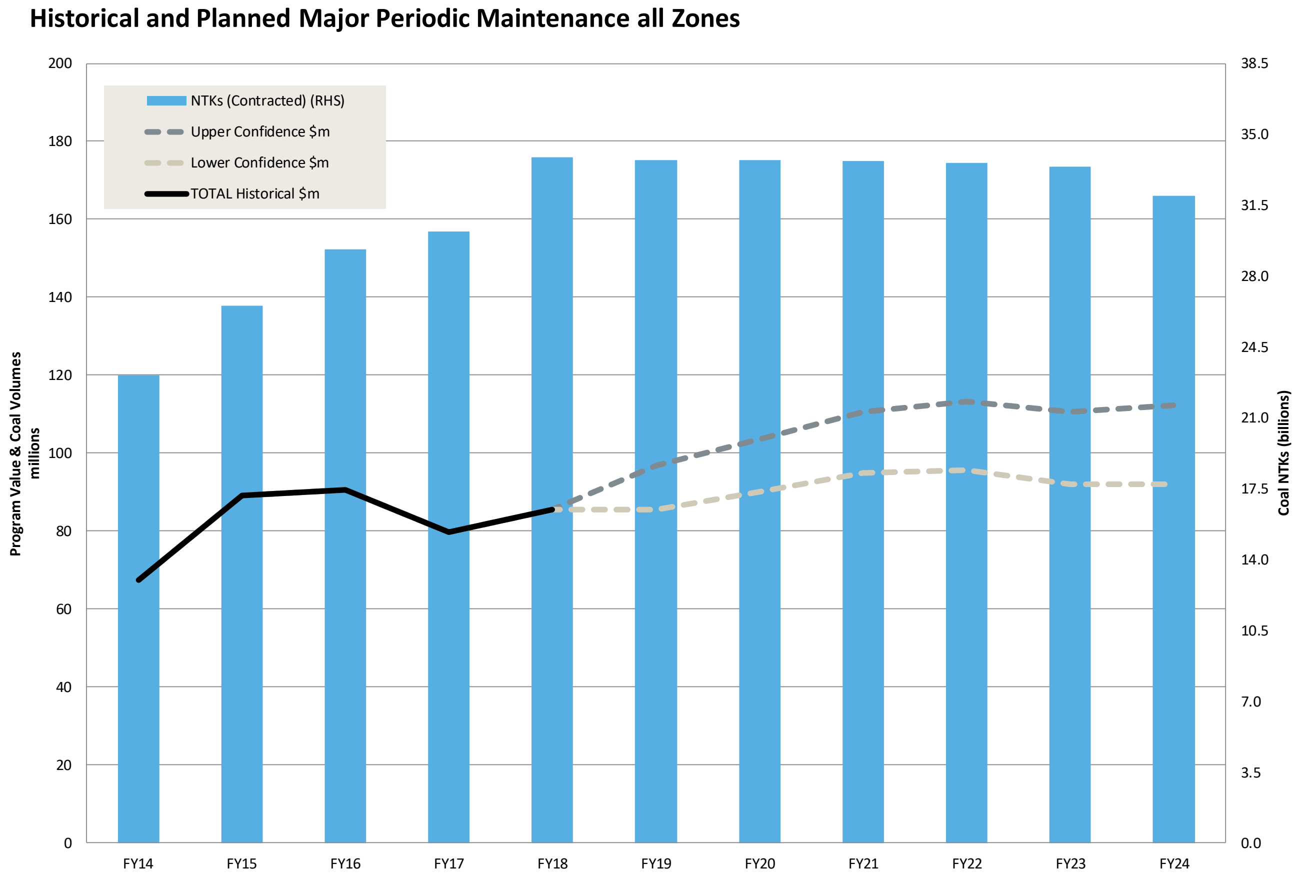

Figure 7-3 - Historical and Planned Major Periodic Maintenance

BALLAST CLEANING

The ballast underneath the sleepers must be free draining for the track asset to function properly. Over time the free draining nature of ballast reduces through the degradation of the ballast and the development of fines throughout the track profile. This degradation is due to many factors including tonnage, the amount of tamping effort, coal debris and formation failures.

Ballast cleaning is performed to remove these fines that build up over time and reduce the efficacy of the drainage system. This process involves major track plant which screens the in-situ ballast and returns good ballast to the track, with fines removed to spoil. As the ballast degradation is highly correlated to tonnage, the ballast cleaning program is cyclic in nature and sensitive to future coal volumes, noting that in the next few years there is a legacy that ARTC is continuing to work on rectifying.

RAIL GRINDING

The rail grinding program is a cyclic program based on tonnage, track curvature and rail performance (internal/external defects). The process of rail grinding involves grinding the surface of the rail to reinstate the rail shape to a profile which best suits the rollingstock wheel profiles. If there is a mismatch in these profiles, excess stresses are transferred into the rail section, creating defects which may lead to temporary speed restrictions (TSRs) or broken rails.

It is an essential part of any rail operation to maintain the rails through rail grinding. This program of works is correlated to tonnage and track curvature (with the sharper curves getting ground more often than straight track).

RESURFACING (TAMPING)

Resurfacing (or tamping) is a process where the track geometry is reinstated to a standard at which trains can travel through a track section at full design track speed. Over time track geometry deteriorates, mainly due to tonnage across the line, weather conditions and the underlying track formation.

The resurfacing program is a cyclic program based on tonnage and track performance.

DRAINAGE AND MUDHOLE RECTIFICATION

The Drainage and Mudhole rectification activity is considered to be an essential part of the maintenance program. This scope of works is variable from site to site (mud hole dig outs, surface drain cleaning, subsurface drain installation etc) however the maintenance of an effective drainage system is critical to ensuring that track geometry faults and the development of TSRs is kept to an acceptable level.

8

RECOMMENDED PROJECTS AND NETWORK CAPACITY

Recommended Projects

This Chapter summarises the projects required under each of the volume scenarios and the outcomes in terms of saleable paths and saleable coal tonnage.

In general, ‘required by’ dates reflect the timing required to deliver capacity in advance of the demand as per a given volume scenario. As discussed elsewhere in this Strategy, and detailed in Chapter 6 for each project, there can be a considerable period between approval by the RCG for a project to proceed to the next delivery phase, and the earliest realistic time that it can be delivered. ‘Proposed by’ dates in this Chapter are the latter of the required by date and the earliest the project could be expected to be delivered as at the time of this Strategy.

