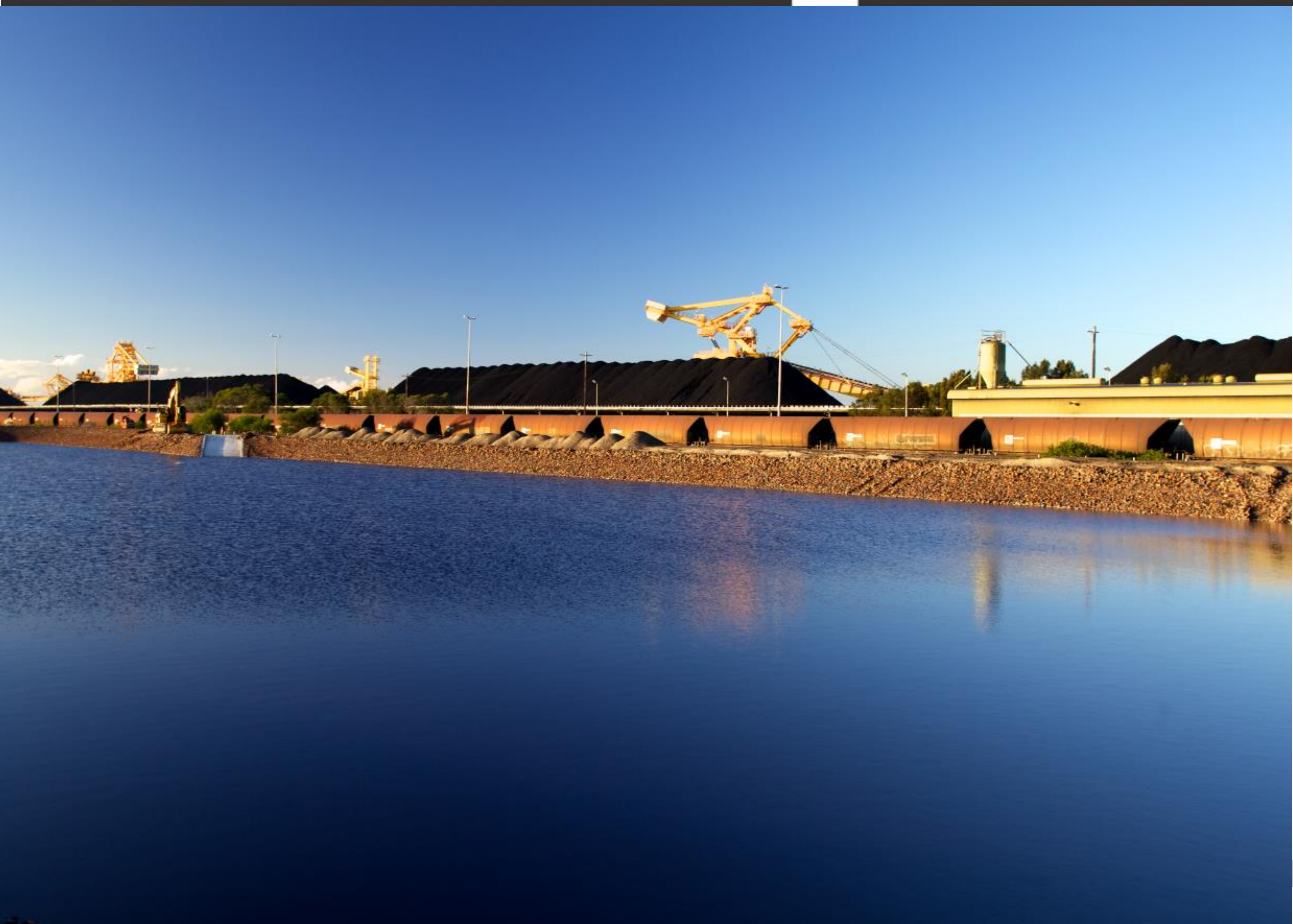
2023 HUNTER VALLEY CORRIDOR CAPACITY STRATEGY

September 2023

ARTC



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SEPTEMBER 2023

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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), or the 'Strategy', 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 fifteenth of these annual strategies.

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 towards Gunnedah and west towards Ulan.

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 demand forecasts.

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 volumes that have not yet been the subject of a contractual commitment, though these are hypothetical scenarios only and do not imply that such volumes will be contracted.

The underlying capacity of the system that has been built up over time has more than accommodated the contracted volumes across the network. However, changes to the configuration and performance of the train fleet that utilise the network, and operational and weather-related impacts on mining, train-running and track and related assets, have impacted the consumption of capacity across the network on a year-on-year basis and this continues to be reported in this edition of the strategy.

Customers have expressed interest in ARTC focusing on the increased efficiency and utilisation of the network rather than investment in additional capital infrastructure. Consistent with this, underlying network capacity increased from Q1 2022 with the adoption of the higher utilisation threshold of 73.5%, which deferred the need for some new capital works.

Like previous strategies, this strategy contemplates 'most likely' and 'prospective' scenarios in addition to the 'contracted' volume scenario. The most likely and prospective scenarios have been directly provided by producers and endorsed by the Rail Capacity Group (RCG).

The nominated most likely and prospective volumes inclusive of domestic demand peak at 194 and 216 million tonnes per annum (mtpa), respectively. The Most Likely volume is marginally higher than in the 2022 Strategy while the Prospective volumes are lower.

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 rather than section names, 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 is interdependent to the trains required, while the train numbers are interdependent to 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 and its consumption 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 balloon 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 includes continuously developing a Hunter Valley Master Plan that deals with the optimisation of capacity enhancements across all elements of the coal chain with a view to providing an integrated planning road map.

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 in the demand context of track contracted volumes. For 2023, the HVCCC has determined that track system capacity does not represent a constraint on system throughput. That is, HVCCC has forecast that track system capacity will not constrain currently contracted volumes.

Delivering capacity efficiently

ARTC's forward investment program has in recent years shifted to focus on 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

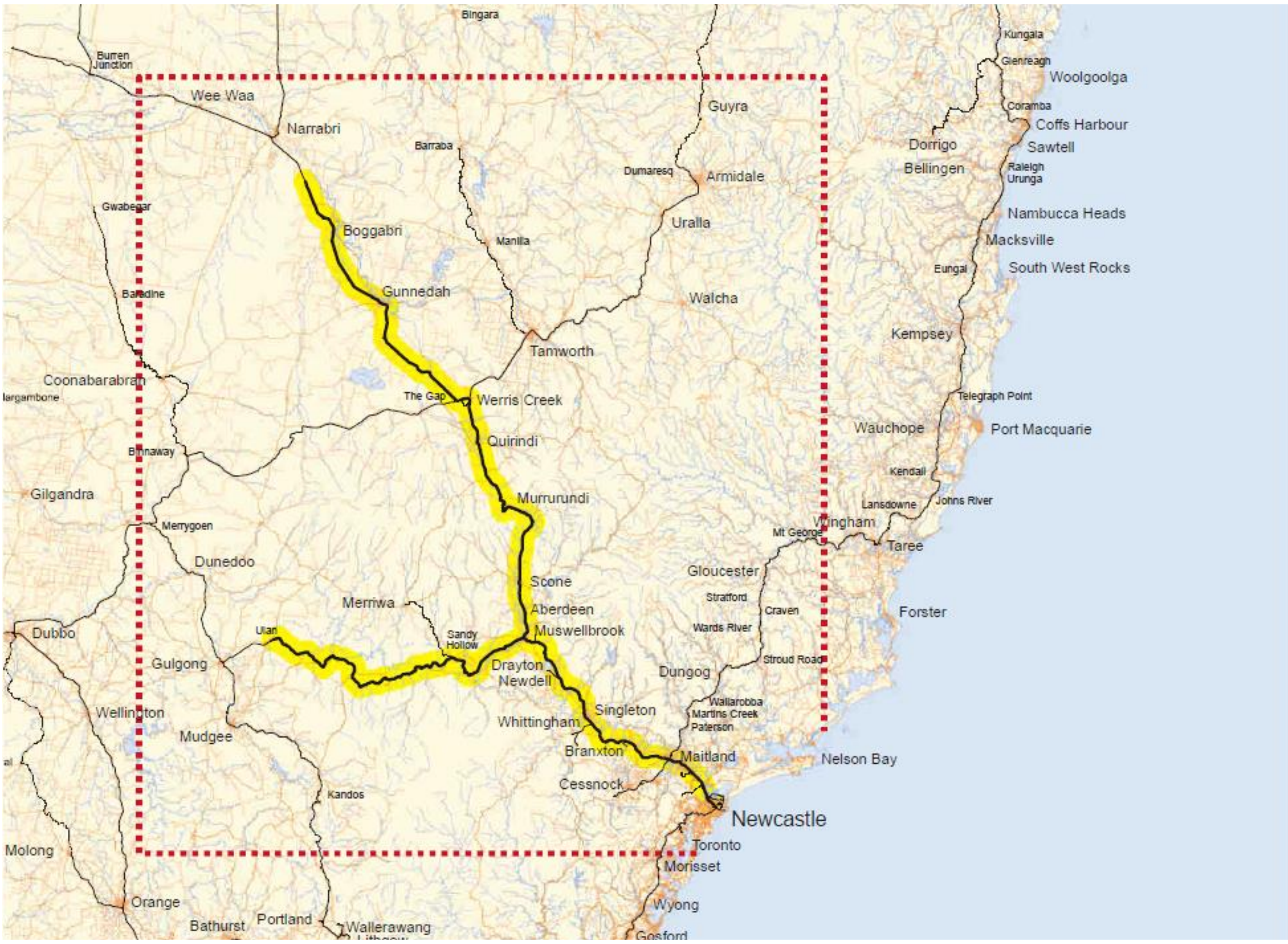

Figure 1-1 - The general location of the Hunter Valley network on the east coast of Australia.

variation and streamline network wide train management.

ANCO was implemented between Hexham and Newcastle port in late 2020, marking the completion of ANCO implementation across the Hunter Valley network that commenced on the Gunnedah and Ulan lines in 2017. ARTC has now shifted its focus towards ensuring the benefits of ANCO are sustained over the longer term, and equipping ANCO with additional functionalities and capabilities to achieve greater efficiencies by leveraging data from the initial ANCO implementation and using advanced data analytics to drive continuous improvement in network operations.

This could in the future be supplemented by the implementation of the Advanced Train Management System (ATMS) which provides communications-based safeworking, and is currently being prepared for implementation across other parts of the ARTC network.

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 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 are 196.5 mtpa in Q1 2023. These volumes gradually decline, falling to 117 mtpa in 2031, as some Access Holders choose not to roll over some volume.

Contracted volumes also include up to 8.8 mtpa of domestic coal. This volume is included in all modelling of capacity and utilisation. This volume declines to 5 mtpa from 2026.

The Strategies have always set out a 'prospective' volume scenario to provide an understanding of the consequences of a high-end volume outcome. The 2017 and subsequent strategies including this 2023 strategy include 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.

This Strategy continues to calculate capacity directly from the contracted number of paths, using the method first used in the 2019 Strategy, rather than the method used in prior Strategies of calculating paths from

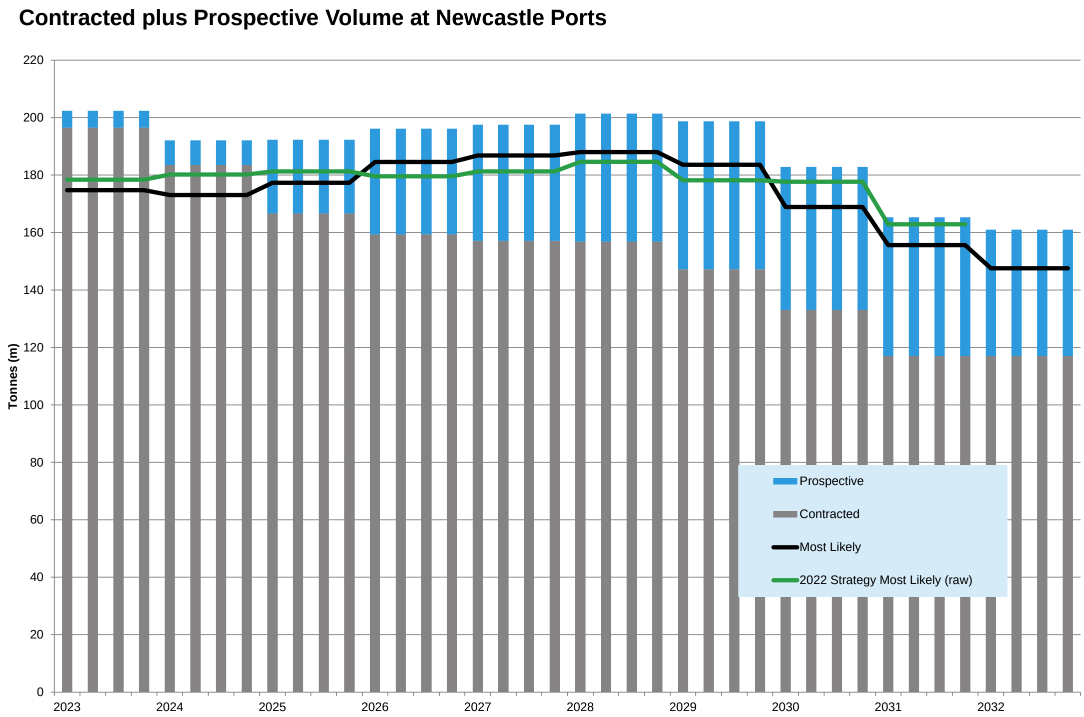

Figure 1-2 - Current Volume Forecasts vs. 2022 Strategy Volume Forecast, Newcastle Terminals (mtpa)

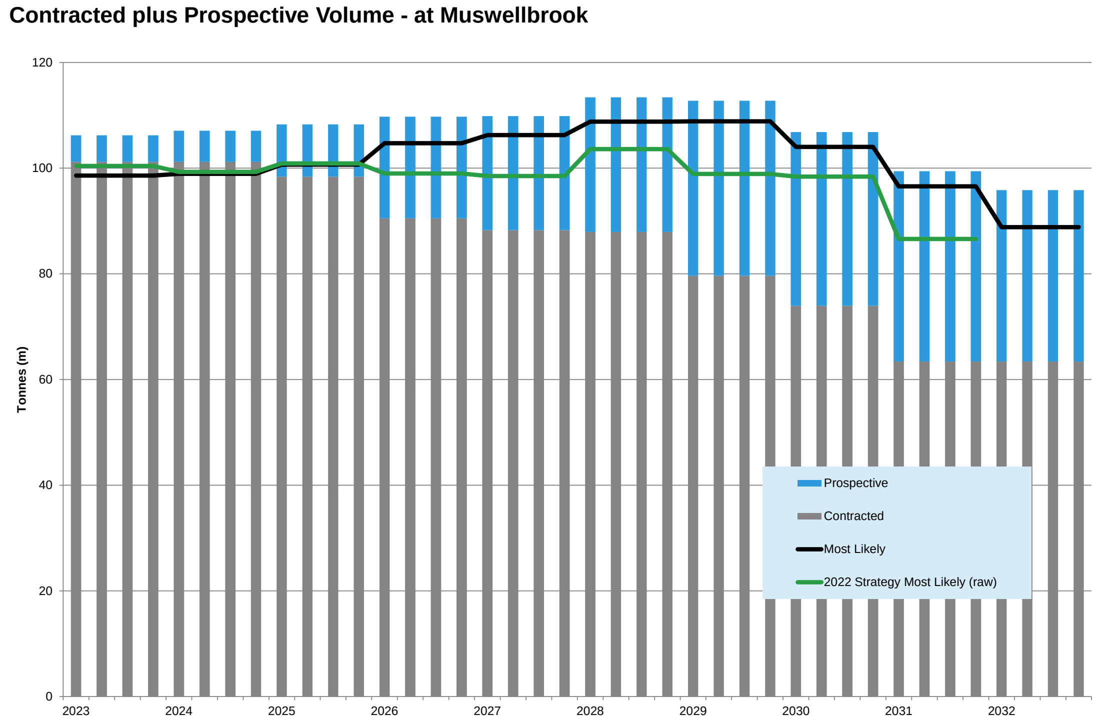

Figure 1-3 - Current Volume Forecasts vs. 2022 Strategy Volume Forecast, Muswellbrook (mtpa)

contracted volumes and assumed train configuration. The change in methodology resulted 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 potential projects required in that growth environment.