Where a project could be delivered in a certain timeframe, but another project with a later feasible delivery date dictates the capacity limit, the ‘Proposed by’ date of the first project is assumed to be the same as the project required to enhance the capacity limiting section.

A summary of the recommended projects for contracted volumes comparing previous and new proposed delivery timeframes, together with estimated costs, is shown in Table 8-1.

Saleable coal path capacity and coal tonnage capacity by sector for the contracted volume scenario is shown in tables 8-2 and 8-3 respectively, for a no-ATMS pathway and in tables 8-4 and 8-5 respectively where ATMS is implemented.

Table 8-6 shows the same detail as Table 8-1, for the scope of work required for the most likely volume scenario. Note that while ATMS is recommended for contracted volumes for the safety and productivity benefits it provides, table 8-6 nonetheless shows both with and without ATMS pathways.

Saleable coal path capacity and coal tonnage capacity by sector for the most likely volume scenario is shown in tables 8-7 and 8-8 respectively for a no-ATMS pathway and tables 8-9 and 8-10 for a with-ATMS pathway.

Table 8-11 is equivalent to table 8-6 for the prospective volume scenario. Saleable coal train capacity and coal tonnage capacity by sector for this scenario is shown in tables 8-12 and 8-13 respectively for a no-ATMS pathway and tables 8-14 and 8-15 for a with-ATMS pathway.

Costs shown in the tables are unescalated, $2018-19 orders of magnitude only. 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 RCG in accordance with the HVAU.

Note also that the projects in tables 8-6 and 8-11 assume ANCO and the coded track circuit upgrades.

Recommended projects - Contracted Volume	2017 Strategy – Proposed by	2019 Strategy – Required by	2019 Strategy – Proposed by	Estimated Cost ($m) un-escalated
Gunnedah Line				
Coded track circuit upgrade	Late 2019	2019	Q3 2019	<$2 m
Ulan Line				
Coded track circuit upgrade	Late 2018	2019	Q3 2019	<$1 m
Muswellbrook - Port				
Nil				
Productivity Projects				
ARTC Network Control Optimisation (ANCO) - Horizon 1				
Gunnedah basin line	Q4 2018	-	Q4 2019	$36
Ulan line	Q2 2019	-	Q4 2019	
Muswellbrook - Port	Q4 2019	-	Q2 2020	
Advanced Train Management System (ATMS) [1]				
Gunnedah basin line	Q1 2021	-	Q1 2023	$41
Ulan line	Q1 2021	-	Q3 2023	$16
Muswellbrook - Hexham	Q1 2023	-	Q1 2024	$32
Hexham - Port	Q1 2023	-	Q3 2024	$38
Trainborne units (270) [2]	-	-	Progressive	$53
System, development and project management	-	-	Progressive	$80

Table 8-1 - Recommended Projects, Delivery Schedule and Costs for Contracted Volumes

General Notes: All 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 unless the project has proceeded, to Phase 5, delivery.

Note 1 - The cost estimate for ATMS includes the roll out for the whole of the Hunter Valley. There are options to implement the project partially and incrementally over a longer period of time reducing this estimate significantly.

Note 2 - The assumed 270 trainbourne units comprises 220 for dedicated coal locomotives and 50 for passenger and non-coal locomotives.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.7	12.7	12.7
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	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 - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Scone - Dartbrook	10.3	10.3	10.3	11.5	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.2	11.2	11.2
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Ulan - Moolarben	9.4	9.4	9.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.9	11.2	11.2	11.2
Moolarben - Wilpinjong	9.4	9.4	9.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.8	10.8	10.9	11.2	11.2	11.2
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Ferndale - Mangoola	15.3	15.3	15.3	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.7	16.8	16.8	16.8
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9
Mt Pleasant - Bengalla	15.5	15.5	16.7	18.1	18.1	18.1	18.1	18.1	18.1	17.9	17.9	17.9	17.8	17.6	17.6	17.6
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9

Table 8-2 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the contracted volume scenario without ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.9	36.9	36.9
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3	34.3
Scone - Dartbrook	29.9	29.9	29.9	33.4	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.8	32.5	32.5	32.5
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
Ulan - Moolarben	30.3	30.3	31.7	34.9	34.9	34.9	34.9	34.9	36.0	36.0	35.9	35.9	36.0	37.1	37.1	37.1
Moolarben - Wilpinjong	30.5	30.5	31.9	35.2	35.2	35.2	35.2	35.2	35.6	35.6	35.5	35.5	35.6	36.6	36.6	36.6
Wilpinjong - Bylong	40.4	40.4	43.0	46.5	46.5	46.5	46.5	46.5	46.9	46.9	47.0	47.0	47.0	47.3	47.3	47.3
Bylong - Ferndale	36.2	36.2	38.2	41.4	41.4	41.4	41.4	41.4	41.7	41.7	41.8	41.8	41.8	42.1	42.1	42.1
Ferndale - Mangoola	49.1	49.1	49.1	53.2	53.2	53.2	53.2	53.2	53.7	53.7	53.7	53.7	54.2	54.7	54.7	54.7
Mangoola - Mt Pleasant	69.5	69.5	77.2	83.3	83.3	83.3	83.3	83.3	83.9	83.9	83.9	84.0	83.9	84.6	84.6	84.6
Mt Pleasant - Bengalla	50.0	50.0	53.6	58.2	58.2	58.2	58.2	58.2	58.5	58.1	58.1	58.1	57.9	57.5	57.5	57.5
Bengalla - Muswellbrook	75.1	75.1	84.0	90.6	90.6	90.6	90.6	90.6	91.2	91.2	91.2	91.2	91.1	91.6	91.6	91.6
Muswellbrook -Drayton	218.2	218.2	218.2	218.2	218.2	218.2	218.2	218.2	219.0	219.0	219.0	219.1	218.8	219.4	219.4	219.4
Drayton - Newdell	243.6	243.6	243.6	243.6	243.6	243.6	243.6	243.6	244.4	244.4	244.4	244.5	244.3	245.0	245.0	245.0
Newdell - Mt Owen	258.8	258.8	258.8	258.8	258.9	258.9	258.9	258.9	260.6	260.6	260.6	260.1	260.0	260.6	260.6	260.6
Mt Owen - Camberwell	275.6	275.6	275.6	275.6	275.8	275.8	275.8	275.8	277.5	277.5	277.5	276.8	276.0	276.7	276.7	276.7
Camberwell - Whittingham	245.4	245.4	245.4	245.4	245.6	245.6	245.6	245.6	247.1	247.0	247.0	246.4	245.7	246.3	246.3	246.3
Whittingham - Maitland	290.4	290.4	290.4	290.4	290.9	290.9	290.9	290.9	293.0	293.0	293.0	292.3	291.6	292.1	292.1	292.1
Maitland - Bloomfield	411.5	411.5	411.5	411.5	412.3	412.3	412.3	412.3	415.2	415.2	415.2	418.9	417.9	418.6	418.6	418.6
Bloomfield - Hexham	282.5	282.5	282.5	282.5	283.0	283.0	283.0	283.0	285.0	285.0	285.0	287.6	286.9	287.3	287.3	287.3

Table 8-3 - Saleable capacity in million tonnes assuming volumes and the recommended scope of work as per the contracted volume scenario without ATMS. This tonnage capacity is equal to table 8-2 times average train size times 365.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.8	5.1	5.1	5.1	5.1	5.1	5.1
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.4	9.4	9.4	9.4	9.4	9.4	11.9	11.9	11.9	11.9	11.9	11.9
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.6	15.3	15.3	15.3	15.4	15.4	15.4
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	10.1	10.1	10.1	10.1	10.1	10.1	12.8	12.8	12.8	12.8	12.8	12.8
Watermark Jct - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	16.5	16.5	16.5	16.5	16.5	16.5
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	11.8	15.0	15.0	15.0	15.0	15.0	15.0
Scone - Dartbrook	10.3	10.3	10.3	11.5	11.3	11.3	11.3	11.3	11.3	11.3	14.2	14.2	14.2	14.1	14.1	14.1
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	32.2	32.2	32.2	32.2	32.2	32.2
Ulan - Moolarben	9.4	9.4	9.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	13.0	13.0	13.1	13.4	13.4	13.4
Moolarben - Wilpinjong	9.4	9.4	9.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	13.0	13.0	13.1	13.4	13.4	13.4
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	14.5	18.4	18.4	18.4	18.4	18.4	18.4
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	16.1	16.1	16.1	16.1	16.1	16.1
Ferndale - Mangoola	15.3	15.3	15.3	16.6	16.6	16.6	16.6	16.6	16.6	16.6	21.1	21.1	21.3	21.4	21.4	21.4
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	35.0	35.0	35.0	35.0	35.0	35.0
Mt Pleasant - Bengalla	15.5	15.5	16.7	18.1	18.1	18.1	18.1	18.1	18.1	17.9	22.2	22.2	22.1	21.9	21.9	21.9
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	37.3	37.3	37.3	37.3	37.3	37.3
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	195.1	195.1	195.1	195.1	195.1
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	195.1	195.1	195.1	195.1	195.1
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	214.5	214.5	214.5	214.5	214.5
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	214.5	214.5	214.5	214.5	214.5

Table 8-4 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the contracted volume scenario with ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	11.2	14.8	14.8	14.8	14.8	14.8	14.8
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.2	27.2	27.2	27.2	27.2	27.2	34.7	34.7	34.7	34.7	34.7	34.7
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.6	36.6	36.6	36.6	36.6	36.6	44.5	44.5	44.5	44.7	44.7	44.7
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	29.2	29.2	37.3	37.3	37.3	37.3	37.3	37.3
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	48.0	48.0	48.0	48.0	48.0	48.0
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.3	34.3	43.7	43.7	43.7	43.7	43.7	43.7
Scone - Dartbrook	29.9	29.9	29.9	33.4	32.8	32.8	32.8	32.8	32.8	32.8	41.2	41.2	41.2	40.9	40.9	40.9
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	93.5	93.5	93.5	93.5	93.5	93.5
Ulan - Moolarben	30.3	30.3	31.7	34.9	34.9	34.9	34.9	34.9	36.0	36.0	43.2	43.3	43.4	44.6	44.6	44.6
Moolarben - Wilpinjong	30.5	30.5	31.9	35.2	35.2	35.2	35.2	35.2	35.6	35.6	42.8	42.7	42.9	44.1	44.1	44.1
Wilpinjong - Bylong	40.4	40.4	43.0	46.5	46.5	46.5	46.5	46.5	46.9	46.9	59.3	59.4	59.4	59.8	59.8	59.8
Bylong - Ferndale	36.2	36.2	38.2	41.4	41.4	41.4	41.4	41.4	41.7	41.7	52.1	52.1	52.1	52.5	52.5	52.5
Ferndale - Mangoola	49.1	49.1	49.1	53.2	53.2	53.2	53.2	53.2	53.7	53.7	68.2	68.2	68.8	69.7	69.7	69.7
Mangoola - Mt Pleasant	69.5	69.5	77.2	83.3	83.3	83.3	83.3	83.3	83.9	83.9	113.4	113.5	113.4	114.3	114.3	114.3
Mt Pleasant - Bengalla	50.0	50.0	53.6	58.2	58.2	58.2	58.2	58.2	58.5	58.1	72.1	72.1	71.8	71.6	71.6	71.6
Bengalla - Muswellbrook	75.1	75.1	84.0	90.6	90.6	90.6	90.6	90.6	91.2	91.2	120.7	120.8	120.7	121.3	121.3	121.3
Muswellbrook -Drayton	218.2	218.2	218.2	218.2	218.2	218.2	218.2	218.2	219.0	219.0	219.0	610.6	609.8	611.6	611.6	611.6
Drayton - Newdell	243.6	243.6	243.6	243.6	243.6	243.6	243.6	243.6	244.4	244.4	244.4	610.5	610.0	611.7	611.7	611.7
Newdell - Mt Owen	258.8	258.8	258.8	258.8	258.9	258.9	258.9	258.9	260.6	260.6	260.6	613.1	612.9	614.4	614.4	614.4
Mt Owen - Camberwell	275.6	275.6	275.6	275.6	275.8	275.8	275.8	275.8	277.5	277.5	277.5	276.8	276.0	276.7	276.7	276.7
Camberwell - Whittingham	245.4	245.4	245.4	245.4	245.6	245.6	245.6	245.6	247.1	247.0	247.0	615.2	613.6	615.0	615.0	615.0
Whittingham - Maitland	290.4	290.4	290.4	290.4	290.9	290.9	290.9	290.9	293.0	293.0	293.0	292.3	291.6	292.1	292.1	292.1
Maitland - Bloomfield	411.5	411.5	411.5	411.5	412.3	412.3	412.3	412.3	415.2	415.2	415.2	678.7	677.0	678.1	678.1	678.1
Bloomfield - Hexham	282.5	282.5	282.5	282.5	283.0	283.0	283.0	283.0	285.0	285.0	285.0	678.7	677.0	678.1	678.1	678.1