The most likely and prospective scenarios include some forecasts that sit below currently contracted volumes. This Strategy is based on these raw volumes rather than using the greater of contracted and producer nominated volumes.

The most likely scenario in this 2023 Strategy are similar to the 2022 Strategy for volumes from zones 1 and 2 but are higher in zone 3. The volumes under the prospective scenario are lower than the previous Strategy.

Figures 1-2 to 1-5 show the three volume scenarios. The most likely scenario is shown for both this Strategy

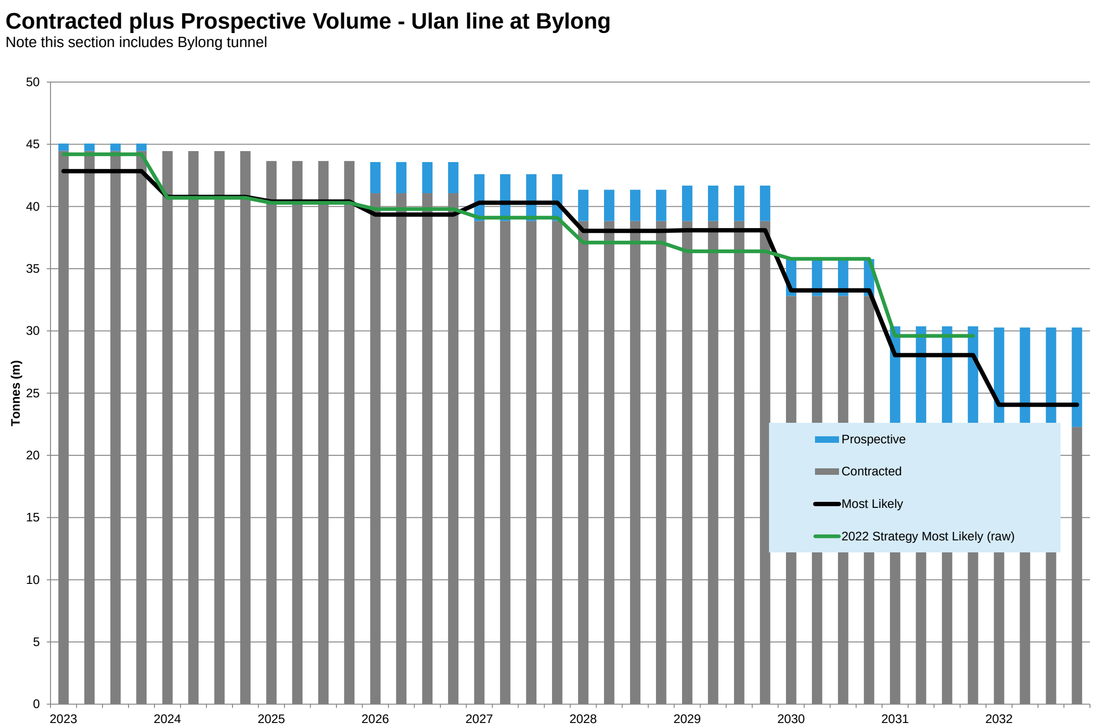

Figure 1-4 - Current Volume Forecasts vs. 2022 Strategy Volume Forecast, Bylong—Mangoola (mtpa)

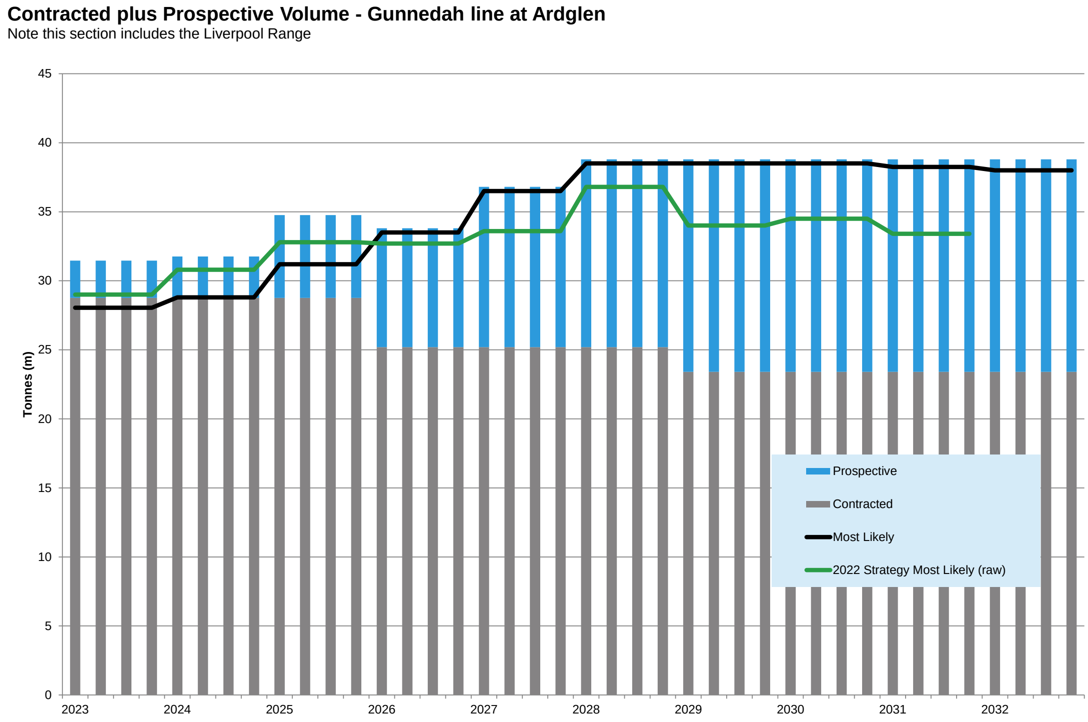

Figure 1-5 - Current Volume Forecast vs. 2020 Strategy Volume Forecast, Werris Creek—Muswellbrook (mtpa).

(black line) and the 2022 Strategy (green line) to allow for a comparison.

Volume is shown at the Newcastle terminals, at Muswellbrook, at Bylong for the Bylong – Mangoola section (which is the majority of the Ulan line), and at Ardglen for the Werris Creek – Muswellbrook (which is representative of most of the Gunnedah basin line). Figure 1-6 shows the proportion of total trains by zone while figure 1-7 shows net growth under the prospective scenario geographically.

There is still a small but notable volume of traffic from the Western coal fields exported through Newcastle rather than the traditional Port Kembla export pathway and there is a small volume originating from mines near Lake Macquarie. This volume is generally using paths contracted from the coal fields south of Newcastle and

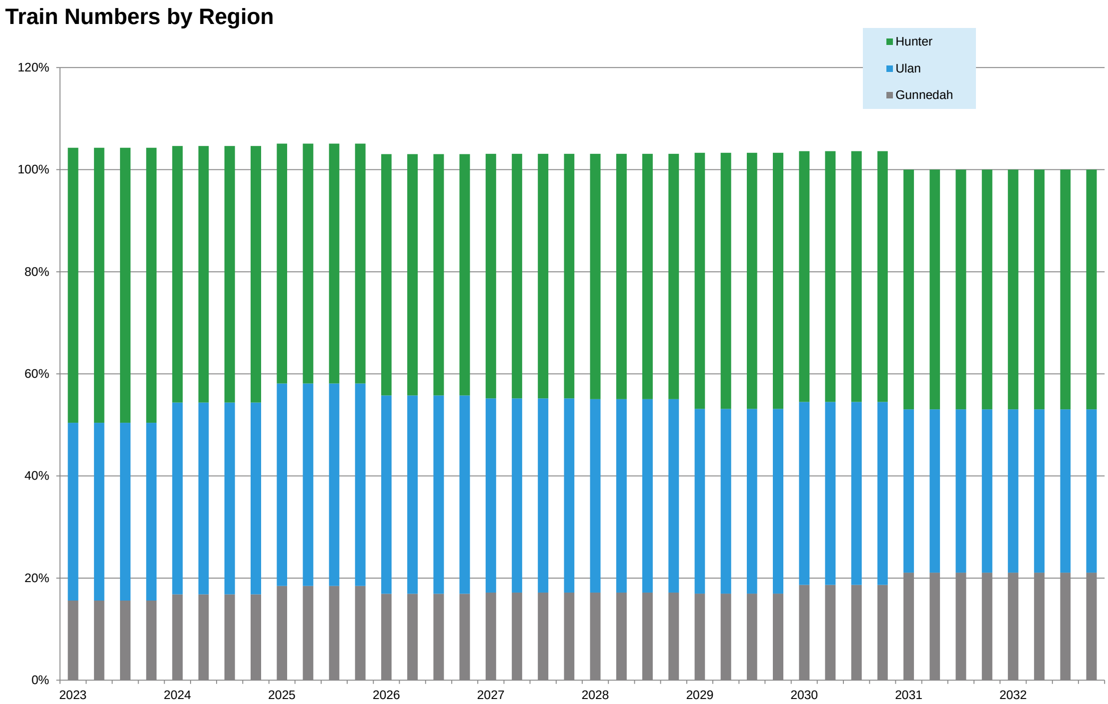

Figure 1-6 - Percentage of Trains by Sub-Network by Year, prospective scenario. Note that total train numbers are calculated as trains from each of the three zones as a proportion of all trains arriving at the port. The total number of trains exceeds 100% due to domestic coal.

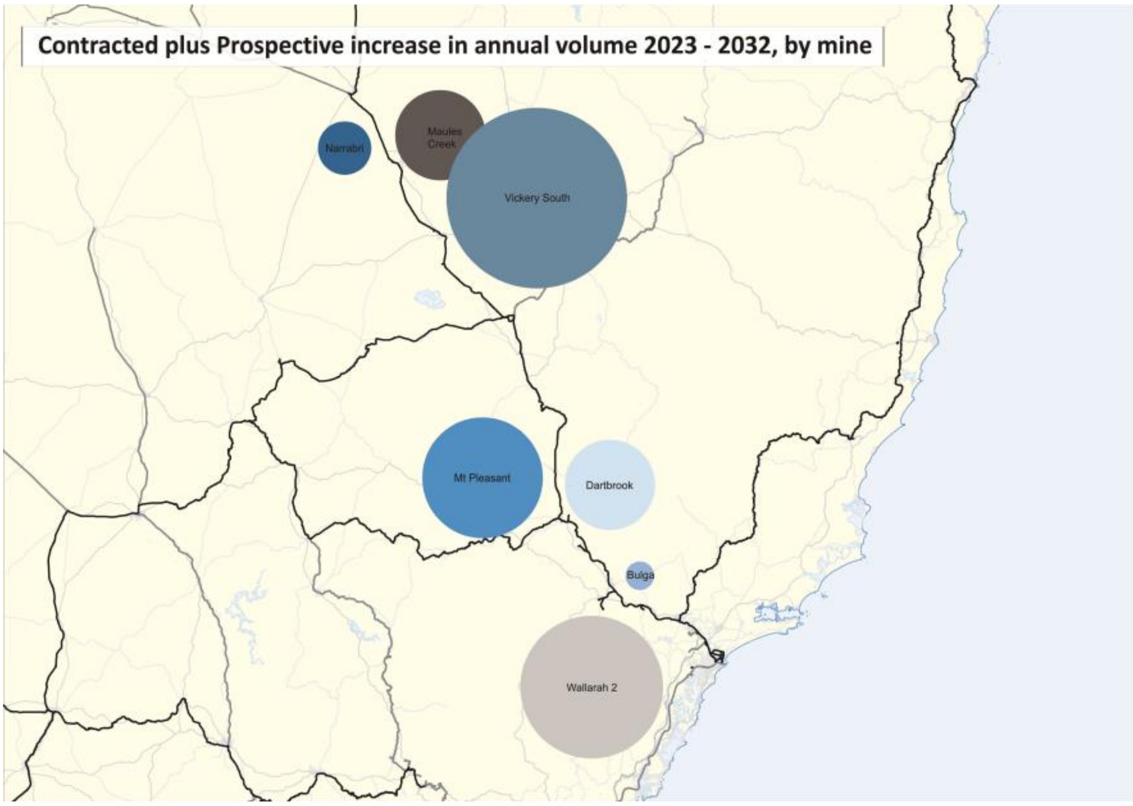

Figure 1-7 - Volume growth forecasts by mine, prospective scenario. Note that growth is represented by diameter.

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 core and well documented methodology of recent editions of the Strategy. For further information, refer to this section of previous editions.

This Strategy factors in the agreed terms of the latest HVAU that commenced in Q1 2022 where at its core ARTC is increasing throughput opportunities by further leveraging the existing network infrastructure instead of delivering significant capital works. The utilisation capacity of the Gunnedah and Ulan lines has increased by 3.5% points to an agreed 73.5% for the term of the HVAU (until the end of 2026).

This increase has been the most recent change in underlying capacity, which has continued to adequately accommodate the coal volumes that are contracted to be moved across the network. This Strategy continues to calculate the impact on the consumption of that capacity from changes in the performance of the train fleet that utilise the network and the impact of changes in live-run losses, which vary year-on-year.

This Strategy uses the live run loss rate methodology that was first used in the 2020 Strategy, but continues to use a three year rolling average to smooth out year-on-year variations as first used in the 2021 Strategy.

The 2020 Strategy adopted cancellation losses that aligned to the true-up test estimates (instead of the methodology in previous strategies that used the Declared Inbound Throughput (DIT) estimates from the HVCCC) and were based on the rate of actual volume losses incurred by zone rather than a uniform train cancellation rate applied across the Hunter Valley Network.

The live run losses are calculated as the difference between planned and actual tonnes divided by planned tonnes. This percentage is then converted into an escalation to reflect the required uplift in capacity. This approach is considered more reflective of actual live run variance than the cancellations rate, and picks up short loading. The adopted rates are shown in Table 1-1.

This methodology provides greater transparency and consistency, and allows for differential rates across the three zones, giving greater accuracy in the calculation of capacity on different sections of the network. However, there is some degree of variation on an annual basis and by adopting a three-year rolling average in this strategy, the impact of the variation will lessen over time.

The maintenance loss rate has been left unchanged at 12.3%. Appropriate levels of maintenance allowance are proposed to be intensively analysed in future strategies. Previous strategies flagged the potential use of zonal maintenance loss rates in future strategies. This may be a consideration in that work.

Consistent with the HVAU, a 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.

Adjustment factor	2022 Strategy	2023 Strategy
Live run losses	Zone 1: 7.3% Zone 2: 8.9% Zone 3: 9.3%	Zone 1: 8.3% Zone 2: 8.7% Zone 3: 9.3%
Maintenance	All zones: 12.3%	All zones: 12.3%
TMTC	All zones: 10%	All zones: 10%
Adjustment Factor	**Zone 1: 75.4% Zone 2: 74.3% Zone 3: 74.1%**	**Zone 1: 74.8% Zone 2: 74.5% Zone 3: 74.1%**

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

This 2023 Strategy uses a 10% TMTC across all zones for all years, consistent with previous strategies except for 2019.

The build-up of the Adjustment Factor for this Strategy, and comparison with the assumptions in the 2022 Strategy, is shown in Table 1-1.

The zonal live run loss rates necessarily result in separate adjustment factors for each of the zones. This is an enhancement that was first used in the 2020 strategy, replacing the single adjustment factor across the network was that was used in earlier editions.

The loss rate for zone 2 was slightly lower than in the 2022 Strategy. In contrast, the loss rate for zones 1 and 3 are higher. In 2022, the increase in Zone 1 losses were largely attributed to load points (+1.0%) and Rail Haulage Provider (RHP) labour (+1%) offsetting some reduction in other areas. In Zone 3 the loss rate for 2022 was nearly 13%, driven by Load Points (1.4%), Loco failures (+1.3%), RHP labour (+1.0%) and ARTC Assets (+0.7%). This increase in Zone 3 appears to be an anomaly and is not reflective of the system when compared to the 8-9% in previous years including 2019—2021 and the first half of 2023 (Jan – Jun inclusive). Adopting the higher rate would disproportionately impact consumed capacity and not present an accurate picture of the network. Hence this edition of the Strategy will use the loss factor for Zone 3 from the 2021 Strategy of 9.27% as shown in Table 1-1.