Table 8-5 - Saleable capacity in million tonnes assuming volumes and the recommended scope of work as per the contracted volume scenario with ATMS. This tonnage capacity is equal to table 8-4 times average train size times 365.

Recommended projects - Most Likely Volume Scenario	2017 Strategy – Proposed by	2019 Strategy – Required by (Note 1)	2019 Strategy – Proposed by without ATMS	2019 Strategy— Proposed by with ATMS	Estimated Cost ($m) un-escalated
Scope as per contracted volume, plus					
Gunnedah Basin Line					
Collygra	2023	Q1 2019	Q3 2023	-	$23
486 km loop	2025	Q1 2022	Q3 2023	-	$26
South Gunnedah loop	2023	Q1 2019	Q3 2021	Q3 2021	$25
Burilda north extension	-	Q1 2023	Q1 2024	-	$82
414 km loop (Werris Creek North)	2025	Q1 2022	Q3 2023	Q1 2024	$30
407 km loop (Werris Creek South)	-	Q1 2023	Q1 2024	-	$30
Bells Gate south extension	2024	Q1 2021	Q3 2022	Q3 2022	$46
Braefield north extension	-	Q1 2021	Q3 2023	-	$51
Kankool—Ardglen	-	Q1 2022	Q1 2024	-	$86
Pages River North extension	-	Q1 2021	Q3 2021	Q3 2021	$91
Blandford loop	2025	Q1 2021	Q3 2022	Q3 2022	$38
Wingen loop	2024	Q1 2021	Q3 2021	Q3 2021	$20
316 km loop (Parkville South)	-	Q1 2021	Q1 2024	-	$42
Togar North Loop	2024	Q1 2019	Q3 2021	Q3 2021	$23
Aberdeen	-	Q1 2022	Q3 2023	-	$13
Ulan Line					
Widden Creek	2021	Q1 2019	Q4 2021		$46
Port—Muswellbrook					
Nil	-	-	-		-
Congestion Projects					
Train Parkup	See Note 2	See Note 2	TBD		-

Table 8-6- Recommended Projects, Delivery Schedule and Costs for Most Likely Volumes

General 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.

Note 1: Required dates for capacity-enhancing projects assume no-ATMS

Note 2: ARTC continue to work with HVCCC to identify the requirements for this project

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.3	9.3	9.3	9.3	9.3	9.1	18.5	18.5	18.5	18.5	18.5	18.5
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.7	22.0	22.0	22.0	22.1	22.1	22.1
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	10.1	10.1	10.1	10.1	17.0	16.7	16.6	16.3	16.3	16.2	16.2	16.2
Watermark Jct - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	15.4	21.8	21.8	21.8	21.8	21.8
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	14.7	14.7	20.6	20.6	20.6	20.6	20.6
Scone - Dartbrook	10.4	10.4	10.4	11.6	11.5	11.5	11.5	11.5	13.9	13.9	16.3	26.4	26.4	26.4	26.4	26.4
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Ulan - Moolarben	9.5	9.5	10.0	11.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.8	11.0	11.1	11.1
Moolarben - Wilpinjong	9.5	9.5	10.0	11.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.8	11.0	11.1	11.1
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	13.9	13.7	13.6	13.5	13.5	13.3	13.3	13.3
Ferndale - Mangoola	15.4	15.4	15.4	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.6	16.4	16.1	16.1
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9
Mt Pleasant - Bengalla	15.6	15.6	16.7	18.2	18.1	18.1	18.1	18.1	18.1	18.0	18.1	18.1	18.1	18.0	18.0	18.0
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9