The Strategy continues to use actual train performance derived from the digital train radio system as the basis for calculating section run times. This approach of using actual rather than simulated performance was applied to the Gunnedah basin in 2016, the Ulan line in 2017, and the Muswellbrook - Ports section in 2019. Ongoing refinement of the process of calculating train performance has resulted in a general improvement in estimated section times and hence capacity across both Gunnedah and Ulan lines.

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

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 2020 Strategy took 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, this reduces the allowance by 15 seconds. These values were adopted as supplements to the actual calculated transaction time in 2020 and 2021 and have been maintained for this Strategy.

Transaction times remain the same as those used in the 2022 Strategy.

The list of train consists used for the purposes of calculating train performance includes the following:

Ulan line:

- Pacific National—3 x 92/93/TT class (4400HP AC) locos with 96 wagons - 9,100 net tonnes, 1,541 metres nominal length.
- Pacific National—3 x 90 class (4000HP DC) locos with 92 wagons - 8,500 net tonnes, 1,529 metres.
- Aurizon—2 x 5000/5020 class (4400HP 30 TAL AC) locos with 88 wagons - 8,600 net tonnes, 1,492 metres.
- Aurizon—3 x 6000 class (4400HP AC) locos with 96 wagons—9,389 net tonnes, 1,543 metres
- One Rail—3 x XRN class (4400HP AC) locos with 96 wagons - 9,100 net tonnes, 1,541 metres.

Gunnedah line:

- Pacific National—3 x 92/93/TT class (4400HP AC) locos with 82 wagons - 7,954 net tonnes, 1,296 metres.
- Aurizon—3 x 6000 class (4400HP AC) locos with 82 wagons - 7,954 net tonnes, 1,296 metres.

To the extent that trains operate with a consist different to the contracted consists, actual performance, and hence available capacity, will be different. The length of wagons can vary resulting in slight variations in train lengths across both lines.

The changes in the consumption of capacity as a result of the enhancements outlined in this section, including using an updated three year rolling average of live run losses and updated train performance, are detailed in the relevant chapters. The impact of each change element has been quantified, which improves the transparency and traceability of changes to the methodology and allows for a comparison of performance in this Strategy with previous strategies.

Saleable & Surplus Capacity

At the time ARTC enters into contracts, capacity is 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.

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, noting that recognition of sustainable changes in performance assists to create appropriate incentives to maximise system performance.

Consistent with previous strategies, the saleable paths and saleable tonnage tables for the contracted, most likely and prospective scenarios remain in the Recommended Projects & Network Capacity chapter (Chapter 8).

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, each 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.

This Strategy applies a uniform 10% across all zones in the Hunter Valley, unchanged from the 2022 Strategy.

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 2023 Strategy includes graphs of forecast transit times for each of the contracted, most likely and prospective scenarios calculated on this basis. These graphs first appeared in the 2019 Strategy and 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 with ANCO and proposed with 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. In the case of ANCO, this is offset by expectations of improved decision making, which is expected to reduce dwell and thereby increase saleable capacity.

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. However, it should be acknowledged that at times train cycle time performance may not be the ultimate objective.

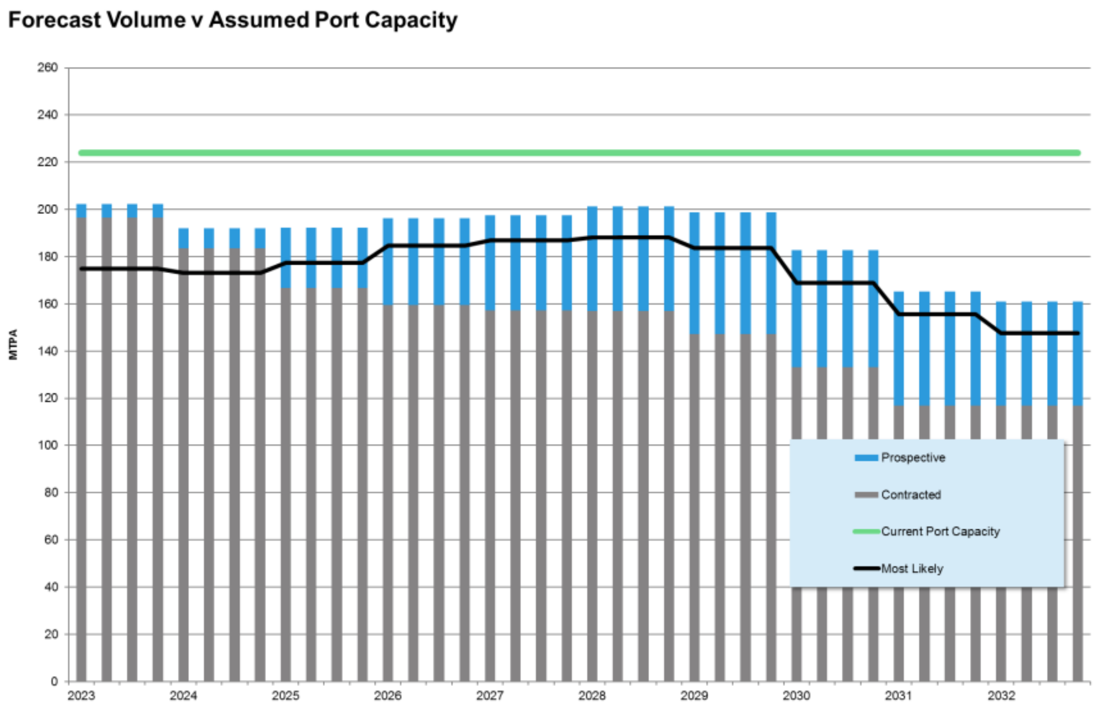

Figure 1-8 - Forecast volume at Newcastle Port compared to assumed port capacity (mtpa)

Terminal Capacity

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).

ARTC's understanding of terminal capacity is that nameplate capacity is currently 224 mtpa. It should be noted that the NCIG push-based assembly model has had a positive impact on the network and terminal operations by smoothing intra-day and intra-week train flows and enhancing network robustness, particularly for trains from the western coalfields. This incremental expansion is therefore consistent with and complementary to improving rail network performance.

There is no requirement for additional terminal capacity for ARTC contracted, most likely or prospective volumes.

The relationship between contracted, most likely and prospective volumes, and potential terminal capacity as assumed for this Strategy, is shown in Figure 1-8.

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 coal export terminals, run by PWCS and NCIG, 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.

Coordinated coal chain planning and live-run disruption management is facilitated by the HVCCC. The daily coal 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, coal terminals 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 2022 contracted volumes and train sizes, an average of around 64 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; East Coast Rail (a newly spun-off entity following the acquisition of One Rail Australia by Aurizon in late 2022) 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 area. 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 Trains network).

Although there are no identified capacity issues, the timetabling requirements of trains accessing the Sydney Trains 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.

Train size

ARTC contracts on the basis of a contractual entitlement to paths known as Base Path Usage (BPU). Tranches of paths are associated with a nominated train configuration, giving an implied contractual volume.

Average train size as contracted with ARTC in 2022 was 8,433 tonnes, marginally higher than in 2021 but significantly higher than compared with under 7,500 tonnes a decade earlier.

Weighted average delivered coal volume per train has generally been rising from approximately 8,091 net tonnes in 2016 to 8,837 in 2022.

The decline in average actual train size from 2016 to 2017 reflected the continued increase in the proportion of coal coming from the Gunnedah basin, 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. The subsequent changes in train size reflect natural variation rather than any major underlying trend.

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 trend of increasing average train size, though probably not to the same extent as the growth achieved in earlier years. The recent move by Aurizon to use the three locomotives with 96 wagons consist has supported this trend.

Train Length

Train length in the Hunter Valley and along the Ulan line is limited to 1,543 metres. This length recognises the constraints at the terminals, the Hexham Holding Roads, Ulan line loop lengths, balloon loop constraints, and standing distances between signals and level crossings.

The length limit in the Gunnedah basin is 1,329 metres, with trains from the Stratford mine along the North Coast line operating to a similar length. Trains 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 trains on the network that are longer than the corridor maximum length without thorough assessment and change management being enacted which may include infrastructure and supporting systems alterations. A longer individual train would deliver an increase in volume per path, but without other supporting infrastructure investment, the de facto priority it gives these trains, the complexity that arises around fairness and competition, the constraints on where they can cross other trains longer than the corridor maximum, 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.

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 rollingstock with 30 tonne axle loadings (TAL) (i.e. 120 gross tonne wagons), but the North Coast line

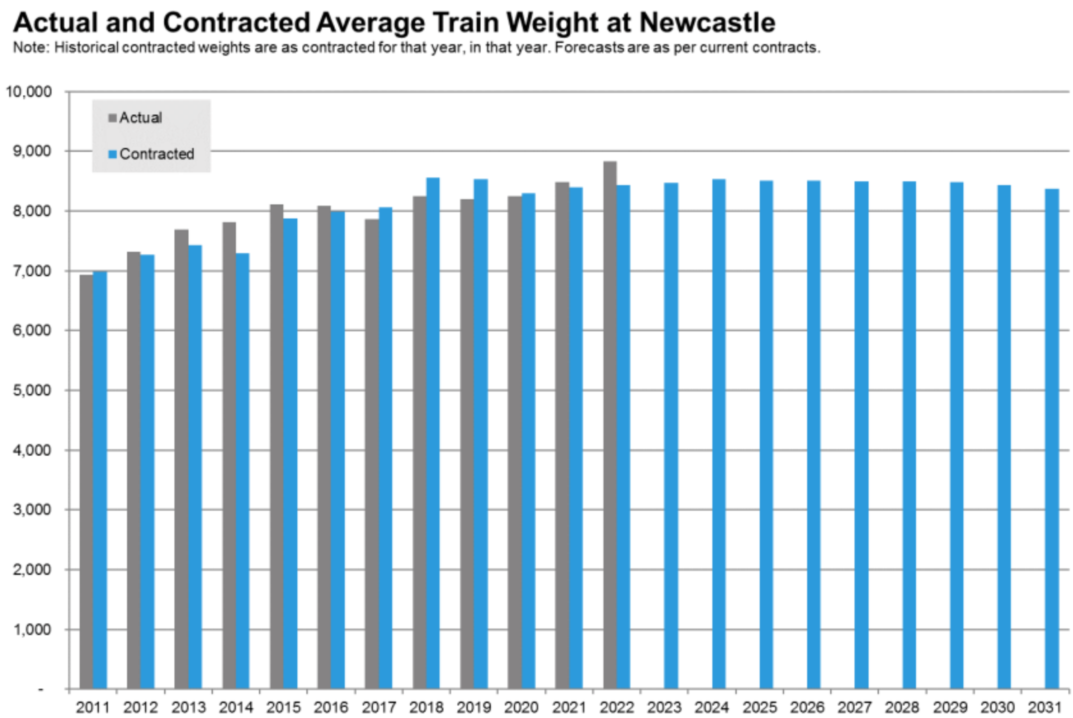

Figure 2-1 - Average Train Capacity under Contracted Volumes (tonnes) to Stratford and the lines south to Vales Point on the Central Coast are only rated for 25 tonne axle loads (100 gross tonne wagons).

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 coal is distributed unevenly within wagons.

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 structure clearances.

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 work to analyse a higher axle load.

Train speed

Trains made up of '120 tonne' (30 TAL) wagons are generally restricted to 60 km/h loaded and 100 km/h empty. 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, such as 30TAL 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. This, however, has declined as an issue as heavier locomotives have not generally been operating on the Gunnedah line since mid 2019.

Trains have been operating at 100km/h empty running in the Down direction in the Gunnedah basin for the past several years providing opportunity to further improve cycle times.

Clearances

The Hunter Valley generally conforms to rollingstock outline plate B, which allows up to 3050mm width and 4030mm height, and 4220mm north of Werris Creek.

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.

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, for interstate container traffic.

This traffic only traverses the short section between Broadmeadow and Maitland, and is precluded from double-stack operations by the overhead wiring south of Broadmeadow. Accordingly, ARTC exempts the Hunter Valley (to Narrabri and Narromine), and the North Coast line, from its double-stack clearance requirement.

Operational Improvement Initiatives

Previous versions of the Strategy outlined a number of operational initiatives that aimed to improve the performance of the Hunter Valley Network aligned with capacity assumptions. Several of the initiatives have since been delivered while others are still being planned.

The initiatives delivered included:

- Continued to increase synergies between the track maintenance and network control functions with the outcome being increased effectiveness in maintenance activities combined with improved train flow on the network. The integration work over the past several years focused on the pre-day whole of network planning processes and coordination across multiple teams in live operations to coordinate safe and efficient track access while improving overall train flow on the day for our customers, particularly during moments of disruption management.
- Continued the effective integration of the coal / non-coal train programming and scheduling with increased non-coal demand. Weekly and daily processes were developed to manage the

different supply chain characteristics of different commodities.

- ARTC created a new dedicated team focused on Live-Run management and communication with clear procedures, roles and accountabilities. Key outcomes have included: positive stakeholder feedback; a decrease in losses attributable to ARTC live run management practices; and an increase in on-time availability of possession windows for productive maintenance. This followed feedback sessions with stakeholders post the delivery of ANCO where ARTC was tasked with reviewing its roles and responsibilities within Live-Run to improve the consistency in comms.

ANCO & ATMS

While there is much benefit in pursuing operational initiatives, the biggest opportunities to increase throughput in the absence of capacity-enhancing capital projects is in the day to day train control decision-making processes.

Historically, the biggest challenge for train control was 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 arose 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.

ANCO

The ANCO (ARTC Network Control Optimisation) project is ARTC's initiative that introduced new processes and technology to improve train control in the Hunter Valley. Horizon 1 has provided digital train planning in Network Control Centre North (NCCN) for train movements from Newcastle port to Narrabri Coal Junction and Ulan.

At the core of the ANCO system is 'Movement Planner', an off-the-shelf product by GE/Wabtec that enables digital train planning. This was implemented across all train control boards in the Hunter Valley between November 2017 and November 2020.

Digital train planning, coupled with near real-time data integration with supply chain partners, enables a rapid response to network variation, with train plans dynamically adjusted to minimise potential flow-on impacts and deliver maximum performance for the supply chain as a whole.

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, on single track it accommodates 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 enables these factors to be considered and optimised dynamically, effectively eliminating the need for additional contingency in the train plan.

This manifests itself in an improvement in crossing decision making. Train dwell has fallen by a minimum of 5% on the single-track sections since the introduction of ANCO. Analysis to date of normalised levels of dwell in a pre and post ANCO environment compared to theoretical efficient dwell have validated the expected level of benefit and the application of higher utilisation of available track capacity. Accordingly, the utilisation rate adopted in the 2020 Strategy was lifted from 65% to 70% in anticipation of the ANCO implementation being completed by the end of that year.

The utilisation rate in this Strategy remains at 73.5% between 2022 and 2026, which was increased in the 2021 Strategy, as part of the agreed terms of the new HVAU that aim to deliver more capacity from the existing infrastructure.

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

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

ATMS

ATMS, or Advanced Train Management System, 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.

It is the primary safeworking system on the Port Augusta to Whyalla section of the ARTC network.

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.

ATMS implementation

The implementation schedule of ATMS across the ARTC network is now the subject of detailed analysis and engagement with rail operators. The three key limits to the speed of implementation have been identified as:

- Availability of suitable resources to undertake the trackside works.
- Manufacturing and fitment of trainborne units.
- Training of drivers and train controllers, and associated organisational change.

As such, there are extensive trade-offs to be resolved in determining a network-wide deployment plan.

The next ATMS project is to deploy the system between Tarcoola and Kalgoorlie. This has completed Concept and Feasibility phases, and has now been granted funding to commence the Assessment phase. Commissioning of ATMS on this section is expected to commence from later this year.

Since the 2020 Strategy, the Australian Government has committed a further $220 million towards advancing the implementation of ATMS across the interstate network. The commitment prioritises ATMS implementation on the remaining sections of the East-West corridor and Inland Rail. Critical planning and development work will be undertaken to enable implementation across those sections in the next few years.

The funding also provides for the purchase of the first significant quantity of trainborne units which will be fitted into the locomotive fleets that operate on those corridors. As a result of this, and in the absence of industry support to date to commence planning for implementation of ATMS in the Hunter Valley, the forecast timeframes for the implementation across the Hunter Valley have been pushed back by a year on the Ulan and Gunnedah lines, to 2027 and 2028, respectively.

However, this remains subject to refinement and there may be potential to bring the timing forward if operators can support a faster implementation, or giving these lines a higher priority within the broader implementation, delivers an overall benefit.

As noted, trainborne unit manufacture and fitment will be a key limit to the speed of implementation and it is likely that the fleet of locomotives that travel on the Ulan and Gunnedah lines will need to be equipped progressively with the ATMS in-cab equipment. This will mean that there will be a transitionary period where some locomotives will need to be captive to Ulan and Gunnedah traffic. The practical limit of this will also be a key issue in determining the implementation timing.

The improved granularity of location position available with ATMS would also feed into greater responsiveness and precision for Movement Planner, which is currently constrained by the limitations of track circuiting.

Initial consideration is now being given to the need to replace life-expired CTC equipment at Newdell and Drayton Junctions to ensure ongoing reliability of the signalling system. While some elements of the renewal may be re-usable for ATMS installation, there is likely to be efficiencies in incorporating the renewal into the ATMS implementation. Given this, extension of ATMS from the single line sections to Singleton is being considered in the current implementation planning, with a target of mid-2029.

Completion of ATMS implementation from Singleton to the ports has a higher relative cost and hence lower commercial benefit and is likely to be toward the back-end of the program, with a target of 2031.

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.

Following on from the lift in utilisation to 70% with ANCO, the Strategy assumes a further five percentage point increase from ATMS, allowing 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 in live run, reducing pressure for trains to stand in the single line sections of the network, however, where more trains are cycling than what is required for efficient delivery of the weekly task, dwell will shift to Hexham Relief Roads, Terminal Departure Roads and Trains Provisioning Centres. This may be further improved by some features of the HVCCC’s optimisation model (known as RACE) which is used as a decision support tool in developing most efficient daily plans.

ARTC has worked with service providers in the industry to develop and implement processes for train park-up to avoid planning inefficient cycling of trains that are not required to meet demand. As per the assumptions listed above, cycle times improved by 8-10% for zones 2 and 3 during the first quarter of 2023 compared to the first quarter of 2022.

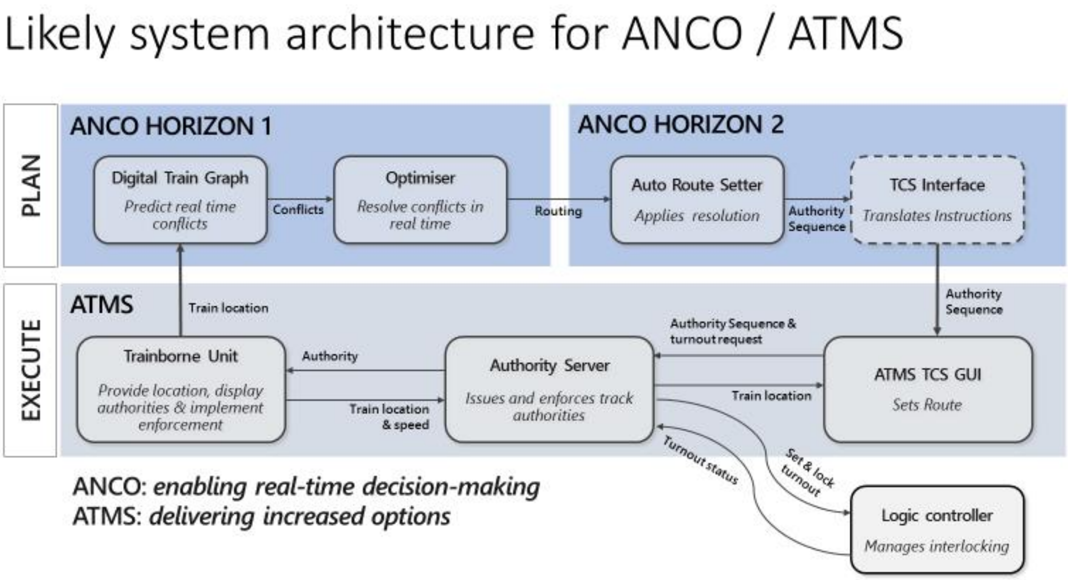

Figure 2-2 - The Long Term Roadmap of ANCO

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 per day between Narrabri and Scone, and 10 trains each way per day south of Scone. Grain movements have been significant in recent years reflecting the favourable growing conditions in northern NSW.

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. Only Aurizon and Pacific National operate coal trains from the mines along this line.

Vickery South, being developed by Whitehaven, is the only major new Gunnedah basin mine included in the most likely and prospective scenarios.

In April 2023, Whitehaven announced that it would commence early mining of the Vickery coal deposit. Initially, up to 1.3 million tonnes a year will be hauled by road to the existing Gunnedah Coal Handling and Preparation Plant and railed to port from that location. This is not expected to consume any additional rail capacity on the network.

Subsequent volumes from Vickery South are assumed to load from a new balloon loop connecting at approximately 498.8 km, between Emerald Hill and Boggabri. Full-scale operations, which will require the new rail loop, are pending approval from Whitehaven later this year.

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

Train Performance

ARTC has been using actual rather than theoretical performance as a basis for capacity modelling between Muswellbrook and Narrabri since the 2016 Strategy and

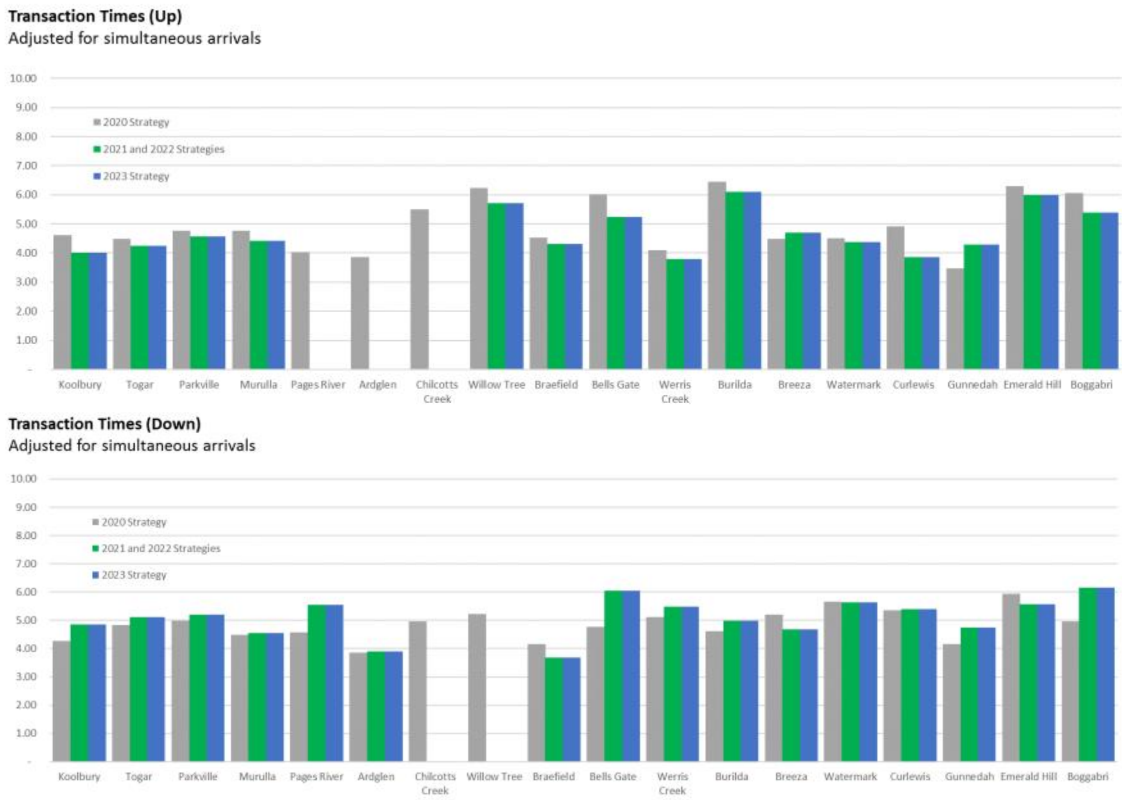

Figure 3-1 - Transaction times

further refined the process by calculating and applying actual transactions times in 2017.

Aurizon and Pacific National operate the following train consists on the Gunnedah line:

- Pacific National—3 x 92/93/TT class (AC 4400HP) locos with 82 wagons - 7,954 net tonnes, 1,296 metres in length.

- Aurizon—3 x 6000 class (AC 4400HP) locos with 82 wagons - 7,954 net tonnes, 1,296 metres.

Since late 2019, empty coal trains have been permitted to operate at up to 100km/h on some sections. Aurizon progressively enabled this change by adopting consists that could travel at 100km/h in the down (empty) direction in late 2019, matching the Pacific National fleet that was already operating at this speed.

In 2020 an engineering investigation was conducted to determine the engineering impacts on rail level crossings and rail assets of running empty coal trains on the Gunnedah line at 100km/h and to determine further opportunities to sanction this speed on further sections of track.

The investigation showed that the proposed speed increase for the cumulative train fleet had the potential to affect the risk profile of the passively protected level crossings along the line. With this in mind, a compliance review of all 81 level crossings in Zone 3 was conducted to determine which level crossings would require upgrades to safely allow for an increase in train speed to 100km/h.

The review identified six (6) level crossings that required upgrades to remove the issues at each location that were generating the need for a reduced speed and, that further to this, a number of transom top bridges would also require upgrades to enable the speed increase. Following consultation, a capital program to upgrade the necessary level crossings and bridges was endorsed by Zone 3 customers. Three of the six crossings received upgrades, two sites were closed while proposed work on the last site are pending approval.

Transaction times used in this strategy have remained unchanged from the 2022 Strategy as the fleet has remained largely the same. These are shown in Figure 3-1 (including adjustment for the effect of simultaneous arrivals).

Table 3-1 shows the incremental change in consumed capacity across seven key sections of the Gunnedah line from the changes mentioned in Chapter 1 and above. The changes are for Q1 2026, as per the 2022 Strategy, and assume no capacity enhancement projects are delivered so that the result reflects the raw change in capacity consumption. The table does not include the changes with and without ATMS because its implementation is now assumed to be implemented along the Gunnedah line in Q1 2028, which is after the applicable period of the current HVAU.

Consumption of Sectional Capacity Q1 2026 (mtpa) - without projects							
2023 Strategy	Gunnedah to Curlewis	Burilda to Werris Creek	Bells Gate to Braefield	Ardglen to Pages River	Pages River to Murulla	Murulla to Parkville	Parkville to Togar
Capacity as per 2022 Strategy (with 73.5% utilisation)	*31.40*	*37.95*	*40.75*	*45.61*	*42.67*	*35.78*	*36.54*
Capacity as per 2022 Strategy (w/o ATMS + w/o 73.5%)	29.25	35.49	38.15	42.79	39.98	33.42	34.03
Add 2023 contract paths	29.25	35.49	38.15	42.79	39.98	33.42	34.03
Live run losses (9.27% - unchanged)	29.25	35.49	38.15	42.79	39.98	33.42	34.03
Maintenance (12.3% - Unchanged)	29.25	35.49	38.15	42.79	39.98	33.42	34.03
Add updated transaction times (unchanged)	29.25	35.49	38.15	42.79	39.98	33.42	34.03
Add updated train performance	29.15	34.85	37.90	42.10	40.48	33.22	34.16
73.5% utilisation (Q1 2022 - Q4 2026)	31.29	37.28	40.48	44.89	43.19	35.56	36.68

Table 3-1 - Changes in consumption of capacity of key line sections of the Gunnedah line

As discussed earlier in chapter 1, Zone 3 cancellations spiked in 2022 to almost 13% compared to 8-9% in previous years including 2019—2021 and the first half of 2023 (Jan – Jun). Using the higher rate would not be reflective of the network and would disproportionately impact capacity. Therefore, this strategy will use the prior Strategy loss factor for Zone 3 of 9.27%.

With maintenance and transaction times also unchanged, the application of the updated train performance trains results in slightly more capacity being consumed on the capacity-limiting Gunnedah to Curlewis section and other sections, with the exception of Pages River to Murrulla and Parkville to Togar.

Following the application of the 73.5% utilisation rate, the overall amount of consumed capacity across the line increases by between 0.1 million and 0.7 million tonnes more than the 2022 Strategy on all sections except for Parkville to Togar and Pages River to Murrulla.

Performance Improvement Initiatives

ARTC identified a number of smaller scale initiatives aimed at incrementally increasing capacity between Narrabri and Muswellbrook at reduced cost compared to loop projects. Relevant initiatives identified as potentially viable options are as follows:

- Higher speeds for Up trains approaching grades at Werris Creek—Bells Gate, Bells Gate—Braefield and Pages River—Murulla:

Increasing the permitted speed of loaded coal trains to 80km/h on the approach to certain grades has been analysed on the basis that higher speeds would give trains additional momentum allowing them to ascend the grade faster, reducing section time. Loaded coal trains at 30 TAL are currently limited to 60km/h across the Hunter Valley Network except for the approaches to the Minimbah and Nundah banks, where 80 km/h is permitted to improve headways.

The 2020 Strategy included analysis that found allowing these trains to operate to 80km/h approaching selected grades would increase capacity in the order of 3.2 mtpa to 4.4 mtpa, depending on specific circumstances.

Despite the potential transit time reduction, producers are not currently supportive of this initiative in advance of a capacity trigger, noting the associated higher track maintenance costs and increased fuel consumption.

- Werris Creek configuration:

The current track configuration at Werris Creek results in trains passing through at low speeds, which affects capacity.

The 2020 Strategy identified several improvements to the track configuration to increase capacity, including increasing the permitted speed over turnout 105, immediately south of the station on the main line, from 25km/h to its capability of 35km/h. This was estimated to deliver a 0.7 to 1.6 mtpa increase in capacity on the sections to Bells Gate and Burilda, respectively. Another initiative involved realigning tracks at Werris Creek station to reduce curvature and remove the little used 104 crossover in Werris Creek yard. This was estimated to increase capacity by between 3.9 and 4.6 mtpa on those sections. These works could delay the need for both the 414km and 407km loops.

However, the reduction in projected coal volumes compared with previous strategies and the increase in the utilisation rate to 73.5% has extended the timeframe for when the additional capacity from these works is required.

- Increased speed through Scone:

Trains are limited to 50km/h passing through Scone to manage noise. An increase in permitted speed to 70km/h would increase capacity by around 2.5 mtpa, but this would require additional noise attenuation to be provided for nearby affected properties. Investigations on whether this is feasible are ongoing.

- Intermediate signals:

An intermediate signal permits a single train to follow another train already in the section, but its benefit is a function of how frequently trains present as a following rather than opposing movement. It also assumes that the following train is less than the section length behind the train in front. The probability of this scenario was analysed in detail for the purposes of establishing the theoretical benefit of ATMS. The benefit is a function of section utilisation, the number of trains operating in a following pattern, and the extent to which there was a conscious decision to take advantage of the following capability. The benefit is equivalent to increasing the section utilisation threshold from 70% to 74%.

The most likely sections where intermediate signals would be deployed, if approved, are Gunnedah to Curlewis and Emerald Hill to Gunnedah, with capacity estimated to increase by around 2.5mtpa.

This initiative would need to be weighed against others that would deliver increased capacity. This initiative will be redundant if and when there is a need to deliver South Gunnedah loop to meet demand, or if ATMS is implemented.

- Increasing permitted speed of Down trains through Gunnedah to above 40km/h:

There is the potential to lift train speed in the Down direction through Gunnedah from the current limit of 40 km/h that was set to meet noise requirements. 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.