Table 8-7 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the most likely volume scenario without ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.1	27.1	27.1	27.1	27.0	26.5	53.6	53.6	53.6	53.6	53.6	53.6
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.7	36.7	36.7	36.7	36.6	36.9	63.8	63.8	63.8	64.2	64.2	64.2
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	49.4	48.6	48.2	47.5	47.2	47.0	47.0	47.0
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	44.6	63.2	63.2	63.2	63.2	63.2
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.4	42.7	42.7	59.7	59.7	59.7	59.7	59.7
Scone - Dartbrook	30.2	30.2	30.2	33.8	33.3	33.3	33.3	33.3	40.3	40.3	47.2	76.7	76.7	76.7	76.7	76.7
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
Ulan - Moolarben	30.6	30.6	32.0	35.3	34.9	34.9	34.9	34.9	36.1	36.0	36.3	36.3	35.8	36.4	36.8	36.8
Moolarben - Wilpinjong	30.8	30.8	32.2	35.5	35.2	35.2	35.2	35.2	35.8	35.7	35.9	35.9	35.4	36.0	36.4	36.4
Wilpinjong - Bylong	40.5	40.5	43.1	46.6	46.6	46.6	46.6	46.6	47.0	47.0	47.0	47.1	47.1	47.5	47.4	47.4
Bylong - Ferndale	36.2	36.2	38.3	41.5	41.4	41.4	41.4	41.4	45.1	44.3	44.0	44.0	43.7	43.7	43.6	43.6
Ferndale - Mangoola	49.4	49.4	49.4	53.5	53.5	53.5	53.5	53.5	54.0	54.2	54.2	54.3	53.9	53.8	52.6	52.6
Mangoola - Mt Pleasant	69.6	69.6	77.3	83.4	83.4	83.4	83.4	83.4	84.0	84.1	84.1	84.2	84.3	85.0	85.0	85.0
Mt Pleasant - Bengalla	50.3	50.3	54.0	58.5	58.2	58.2	58.2	58.2	58.7	58.4	58.7	58.8	58.8	59.0	59.0	59.0
Bengalla - Muswellbrook	75.2	75.2	84.1	90.8	90.8	90.8	90.8	90.8	91.3	91.4	91.4	91.4	91.5	92.1	92.0	92.0
Muswellbrook -Drayton	217.9	217.9	217.8	217.8	217.7	217.7	217.7	217.7	217.8	217.4	216.6	216.5	216.4	217.1	217.0	217.0
Drayton - Newdell	243.4	243.4	243.2	243.2	243.5	243.5	243.5	243.5	243.5	243.0	242.2	242.4	242.8	243.6	243.5	243.5
Newdell - Mt Owen	258.7	258.7	258.6	258.6	258.8	258.8	258.8	258.8	259.7	259.1	258.4	258.1	258.4	259.1	259.0	259.0
Mt Owen - Camberwell	275.4	275.4	275.3	275.3	275.7	275.7	275.7	275.7	276.5	276.0	275.2	274.6	274.9	275.5	275.4	275.4
Camberwell - Whittingham	245.3	245.3	245.1	245.1	245.4	245.4	245.4	245.4	246.2	245.7	245.0	244.4	244.6	245.2	245.0	245.0
Whittingham - Maitland	290.4	290.4	290.3	290.3	291.0	291.0	291.0	291.0	292.3	291.8	291.0	290.4	290.5	291.1	291.0	291.0
Maitland - Bloomfield	407.6	407.6	407.5	407.5	406.6	406.6	406.6	406.6	408.3	408.0	406.0	408.3	407.6	410.0	408.9	408.9
Bloomfield - Hexham	279.8	279.8	279.7	279.7	279.1	279.1	279.1	279.1	280.3	280.1	278.7	280.3	279.8	281.4	280.7	280.7

Table 8-8 - Saleable capacity in tonnes assuming volumes and the recommended scope of work as per the most likely volume scenario without ATMS. This tonnage capacity is equal to table 8-7 times average train size times 365.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.8	5.1	5.1	5.1	5.1	5.1	5.1
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.3	9.3	9.3	9.3	9.3	9.1	11.4	11.4	11.4	11.4	11.4	11.4
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.7	15.4	15.4	15.4	15.5	15.5	15.5
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	10.1	10.1	10.1	10.1	17.0	16.7	20.3	20.0	19.9	19.9	19.9	19.9
Watermark Jct - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	16.5	19.0	19.0	19.0	19.0	19.0
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	14.7	19.4	19.4	19.4	19.4	19.4	19.4
Scone - Dartbrook	10.4	10.4	10.4	11.6	11.5	11.5	11.5	11.5	13.9	13.9	18.2	18.2	18.2	18.2	18.2	18.2
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	32.2	32.2	32.2	32.2	32.2	32.2
Ulan - Moolarben	9.5	9.5	10.0	11.0	10.9	10.9	10.9	10.9	10.9	10.9	13.1	13.1	13.0	13.2	13.3	13.3
Moolarben - Wilpinjong	9.5	9.5	10.0	11.0	10.9	10.9	10.9	10.9	10.9	10.9	13.1	13.1	13.0	13.2	13.3	13.3
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	14.5	18.4	18.4	18.4	18.4	18.4	18.4
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	16.0	16.0	15.9	15.8	15.8	15.8
Ferndale - Mangoola	15.4	15.4	15.4	16.7	16.7	16.7	16.7	16.7	16.7	16.7	21.2	21.2	21.0	20.9	20.4	20.4
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	35.0	35.0	35.0	35.0	35.0	35.0
Mt Pleasant - Bengalla	15.6	15.6	16.7	18.2	18.1	18.1	18.1	18.1	18.1	18.0	22.3	22.4	22.4	22.3	22.3	22.3
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	37.3	37.3	37.3	37.3	37.3	37.3
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	195.1	195.1	195.1	195.1	195.1
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	195.1	195.1	195.1	195.1	195.1
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	214.5	214.5	214.5	214.5	214.5
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	214.5	214.5	214.5	214.5	214.5

Table 8-9 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the most likely volume scenario with ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	11.2	14.8	14.8	14.8	14.8	14.8	14.8
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.1	27.1	27.1	27.1	27.0	26.5	33.0	33.0	33.0	33.0	33.0	33.0
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.7	36.7	36.7	36.7	36.6	36.9	44.8	44.8	44.8	44.9	44.9	44.9
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	49.4	48.6	59.0	58.1	57.8	57.6	57.6	57.6
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	48.0	55.1	55.1	55.1	55.1	55.1
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.4	42.7	56.3	56.3	56.3	56.3	56.3	56.3
Scone - Dartbrook	30.2	30.2	30.2	33.8	33.3	33.3	33.3	33.3	40.3	40.3	52.9	52.9	52.9	52.9	52.9	52.9
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	93.5	93.5	93.5	93.5	93.5	93.5
Ulan - Moolarben	30.6	30.6	32.0	35.3	34.9	34.9	34.9	34.9	36.1	36.0	43.5	43.5	43.1	43.8	44.3	44.3
Moolarben - Wilpinjong	30.8	30.8	32.2	35.5	35.2	35.2	35.2	35.2	35.8	35.7	43.1	43.0	42.6	43.3	43.8	43.8
Wilpinjong - Bylong	40.5	40.5	43.1	46.6	46.6	46.6	46.6	46.6	47.0	47.0	59.4	59.5	59.5	60.0	59.9	59.9
Bylong - Ferndale	36.2	36.2	38.3	41.5	41.4	41.4	41.4	41.4	41.8	41.9	51.9	51.9	51.6	51.6	51.5	51.5
Ferndale - Mangoola	49.4	49.4	49.4	53.5	53.5	53.5	53.5	53.5	54.0	54.2	68.8	68.9	68.3	68.3	66.7	66.7
Mangoola - Mt Pleasant	69.6	69.6	77.3	83.4	83.4	83.4	83.4	83.4	84.0	84.1	113.7	113.8	113.9	114.9	114.9	114.9
Mt Pleasant - Bengalla	50.3	50.3	54.0	58.5	58.2	58.2	58.2	58.2	58.7	58.4	72.7	72.8	72.8	73.2	73.1	73.1
Bengalla - Muswellbrook	75.2	75.2	84.1	90.8	90.8	90.8	90.8	90.8	91.3	91.4	121.0	121.1	121.1	121.9	121.9	121.9
Muswellbrook -Drayton	217.9	217.9	217.8	217.8	217.7	217.7	217.7	217.7	217.8	217.4	216.6	603.4	603.2	605.1	604.9	604.9
Drayton - Newdell	243.4	243.4	243.2	243.2	243.5	243.5	243.5	243.5	243.5	243.0	242.2	605.4	606.4	608.3	608.2	608.2
Newdell - Mt Owen	258.7	258.7	258.6	258.6	258.8	258.8	258.8	258.8	259.7	259.1	258.4	608.4	609.2	610.7	610.6	610.6
Mt Owen - Camberwell	275.4	275.4	275.3	275.3	275.7	275.7	275.7	275.7	276.5	276.0	275.2	274.6	274.9	275.5	275.4	275.4
Camberwell - Whittingham	245.3	245.3	245.1	245.1	245.4	245.4	245.4	245.4	246.2	245.7	245.0	610.4	610.9	612.3	611.9	611.9
Whittingham - Maitland	290.4	290.4	290.3	290.3	291.0	291.0	291.0	291.0	292.3	291.8	291.0	290.4	290.5	291.1	291.0	291.0
Maitland - Bloomfield	407.6	407.6	407.5	407.5	406.6	406.6	406.6	406.6	408.3	408.0	406.0	661.5	660.3	664.1	662.5	662.5
Bloomfield - Hexham	279.8	279.8	279.7	279.7	279.1	279.1	279.1	279.1	280.3	280.1	278.7	661.6	660.3	664.1	662.5	662.5