The 2020 Strategy discussed that 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. Lifting the speed to 70km/h would increase capacity by 2.6 mtpa, or a further 0.9mtpa. An engineering assessment indicated that 70km/h would be the maximum permissible speed for down trains through Gunnedah.

Further work is required before a decision is made on this initiative and would need to be assessed following the decision to increase utilisation to 73.5%, and be assessed against other initiatives including intermediate signalling, delivery of South Gunnedah loop and ATMS.

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 1,330m – 1,450m with only a small number of short loops remaining. Of these short loops, Gunnedah, Quipolly, Quirindi, Kankool and Scone have specific challenges that make extension difficult. Only two loops (Aberdeen and Murrurundi) remain for potential extension. The location of these, and other existing and potential loops, is shown in Figure 3-2.

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, though this would be tested again before a final decision on a solution if and when required. 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 most-likely scenario.

Investment Pathway

Table 3-2 shows the projects required to address the capacity constraint on each local section to meet demand, for the most likely and prospective scenarios and with and without ATMS. No loop projects are required or proposed for contracted volumes.

As discussed in Chapter 2, the utilisation rate increases to 73.5% from Q1 2022 through to Q4 2026 and builds on the 70% threshold following the implementation of ANCO. It should be noted that some loops would not be required or at least delayed to the extent the Performance Improvement Initiatives outlined earlier in this chapter are implemented.

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

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.

It is also important to note that the current best assessment is that ATMS provides the single biggest capacity increment and is equivalent to many of the projects in Table 3-2. As such the ATMS pathway helps to deliver the required capacity at a lower cost than the no-ATMS pathway. Specifically, the Most Likely scenario with ATMS requires the delivery of one new loop compared with four more in the Without-ATMS scenario.

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 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.

ATMS has also been assessed as having the theoretical potential to lift utilisation by a further five percentage points, from 70% (73.5% between 2022 and 2026) to 75%. A 2.5% improvement in average train speed has also been assumed.

The strategy and achievable timeframe for implementation of ATMS is subject to ongoing review informed by progress in the finalisation of the system safety case and the priority implementation of the system across the East-West and Inland Rail corridors. The current judgement is that Q2 2027 is a plausible target for implementation of ATMS in the Hunter Valley and it has been assumed that full deployment across the Gunnedah basin line would be complete by Q1 2028.

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 remains preferable to continue with the design and approvals process for loop projects in parallel with the

Required by timing[1]	Most Likely with ANCO (no ATMS)	Most Likely with ANCO / ATMS	Prospective with ANCO (no ATMS)	Prospective with ANCO / ATMS
South Gunnedah loop	Q1 2026	-	Q1 2025	Q1 2025
Burilda north extension	-	-	-	-
414 km loop (Werris Creek North)	Q1 2027	-	Q1 2027	-
407 km loop (Werris Creek South)	-	-	-	-
Bells Gate south extension	Q1 2028	-	Q1 2028	-
Braefield north extension	-	-	-	-
Kankool—Ardglen	-	-	-	-
Pages River North extension	-	-	-	-
Blandford loop	-	-	-	-
Wingen loop	Q1 2027	-	Q1 2027	-
316 km loop (Parkville South)	-	-	-	-
Togar North Loop	Q1 2027	-	Q1 2027	-
Aberdeen	-	-	-	-

Table 3-2 - 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.

Figure 3-2 - Muswellbrook to Narrabri Loops

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, mitigates 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.

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.

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 10% TMTC, and is effectively the difference between the volume and capacity pathways shown in figures 3-3 and 3-4.

The most likely volume scenario identified by producers has volume growing faster than ATMS can be delivered. Accordingly the 'surplus capacity' chart shows a capacity shortfall until delivery is completed.

Transit Times

As discussed in Chapter 1, the capacity modelling tools were enhanced for the 2019 Strategy 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.

This is shown in Figure 3-8 for the three volume / infrastructure scenarios, in the with ATMS case. The predicted Muswellbrook - Narrabri mine transit time has been adopted as being illustrative of the likely performance for all load points. The no-ATMS scenario is shown in Figure 3-9. Overall transit time is forecast to remain relatively constant in the most likely and prospective scenarios because the forecast train numbers are expected to remain relatively high,

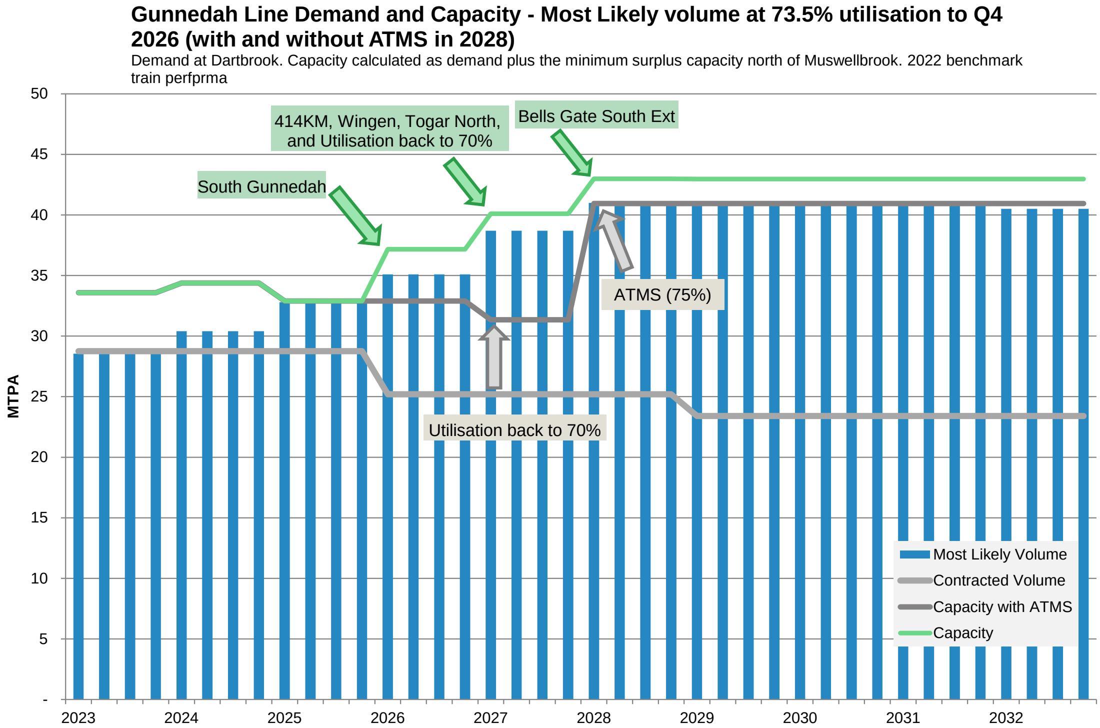

Figure 3-3 - Conceptual pathway for investment to meet the most likely volume scenario.

Note 1—No investment required for Contracted volumes.

requiring additional infrastructure, and increasing the probability of extended dwell.

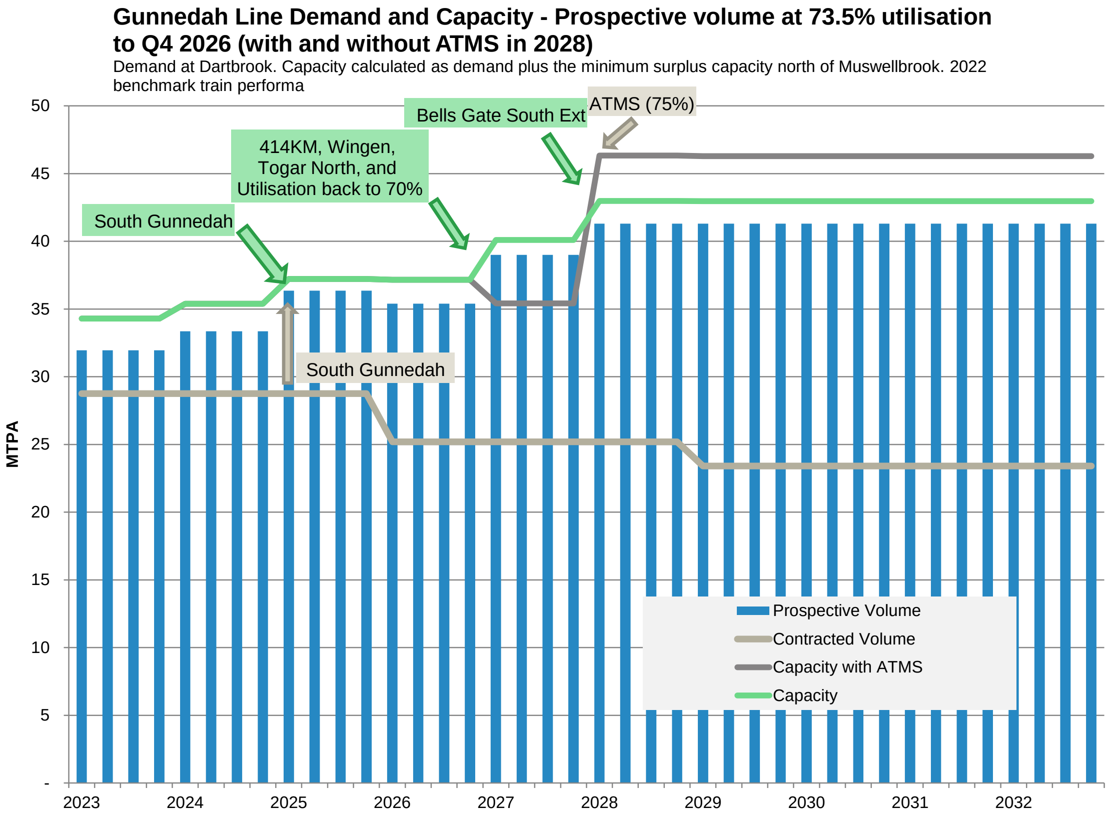

Figure 3-4 - Conceptual pathway for investment to meet the prospective volume scenario.

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

Note 2—No investment required for Contracted volumes.

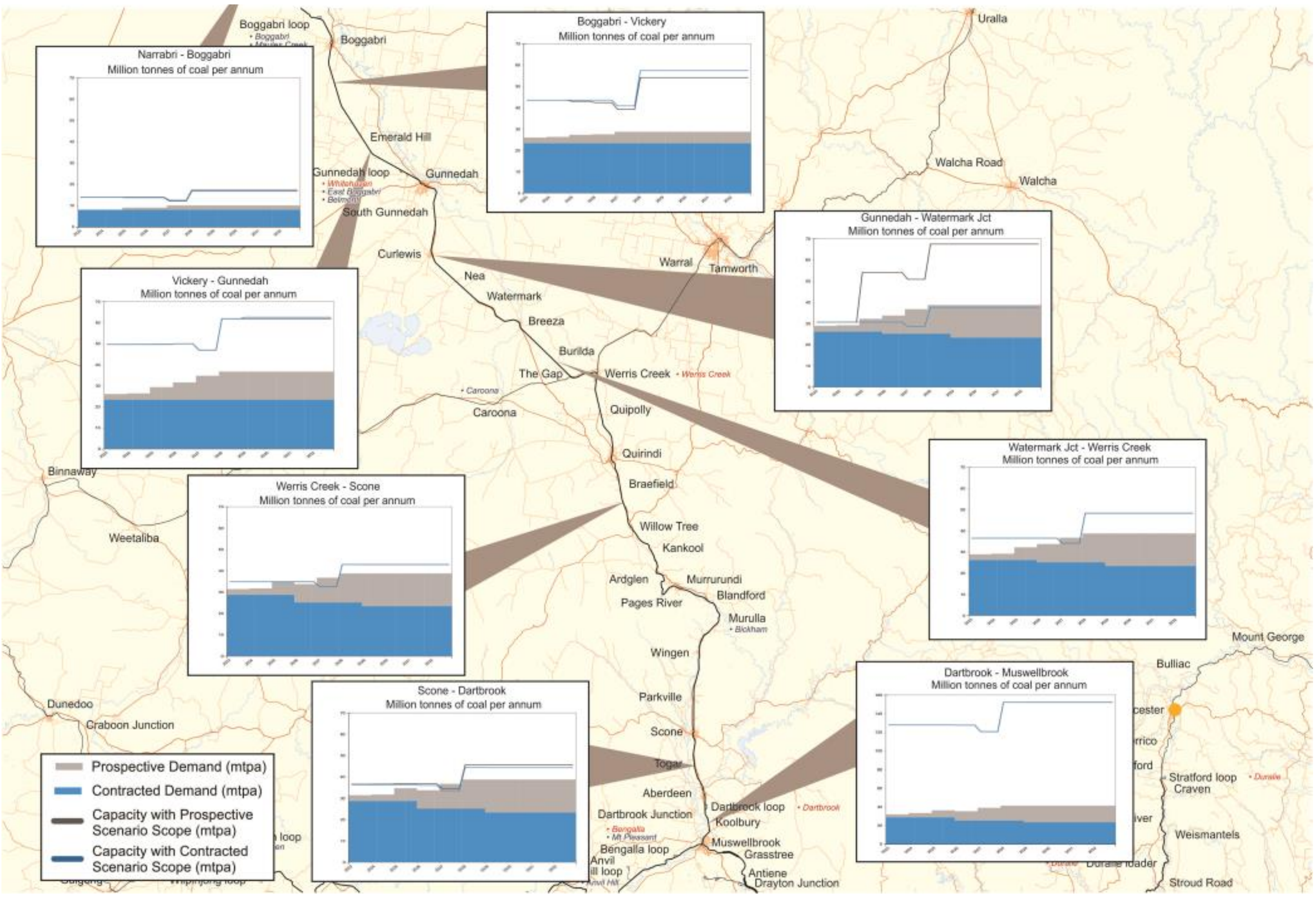

Figure 3-5- Volume and capacity on the Gunnedah basin line.

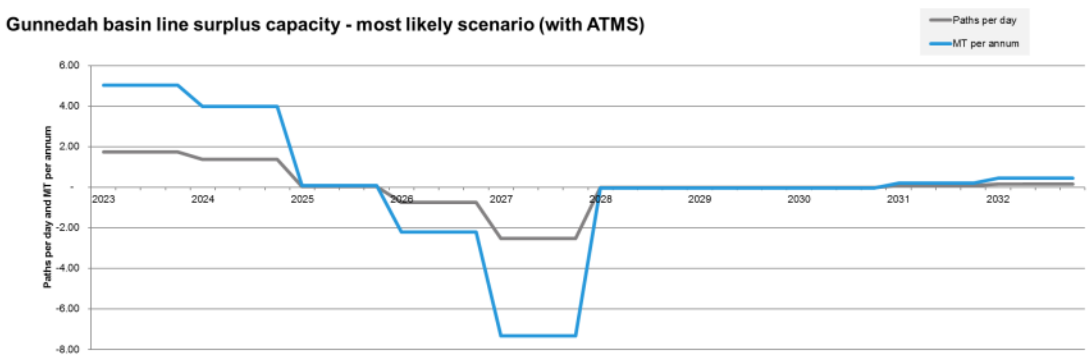

Figure 3-6 - Saleable surplus capacity in paths and tonnes for Zone 3 under the most likely volume and recommended projects scenario with ATMS

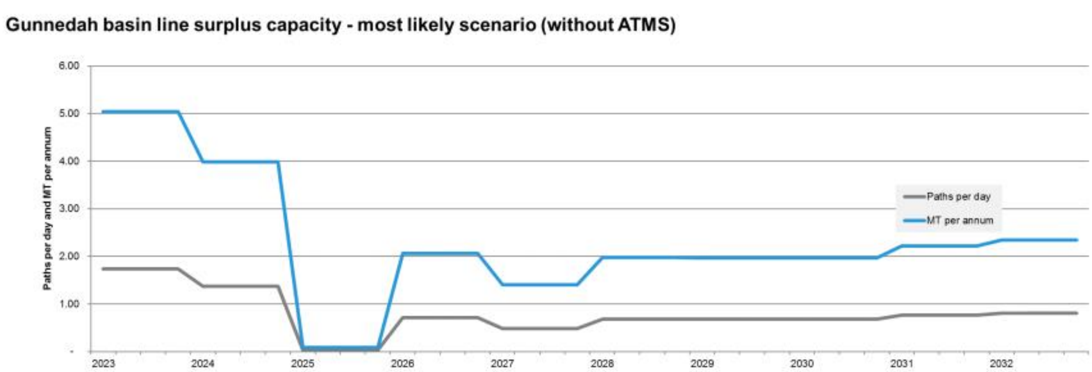

Figure 3-7 - Saleable surplus capacity in paths and tonnes for Zone 3 under the most likely volume and recommended projects without ATMS

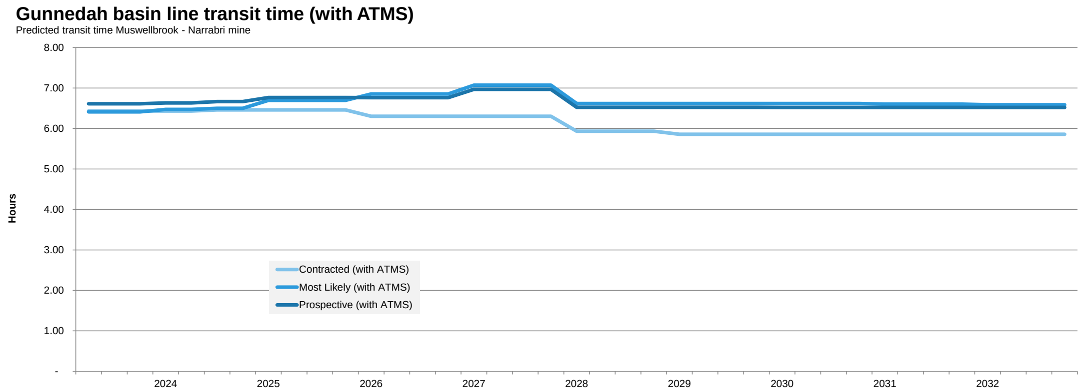

Figure 3-8 - Forecast transit time Muswellbrook - Narrabri mine under contracted, most likely and prospective volume scenarios and works as per Table 3-1 with ATMS.