Table 8-10 - Saleable capacity in tonnes assuming volumes and the recommended scope of work as per the most likely volume scenario with ATMS. This

Recommended projects - Prospective Volume Scenario	2017 Strategy – Proposed by	2019 Strategy – Required by (Note 1)	2019 Strategy – Proposed by without ATMS	2019 Strategy—Proposed by with ATMS	Estimated Cost ($m) un-escalated
Scope as per contracted volume, plus					
Gunnedah Basin Line					
Collygra	2023	Q1 2019	Q3 2023	Q3 2023	$23
486 km loop	2023	Q1 2022	Q3 2023	Q1 2024	$26
South Gunnedah loop	2020	Q1 2019	Q3 2021	Q3 2021	$25
Breeza north extension	-	Q1 2023	Q1 2024	-	$40
Burilda north extension	2023	Q1 2022	Q1 2024	Q1 2024	$82
414 km loop (Werris Creek North)	2022	Q1 2021	Q3 2023	Q3 2023	$30
407 km loop (Werris Creek South)	2023	Q1 2022	Q1 2024	-	$30
Bells Gate south extension	2021	Q1 2021	Q3 2022	Q3 2022	$46
Braefield north extension	2023	Q1 2021	Q3 2023	-	$51
Kankool—Ardglen	2023	Q1 2022	Q1 2024	Q1 2024	$86
Pages River North extension	2023	Q1 2021	Q3 2021	Q3 2021	$91
Blandford loop	2022	Q1 2021	Q3 2022	Q3 2022	$38
Wingen loop	2020	Q1 2021	Q3 2021	Q3 2021	$20
316 km loop (Parkville South)	-	Q1 2021	Q1 2024	-	$42
Togar North Loop	2020	Q1 2019	Q3 2021	Q3 2021	$23
Aberdeen	2023	Q1 2021	Q3 2023	Q3 2023	$13
Ulan Line					
Coggan Creek West extension	-	Q1 2021	Q4 2022	-	$57
Murrumbo west extension	-	Q1 2021	Q4 2022	-	$48
Widden Creek	2021	Q1 2019	Q4 2021	-	$46
Mt Pleasant	2027	Q1 2019	Q4 2022	-	$33
Port—Muswellbrook					
Nil	-	-	-		-
Congestion Projects					
Train Parkup	See Note 2	See Note 2	TBD		-

Table 8-11 - Recommended Projects, Delivery Schedule and Costs for Prospective Volumes

General 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.

Note 1: The required dates for the capacity-enhancing projects assume no-ATMS.

Note 2: ARTC continue to work with HVCCC to identify the requirements for this project

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.6	3.4	3.4	3.4	3.4	3.4	3.4
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.3	9.3	9.3	9.3	9.2	9.2	18.5	18.5	18.5	18.5	18.5	18.5
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.7	22.0	22.0	22.0	22.2	22.2	22.2
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	10.1	10.1	10.1	10.1	16.9	16.7	16.6	18.1	18.1	18.1	18.1	18.1
Watermark Jct - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	15.4	21.8	21.8	21.8	21.8	21.8
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	14.7	14.7	20.6	20.6	20.6	20.6	20.6
Scone - Dartbrook	10.4	10.4	10.4	11.6	11.5	11.5	11.5	11.5	13.8	13.8	16.5	26.4	26.4	26.4	26.4	26.4
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Ulan - Moolarben	9.5	9.5	9.9	10.9	10.8	10.8	10.8	10.8	10.9	10.9	10.9	10.9	10.7	10.8	10.9	10.9
Moolarben - Wilpinjong	9.5	9.5	9.9	10.9	10.8	10.8	10.8	10.8	10.9	10.9	10.9	10.9	10.7	10.8	10.9	10.9
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	13.9	14.9	14.9	14.8	14.8	14.7	14.7	14.7
Ferndale - Mangoola	15.4	15.4	15.4	16.7	16.7	16.7	16.7	16.7	16.8	16.8	16.8	16.8	16.7	16.6	16.3	16.3
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9	25.9
Mt Pleasant - Bengalla	15.7	15.7	16.8	18.2	18.2	18.2	18.2	18.2	18.3	18.1	18.2	18.2	18.2	18.2	18.1	18.1
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9