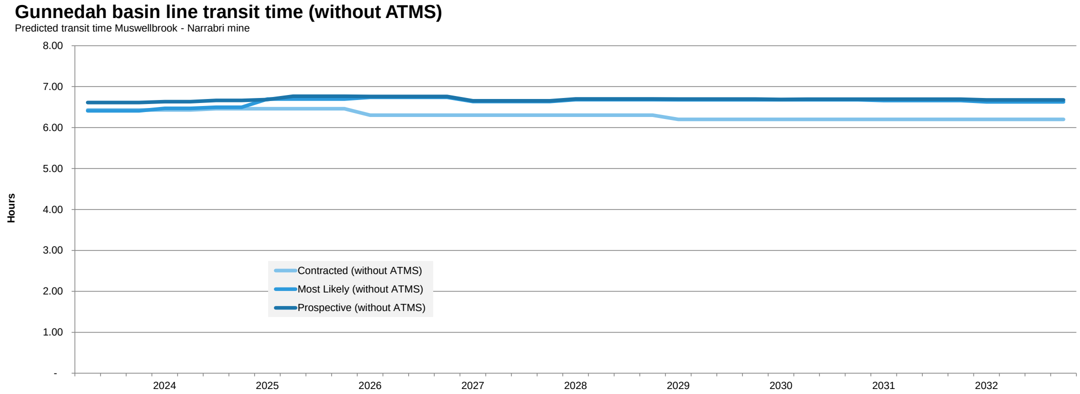

Figure 3-9 - Forecast transit time Muswellbrook - Narrabri mine under contracted, most likely and prospective volume scenarios and works as per Table 3-1 without ATMS.

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 country ore and grain trains 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.

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 updated to 2022 train performance, consistent with the methodology in the 2022 Strategy that continued to apply section times weighted by the expected proportions of each train type that was first used in the 2020 Strategy.

Five coal train consists are contracted for use on the Ulan line. The consists, as noted in Chapter 1, are:

- Pacific National—3 x 92/93/TT class (4400HP AC) locos with 96 wagons - 9,100 net tonnes, 1,541 metres nominal length.
- Pacific National—3 x 90 class (4000HP DC) locos with 92 wagons - 8,500 net tonnes, 1,529 metres.
- Aurizon—2 x 5000/5020 class (4400HP 30 TAL AC) locos with 88 wagons - 8,600 net tonnes, 1,514 metres.
- Aurizon—3 x 6000 class (4400HP AC) locos with 96 wagons—9,389 net tonnes, 1,541 metres
- One Rail—3 x XRN class (4400HP AC) locos with 96 wagons - 9,100 net tonnes, 1,541 metres.

The train performance in this strategy again incorporates the Aurizon consist comprising three 6000 class (4400HP AC) locos with 96 wagons now a number of these consists have now been contracted. These new Aurizon consists still account for a relatively small proportion of the overall fleet of trains that traverse the Ulan line and hence does not materially affect track capacity on the corridor.

Actual transaction times remain unchanged from 2022 and are shown in Figure 4-1, including the simultaneous arrivals adjustment.

Table 4-1 shows the incremental change in consumed capacity on the two most capacity-limited sections on the Ulan line, Baerami to Kerrabee and Bylong to Murrumbo, from the changes above compared with the methodology and inputs used in the 2022 Strategy. The changes are for Q1 2026 and assume no capacity enhancement projects are delivered so that the result reflects the raw change. ATMS is not included in this table because the rollout of ATMS on the Ulan line is not expected to occur until 2027.

The three year rolling average live run loss rate specific to the Ulan line is 8.7%, lower than the 8.9% in the 2022 Strategy. Consumed capacity is slightly lower on both sections as a result of applying this lower rate.

Application of updated train performance for the Ulan line offsets the reduction in capacity consumption above

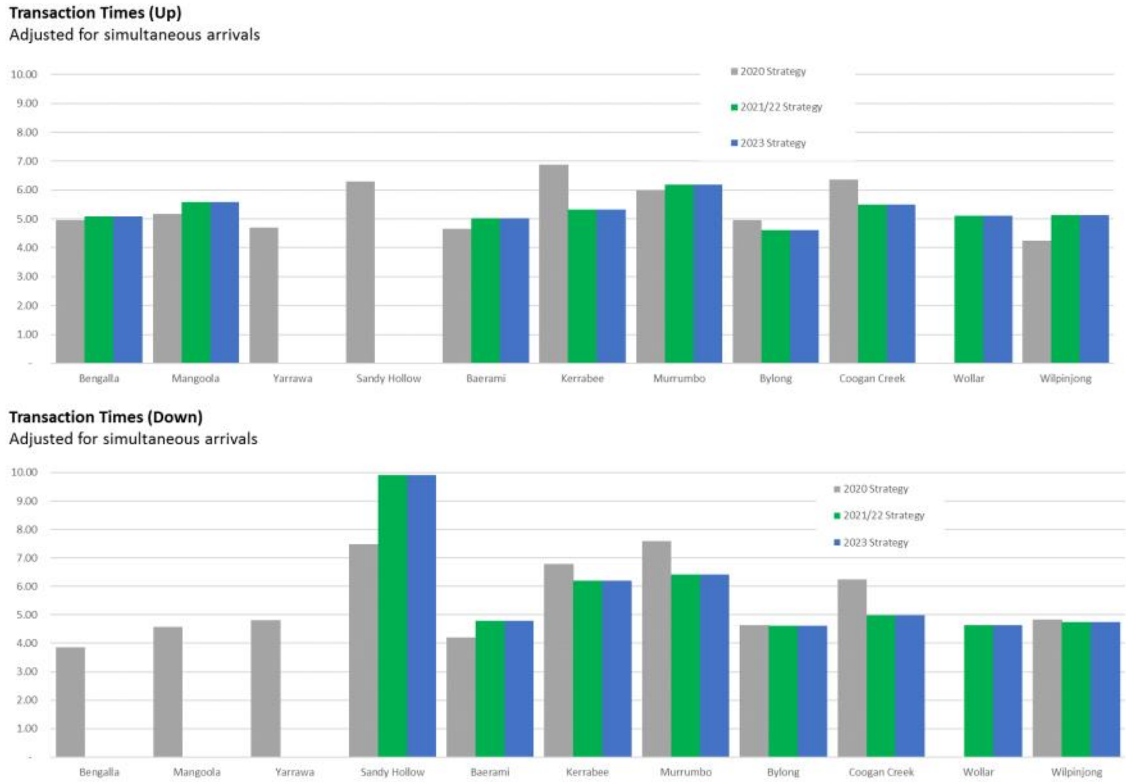

Figure 4-1 - Transaction times

on the capacity-limiting Baerami to Kerrabee section but more than offsets the reduction on Bylong to Murrumbo with consumption increasing by around 1.1 million tonnes. However, there is adequate capacity on these sections to accommodate contracted volumes.

Following the application of the 73.5% utilisation rate, overall consumption of capacity on the Baerami to Kerrabee remains unchanged compared with the 2022 Strategy while it increases on Bylong to Murrumbo by just over 1 million tonnes.

Performance Improvement Initiatives

Similarly to the Gunnedah line, ARTC has explored low cost capacity initiatives on the Ulan line. ARTC previously undertook analysis of intermediate signals between Baerami and Kerrabee, which was estimated to have added up to 2.6 mtpa, and potentially operating down coal trains at up to 100km/h.

Given the Contracted, Most Likely and Prospective scenarios are projected to be accommodated without the need for further enhancement on the Ulan line, it is unlikely that ARTC will pursue these initiatives until required.

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 have long shown interest in introducing longer trains on the Ulan line. The issue of longer trains is discussed in general in Section 2.

Past analysis by the HVCCC and ARTC found that any introduction of trains that were longer than the current length without complimentary investment would lead to a net reduction in capacity due to the inability of such trains to fit in some loops.

The 2020 Strategy discussed the analysis by ARTC that found the most cost effective way to introduce longer trains without negatively impacting on capacity involved delivering a series of infrastructure enhancements on the Ulan line and between Muswellbrook and the port, optimised for a 102 wagon train, or 1640 metres.

Previous editions of the Strategy provided discussion of analysis of the needs and costs of infrastructure and modifications to accommodate longer trains on the Ulan line. Please refer to these previous editions for further information.

Consumption of Sectional Capacity Q1 2026 (mtpa) - w/o projects		
2023 Strategy	Baerami to Kerrabee	Bylong to Murrumbo
Capacity as per 2022 Strategy (with 73.5% utilisation)	*47.54*	*52.41*
Capacity as per 2022 Strategy (w/o ATMS + w/o 73.5%)	45.17	49.81
Add 2023 contract paths	45.17	49.81
Live run losses (8.9% to 8.71%)	45.24	49.89
Maintenance (12.3% - Unchanged)	45.24	49.89
Add updated transaction times (unchanged)	45.24	49.89
Add updated train performance	45.17	48.79
73.5% utilisation (Q1 2022 - Q4 2026)	47.54	51.35

Table 4-1 - Changes in the consumption of capacity of key line sections of the Ulan line.

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]
Widden Creek loop	-	-	-	-

Table 4-2 - Project timings under various demand scenarios

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 discussion about these issues were discussed in detail in the 2021 Strategy and should be referred to for further information.

Investment Pathway

Table 4-2 shows that there are no projects required or proposed for any volume scenario beyond the technology initiatives.

As there are no projects required under either the Most Likely or Prospective volume scenarios, Figure 4-2 only shows the location of existing loops while figures 4-3 and 4-4 also show no proposed projects under the investment pathways of both scenarios.

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

ATMS has been assessed as having the theoretical potential to lift utilisation by five percentage points, which would take utilisation from 70% (73.5% between Q1 2022 and Q4 2026) to 75%. A 2.5% improvement in average train speed has also been assumed.

The strategy and achievable timeframe for implementation of ATMS is the subject of ongoing review informed by progress in the finalisation of the system safety case and the prioritisation of implementation of the system across the East-West and Inland Rail corridors. The current judgement is that Q2 2027 is a realistic target for implementation of ATMS on the Ulan line.

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.

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 4-5. This chart shows both contracted and prospective volumes for the proposed infrastructure scope including ATMS.

A chart showing forecast surplus capacity, in both paths and tonnes, under the most likely volume and infrastructure scenario with ATMS, is shown in Figure 4-6. Figure 4-7 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 4-3.

Volumes are only expected to increase under the Prospective scenario, but only for several years. However this does not result in a shortfall in capacity. In the long run, there is no case for additional capacity.

Figure 4-2 - Ulan Loops

Transit Times

As discussed in Chapter 1, the capacity modelling tools were enhanced for the 2019 Strategy 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 4-8 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 4-9.

Transit time generally improves over time as demand declines.

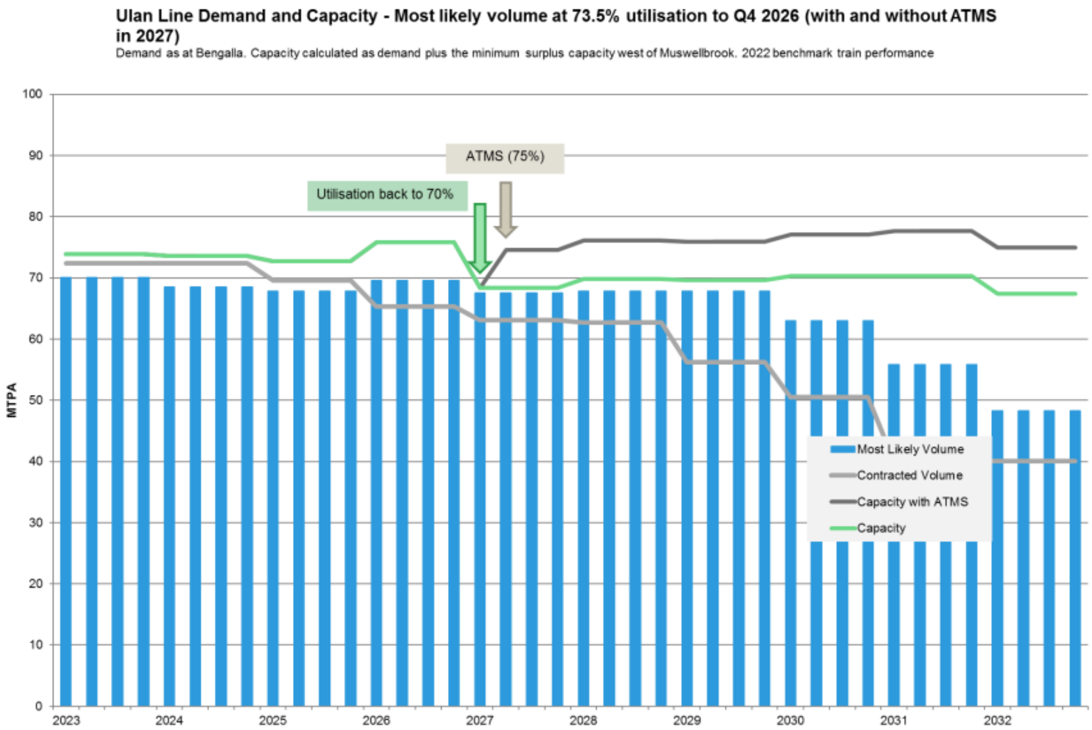

Figure 4-3 - Conceptual pathway for investment to meet Most Likely volume scenario.