Table 8-12 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the prospective volume scenario without ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	10.4	10.0	10.0	10.0	10.0	10.0	10.0
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.1	27.1	27.1	27.1	26.7	26.6	53.6	53.6	53.6	53.6	53.6	53.6
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.7	36.7	36.7	36.7	36.6	37.0	64.0	64.0	64.0	64.3	64.3	64.3
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	48.9	48.6	48.2	52.6	52.6	52.6	52.6	52.6
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	44.6	63.2	63.2	63.2	63.2	63.2
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.4	42.7	42.7	59.7	59.7	59.7	59.7	59.7
Scone - Dartbrook	30.2	30.2	30.2	33.8	33.4	33.4	33.4	33.4	40.2	40.2	47.8	76.7	76.6	76.6	76.6	76.6
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
Ulan - Moolarben	30.6	30.6	31.9	35.1	34.8	34.8	34.8	34.8	36.1	36.0	36.2	36.2	35.6	35.8	36.1	36.1
Moolarben - Wilpinjong	30.9	30.9	32.2	35.4	35.2	35.2	35.2	35.2	35.9	35.7	35.9	35.9	35.2	35.5	35.7	35.7
Wilpinjong - Bylong	40.6	40.6	43.2	46.7	46.7	46.7	46.7	46.7	47.2	52.9	52.9	52.9	52.9	53.3	53.3	53.3
Bylong - Ferndale	36.3	36.3	38.4	41.5	41.6	41.6	41.6	41.6	45.2	48.5	48.4	48.3	48.1	48.2	48.1	48.1
Ferndale - Mangoola	49.6	49.6	49.6	53.8	53.8	53.8	53.8	53.8	54.5	54.7	54.8	54.8	54.5	54.5	53.3	53.3
Mangoola - Mt Pleasant	69.7	69.7	77.4	83.5	83.5	83.5	83.5	83.5	84.2	84.3	84.3	84.4	84.4	85.1	85.1	85.1
Mt Pleasant - Bengalla	50.7	50.7	54.3	58.8	58.6	58.6	58.6	58.6	59.4	59.0	59.4	59.5	59.5	59.7	59.6	59.6
Bengalla - Muswellbrook	75.3	75.3	84.2	90.9	91.0	91.0	91.0	91.0	91.5	91.6	91.6	91.6	91.7	92.2	92.2	92.2
Muswellbrook -Drayton	218.1	218.1	218.1	218.1	218.1	218.1	218.1	218.1	218.0	216.9	216.1	215.9	215.8	216.6	216.7	216.7
Drayton - Newdell	243.5	243.5	243.5	243.5	243.5	243.5	243.5	243.5	243.4	242.3	241.8	241.7	242.1	242.6	243.0	243.0
Newdell - Mt Owen	258.8	258.8	258.8	258.8	258.8	258.8	258.8	258.8	259.5	258.4	257.8	257.3	257.7	258.1	258.4	258.4
Mt Owen - Camberwell	275.5	275.5	275.5	275.5	275.7	275.7	275.7	275.7	276.3	275.1	274.5	273.8	274.0	274.4	274.7	274.7
Camberwell - Whittingham	245.4	245.4	245.4	245.4	245.5	245.5	245.5	245.5	246.0	244.9	244.4	243.7	243.9	244.2	244.5	244.5
Whittingham - Maitland	290.5	290.5	290.5	290.5	291.1	291.1	291.1	291.1	292.1	291.0	290.3	289.6	289.6	290.0	290.3	290.3
Maitland - Bloomfield	408.0	408.0	408.0	408.0	406.9	406.9	406.9	406.9	408.5	407.6	406.0	407.9	407.3	409.2	408.9	408.9
Bloomfield - Hexham	280.1	280.1	280.1	280.1	279.3	279.3	279.3	279.3	280.5	279.8	278.7	280.0	279.6	281.1	280.9	280.9

Table 8-13 - Saleable capacity in tonnes assuming volumes and the recommended scope of work as per the prospective volume scenario without ATMS. This tonnage capacity is equal to table 8-12 times average train size times 365.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	3.1	3.1	3.2	3.9	3.8	3.8	3.8	3.8	3.8	3.6	4.7	4.7	4.7	4.7	4.7	4.7
Boggabri - Vickery	8.0	8.0	8.5	9.5	9.3	9.3	9.3	9.3	9.2	9.2	23.5	23.5	23.5	23.5	23.5	23.5
Vickery - Gunnedah	10.8	10.8	11.6	12.8	12.6	12.6	12.6	12.6	12.6	12.7	15.5	27.1	27.1	27.2	27.2	27.2
Gunnedah - Watermark Jct	8.6	8.6	9.2	10.3	10.1	10.1	10.1	10.1	16.9	16.7	20.3	20.1	20.1	20.0	20.0	20.0
Watermark Jct - Werris Creek	10.9	10.9	11.7	12.9	12.7	12.7	12.7	12.7	12.7	12.7	19.0	29.2	29.2	29.2	29.2	29.2
Werris Creek - Scone	10.8	10.8	10.8	12.0	11.8	11.8	11.8	11.8	11.8	14.7	19.4	20.3	20.3	20.3	20.3	20.3
Scone - Dartbrook	10.4	10.4	10.4	11.6	11.5	11.5	11.5	11.5	13.8	13.8	20.7	20.7	20.7	20.7	20.7	20.7
Dartbrook - Muswellbrook	21.8	21.8	21.8	24.0	23.5	23.5	23.5	23.5	23.5	23.5	32.2	32.2	32.2	32.2	32.2	32.2
Ulan - Moolarben	9.5	9.5	9.9	10.9	10.8	10.8	10.8	10.8	10.9	10.9	12.9	12.9	12.7	12.8	13.0	13.0
Moolarben - Wilpinjong	9.5	9.5	9.9	10.9	10.8	10.8	10.8	10.8	10.9	10.9	12.9	12.9	12.7	12.8	13.0	13.0
Wilpinjong - Bylong	12.6	12.6	13.4	14.5	14.5	14.5	14.5	14.5	14.5	14.5	18.4	18.4	18.4	18.4	18.4	18.4
Bylong - Ferndale	11.3	11.3	11.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	16.1	16.1	16.0	15.9	15.9	15.9
Ferndale - Mangoola	15.4	15.4	15.4	16.7	16.7	16.7	16.7	16.7	16.8	16.8	21.3	21.3	21.2	21.0	20.6	20.6
Mangoola - Mt Pleasant	21.6	21.6	24.0	25.9	25.9	25.9	25.9	25.9	25.9	25.9	35.0	35.0	35.0	35.0	35.0	35.0
Mt Pleasant - Bengalla	15.7	15.7	16.8	18.2	18.2	18.2	18.2	18.2	18.3	18.1	22.5	22.5	22.5	22.4	22.3	22.3
Bengalla - Muswellbrook	23.3	23.3	26.1	28.2	28.2	28.2	28.2	28.2	28.2	28.2	37.3	37.3	37.3	37.3	37.3	37.3
Muswellbrook -Drayton	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	195.1	195.1	195.1	195.1	195.1
Drayton - Newdell	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Newdell - Mt Owen	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	195.1	195.1	195.1	195.1	195.1
Mt Owen - Camberwell	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Camberwell - Whittingham	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	78.1	195.1	195.1	195.1	195.1	195.1
Whittingham - Maitland	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Maitland - Bloomfield	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	132.4	214.5	214.5	214.5	214.5	214.5
Bloomfield - Hexham	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	90.9	214.5	214.5	214.5	214.5	214.5