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

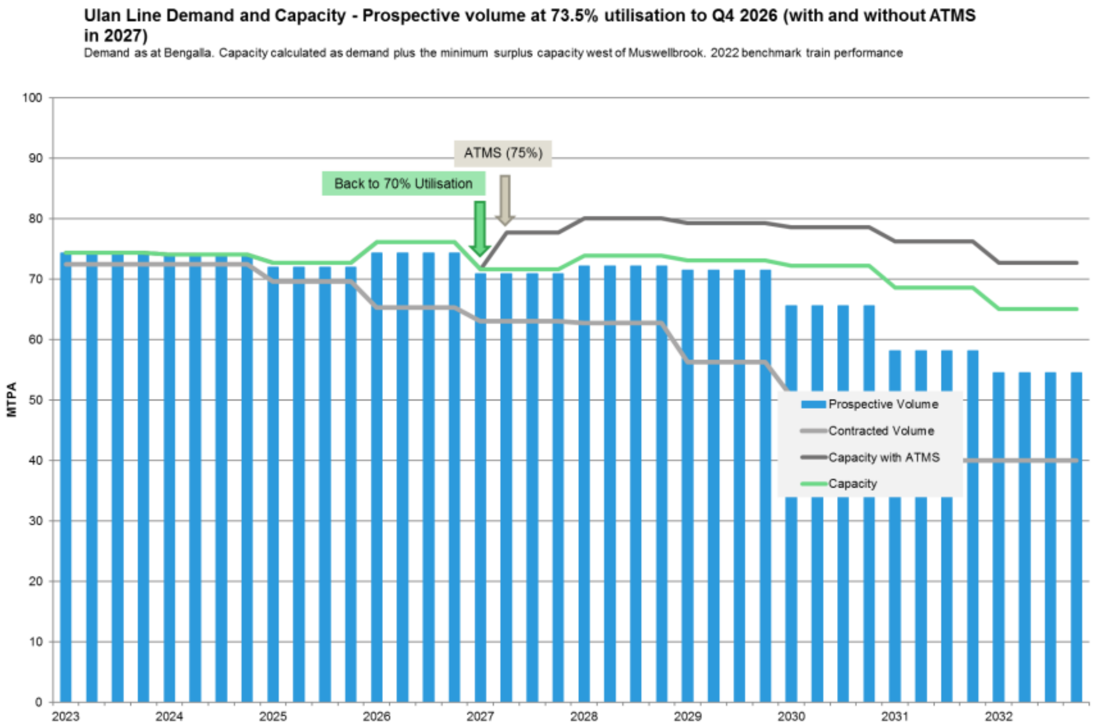

Figure 4-4 - Conceptual pathway for investment to meet the Prospective volume scenario.
Note 1—Unlabelled changes in capacity reflect changes in volume on the port side of the capacity limiting section.

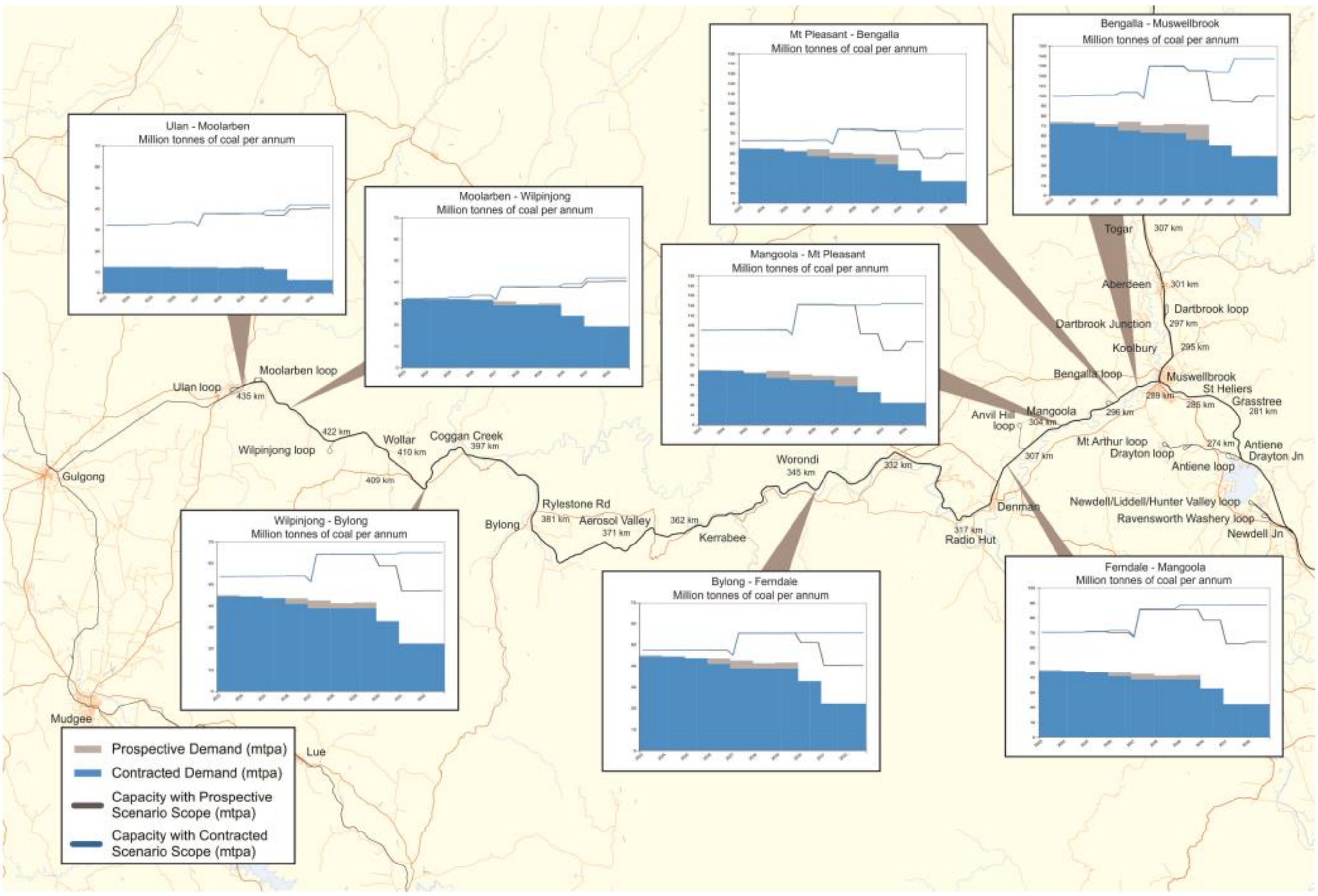

Figure 4-5 - Volume and capacity on the Ulan line

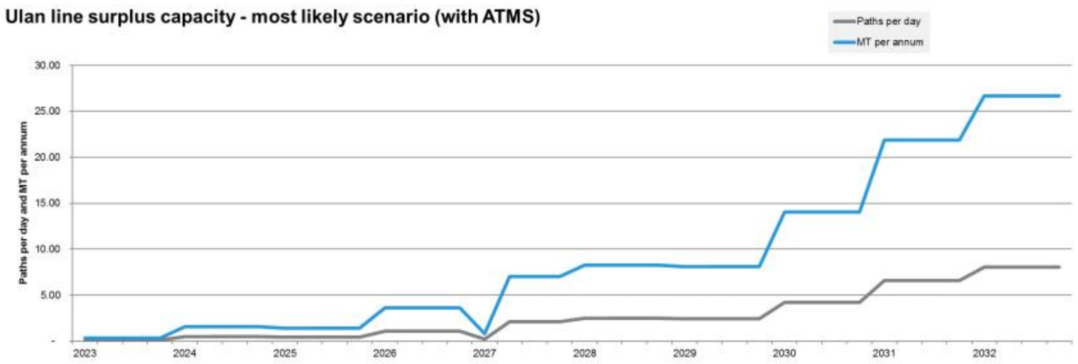

Figure 4-6 - Saleable surplus capacity in paths and tonnes for Zone 2 under the most likely volume and recommended projects scenario with ATMS

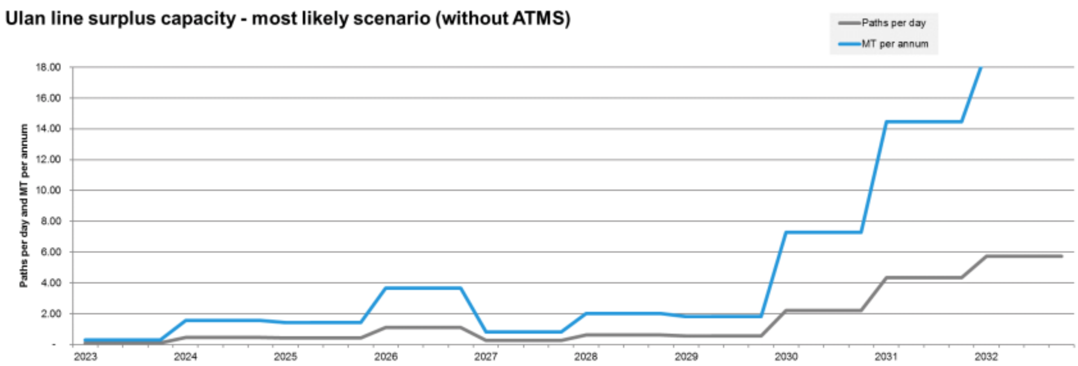

Figure 4-7- Saleable surplus capacity in paths and tonnes for Zone 2 under the most likely volume and recommended projects without ATMS

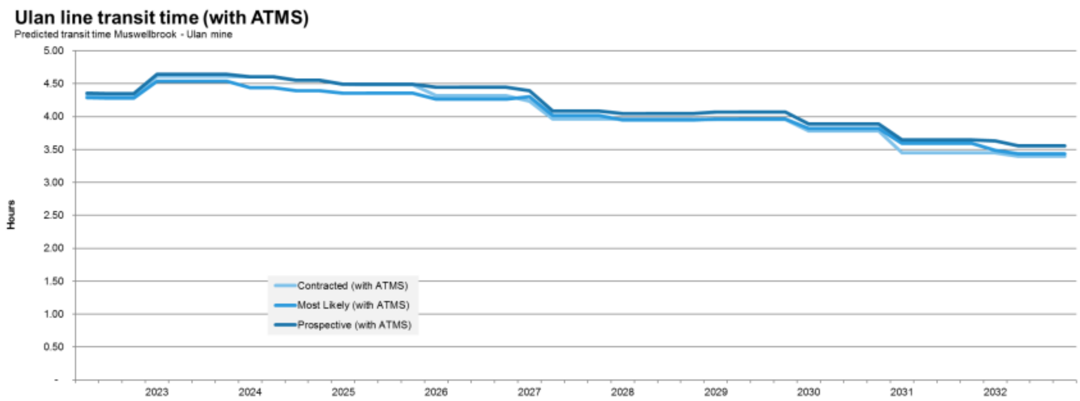

Figure 4-8 - Forecast transit time Muswellbrook - Ulan mine under contracted, most likely and prospective volume scenarios and works as per Table 4-1 with ATMS

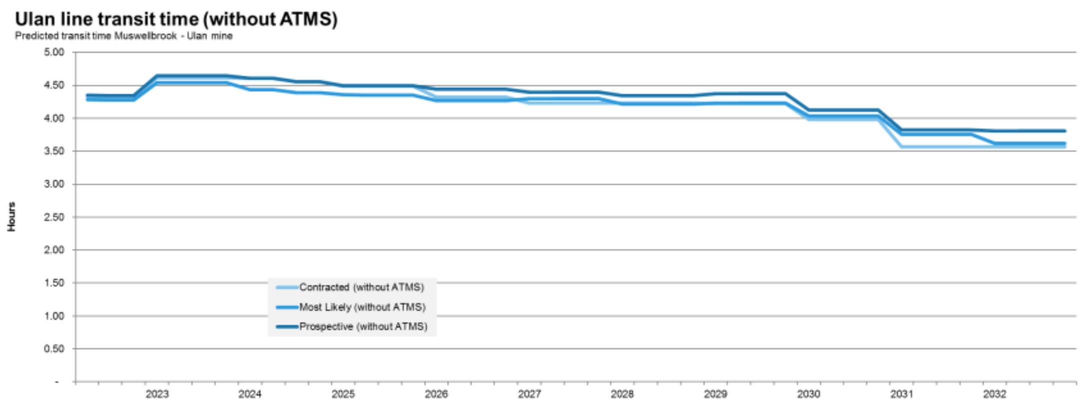

Figure 4-9 - Forecast transit time Muswellbrook - Ulan mine under contracted, most likely and prospective volume scenarios and works as per Table 4-1 without ATMS.

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 two daily return Singleton passenger services and a daily return 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

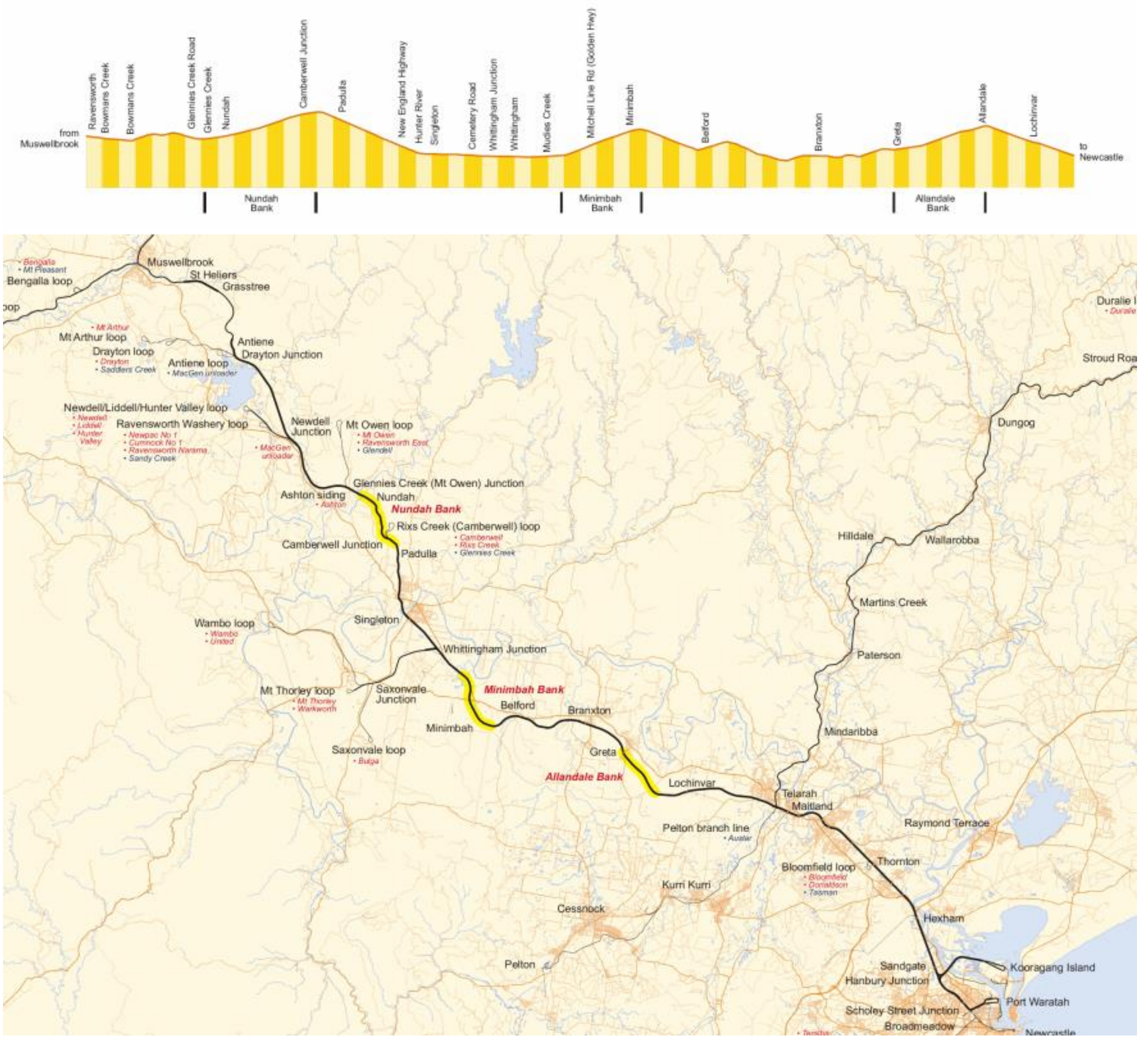

Figure 5-1 - The Nundah, Minimbah and Allandale Banks.

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. A third track, or second Up track, exists on all three of the major banks.

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

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.

The 2019 Strategy calculated actual train performance between Muswellbrook and the ports for the first time. This actual train data 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. Headway increases further up the valley with spacing as high as 14 minutes in the vicinity of Drayton Junction in the Up direction.

There were no capacity constraints identified. Given the ample capacity on this section and that train performance for the Gunnedah and Ulan lines in this Strategy was an improvement on the performance used in the 2019 Strategy, there would be no adverse impact on this section and hence it was determined that there was no requirement to update train performance for Muswellbrook to the port for this Strategy.