Table 8-14 - Saleable capacity in coal train numbers (round-trips per day) assuming volumes and the recommended scope of work as per the prospective volume scenario with ATMS.

	2019				2020				2021	2022	2023	2024	2025	2026	2027	2028
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4	Q4
Narrabri - Boggabri	8.9	8.9	9.4	11.4	11.2	11.2	11.2	11.2	11.2	10.4	13.5	13.5	13.5	13.5	13.5	13.5
Boggabri - Vickery	23.3	23.3	24.7	27.7	27.1	27.1	27.1	27.1	26.7	26.6	68.2	68.2	68.2	68.2	68.2	68.2
Vickery - Gunnedah	31.4	31.4	33.6	37.3	36.7	36.7	36.7	36.7	36.6	37.0	44.9	78.6	78.6	79.0	79.0	79.0
Gunnedah - Watermark Jct	25.1	25.1	26.7	29.8	29.2	29.2	29.2	29.2	48.9	48.6	58.9	58.4	58.3	58.2	58.2	58.2
Watermark Jct - Werris Creek	31.7	31.7	33.9	37.6	36.9	36.9	36.9	36.9	36.9	36.9	55.1	84.7	84.7	84.7	84.7	84.7
Werris Creek - Scone	31.5	31.5	31.5	35.0	34.3	34.3	34.3	34.3	34.4	42.7	56.3	59.0	59.0	59.0	59.0	59.0
Scone - Dartbrook	30.2	30.2	30.2	33.8	33.4	33.4	33.4	33.4	40.2	40.2	60.0	60.1	60.1	60.0	60.0	60.0
Dartbrook - Muswellbrook	63.2	63.2	63.2	69.6	68.3	68.3	68.3	68.3	68.3	68.3	93.5	93.5	93.5	93.5	93.5	93.5
Ulan - Moolarben	30.6	30.6	31.9	35.1	34.8	34.8	34.8	34.8	36.1	36.0	42.9	43.0	42.3	42.7	43.0	43.0
Moolarben - Wilpinjong	30.9	30.9	32.2	35.4	35.2	35.2	35.2	35.2	35.9	35.7	42.5	42.6	41.9	42.2	42.6	42.6
Wilpinjong - Bylong	40.6	40.6	43.2	46.7	46.7	46.7	46.7	46.7	47.2	47.2	59.6	59.7	59.7	60.1	60.1	60.1
Bylong - Ferndale	36.3	36.3	38.4	41.5	41.6	41.6	41.6	41.6	42.0	42.0	52.4	52.4	52.1	52.2	52.1	52.1
Ferndale - Mangoola	49.6	49.6	49.6	53.8	53.8	53.8	53.8	53.8	54.5	54.7	69.4	69.4	69.0	68.9	67.5	67.5
Mangoola - Mt Pleasant	69.7	69.7	77.4	83.5	83.5	83.5	83.5	83.5	84.2	84.3	114.0	114.0	114.1	115.0	115.0	115.0
Mt Pleasant - Bengalla	50.7	50.7	54.3	58.8	58.6	58.6	58.6	58.6	59.4	59.0	73.4	73.4	73.5	73.7	73.4	73.4
Bengalla - Muswellbrook	75.3	75.3	84.2	90.9	91.0	91.0	91.0	91.0	91.5	91.6	121.3	121.3	121.4	122.1	122.2	122.2
Muswellbrook -Drayton	218.1	218.1	218.1	218.1	218.1	218.1	218.1	218.1	218.0	216.9	216.1	601.7	601.6	603.8	604.0	604.0
Drayton - Newdell	243.5	243.5	243.5	243.5	243.5	243.5	243.5	243.5	243.4	242.3	241.8	603.7	604.6	605.9	606.9	606.9
Newdell - Mt Owen	258.8	258.8	258.8	258.8	258.8	258.8	258.8	258.8	259.5	258.4	257.8	606.6	607.4	608.3	609.2	609.2
Mt Owen - Camberwell	275.5	275.5	275.5	275.5	275.7	275.7	275.7	275.7	276.3	275.1	274.5	273.8	274.0	274.4	274.7	274.7
Camberwell - Whittingham	245.4	245.4	245.4	245.4	245.5	245.5	245.5	245.5	246.0	244.9	244.4	608.6	609.0	609.9	610.5	610.5
Whittingham - Maitland	290.5	290.5	290.5	290.5	291.1	291.1	291.1	291.1	292.1	291.0	290.3	289.6	289.6	290.0	290.3	290.3
Maitland - Bloomfield	408.0	408.0	408.0	408.0	406.9	406.9	406.9	406.9	408.5	407.6	406.0	660.8	659.8	662.8	662.4	662.4
Bloomfield - Hexham	280.1	280.1	280.1	280.1	279.3	279.3	279.3	279.3	280.5	279.8	278.7	660.9	659.9	663.4	663.0	663.0

Table 8-15 - Saleable capacity in tonnes assuming volumes and the recommended scope of work as per the prospective volume scenario with ATMS. This tonnage capacity is equal to table 8-14 times average train size times 365.

Refer to ARTC's website for more information on ARTC.

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