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, 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. As discussed in Chapter 2, there is likely to be a case for early delivery of ATMS between Muswellbrook and Singleton and the current ATMS implementation strategy has this targeted for Q2 2029. Singleton—Maitland—Ports is likely to have a relatively higher cost due to the number of interlockings and the scope of benefits will be relatively less. Hence it is targeted for toward the end of the roll-out program, in 2031. As discussed in Chapter 2, there may be opportunities to accelerate this timeframe if there is an appetite to do so.

Junctions

There are numerous junctions on the Hunter Valley rail network where train conflicts at the at-grade interfaces impact on capacity (figure 5-2).

Replacement of the low speed, high maintenance turnouts around Maitland was completed in early 2018. This upgrade was 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

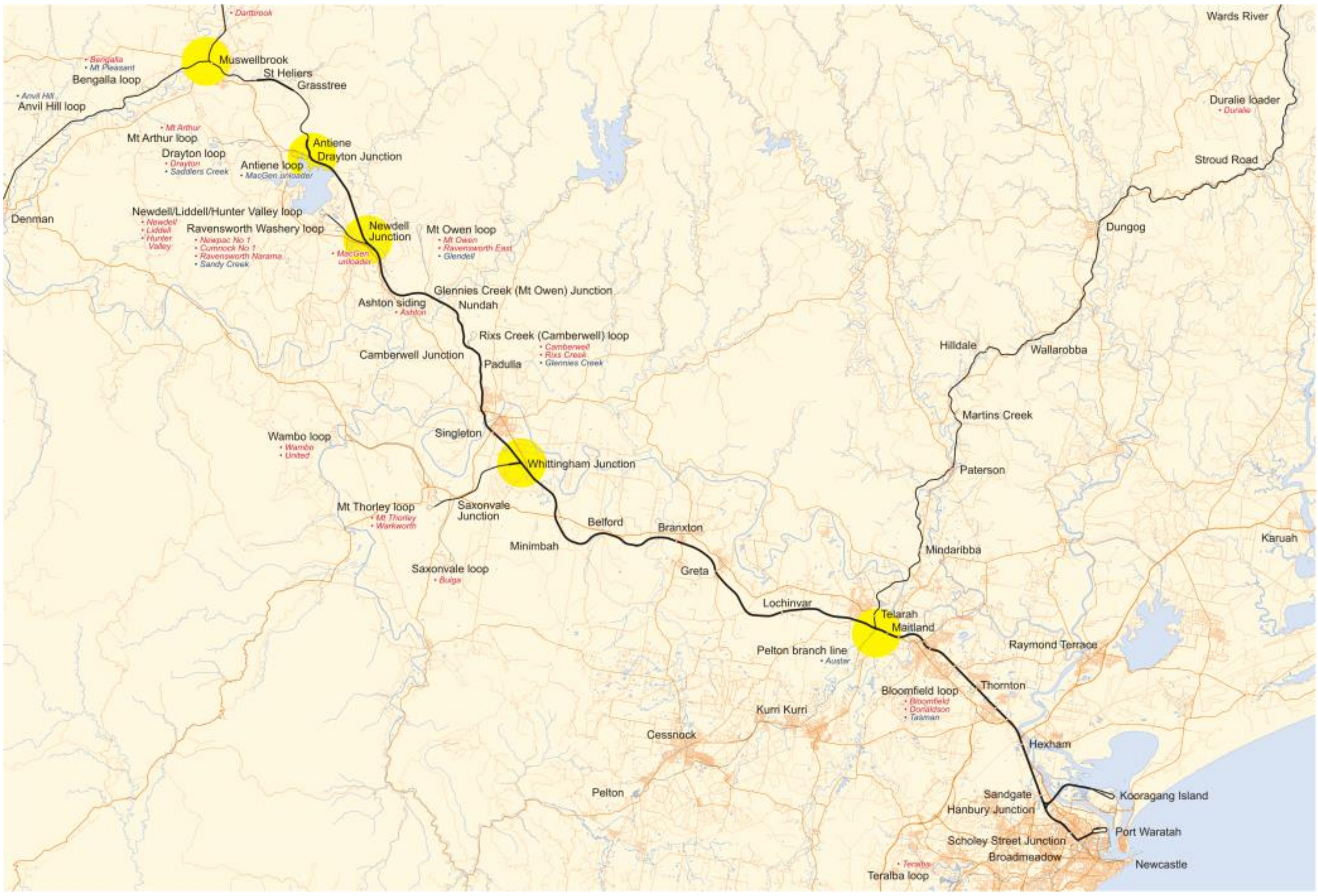

Figure 5-2 - Maitland, Whittingham, Newdell, Drayton and Muswellbrook Junctions

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. As discussed in Chapter 2, there is an emerging need for renewal of some of the signalling equipment at these junctions, but this is not driven by capacity.

Muswellbrook junction stands apart from the other junctions due to the need to sequence trains onto the single track lines to Gunnedah and Ulan 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 and since the implementation of ANCO.

In previous editions of the Strategy, ARTC highlighted the potential need for additional capacity at Muswellbrook junction in the event that volumes would reach a threshold of 45 coal paths a day. This threshold is not achieved under the most likely and prospective volume scenarios.

The HVCCC confirmed in its 2021-2030 Master Plan Upside Scenario analysis that there was no need for a holding track at Muswellbrook in an environment of dynamic management of the network. This is consistent with their modelling completed in 2013. With ANCO Horizon 1 completed, there is now 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.

Whittingham branch

ARTC owns the short network of branches from Whittingham to Mt Thorley, Bulga and Wambo commonly known as the Whittingham branch.

This network was the subject of intensive analysis in 2014 in response to concerns that the branch network could contribute to upstream congestion. ARTC and HVCCC agreed at that time that the capacity of the branch network was in the order of 30 mtpa +/- 2 mtpa once signalling modifications proposed by ARTC, and subsequently implemented, were taken into account. Actual annual volume of around 29 mtpa was achieved prior to the signalling modifications, suggesting that the modelled capacity was conservative.

Track capacity on its own is an order of magnitude greater than this. Key issues in assessing the capacity were:

- Management of train flow, in particular terminal departure filtering and the feasible extent of staging at Whittingham Junction to access the single track sections, and
- Peaking, which historically has exceeded the 10% TMTC allowance.

The rollout of ANCO between Maitland and the port terminals in late 2020 further assists in improving train flow to help mitigate these issues.

Contracted and most likely volumes from Whittingham Junction are comfortably within the agreed capacity limits, but prospective volume peaks at 33 mtpa between 2023 and 2025. While the track capacity to achieve this is available, capacity limits will be a function of system issues. As discussed in Chapter 1, this is a matter for the HVCCC.

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.

Terminals

The Hunter Valley coal industry is serviced by three coal loader terminals, PWCS Carrington (CCT), PWCS Kooragang Island (KCT) and NCIG Kooragang Island (NCT). 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 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 by coal services from the south and western coalfields. 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.

PWCS Kooragang Island is better configured for modern rail operations. It 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 145 mtpa, while NCIG has nameplate capacity of 79 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

Forecast surplus capacity, in both paths and tonnes, under the most likely volume and infrastructure scenario with ATMS, is shown in Figure 5-3. A scenario without ATMS is shown in Figure 5-4. 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 5-6. This chart shows both contracted and prospective volumes for the proposed infrastructure scope including ATMS.

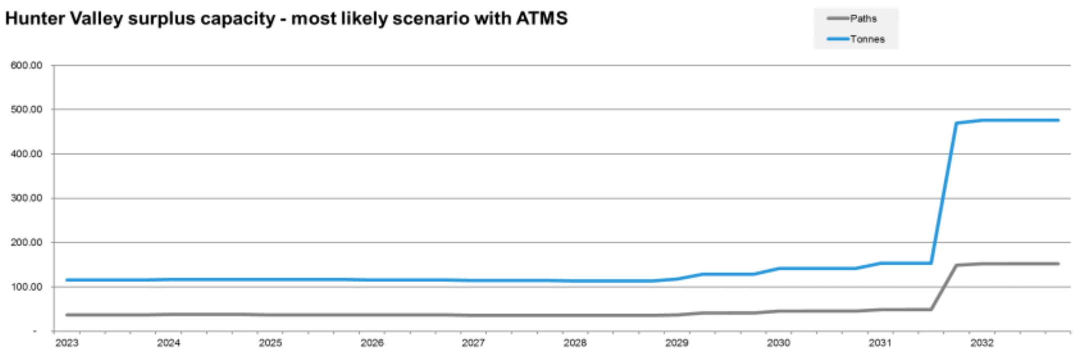

Figure 5-3 - Saleable surplus capacity for Zone 1 under the most likely volume and recommended projects scenario with ATMS

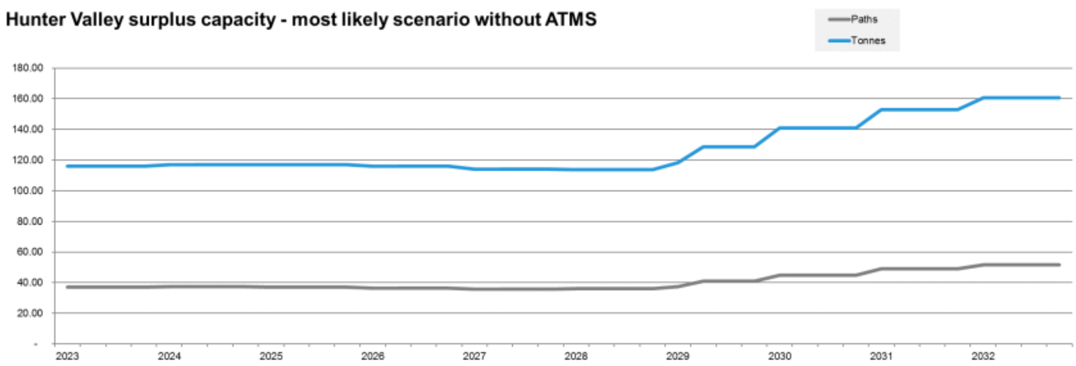

Figure 5-4 - Saleable surplus capacity for Zone 1 under the most likely volume and recommended projects scenario without ATMS

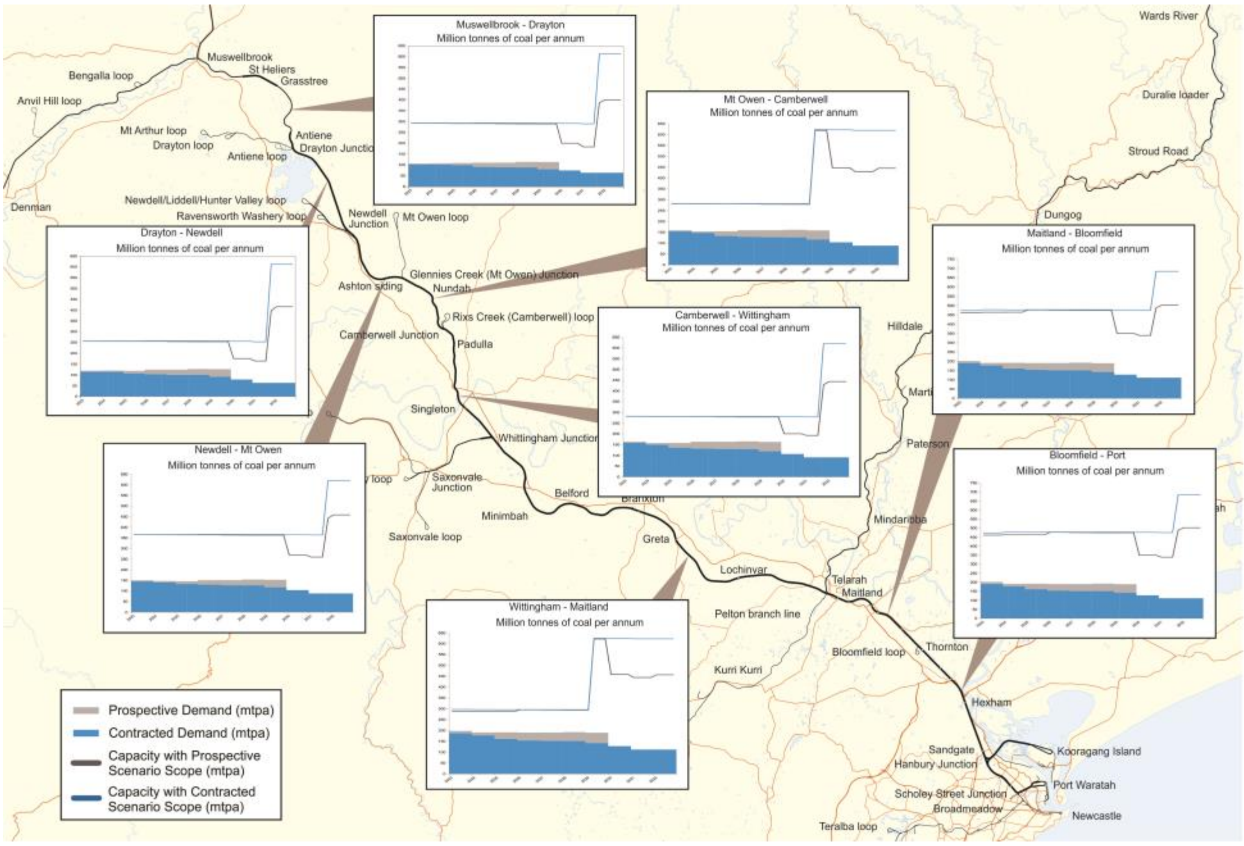

Figure 5-6 - Volume and capacity Muswellbrook—Newcastle

6

PROJECT INFORMATION

Context

This chapter aims to provide additional detail on the projects that are proposed to achieve the capacity outcomes. This chapter has been included in the strategies since 2019 following feedback from stakeholders.

The projects in this section are only those that are required under the Most Likely scenario without ATMS.

ATMS and ANCO are discussed in detail in Chapter 2.

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.

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:

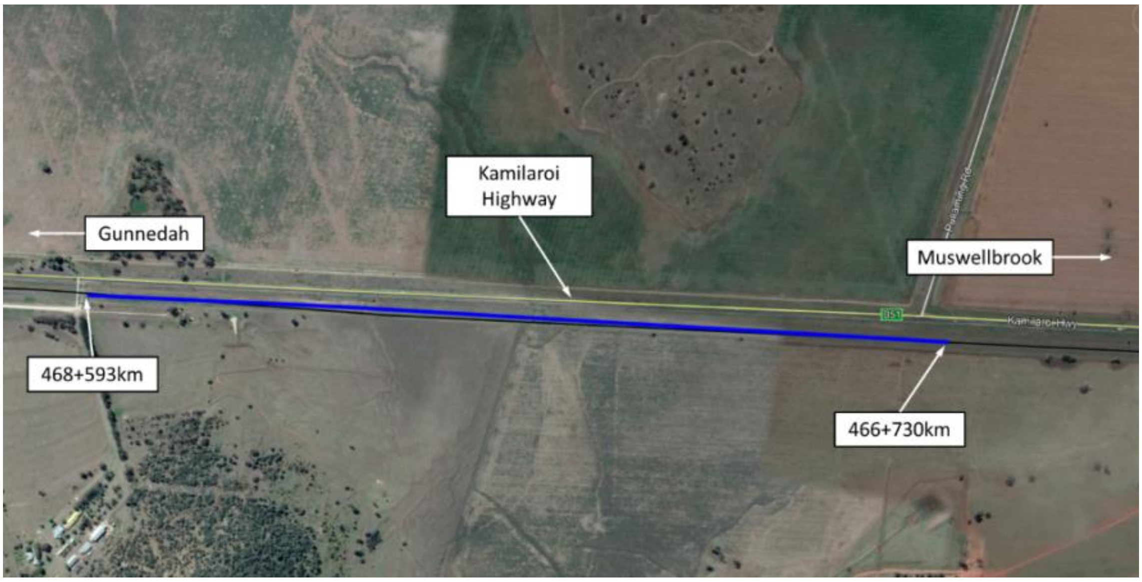

Figure 6-2 - Proposed South Gunnedah loop

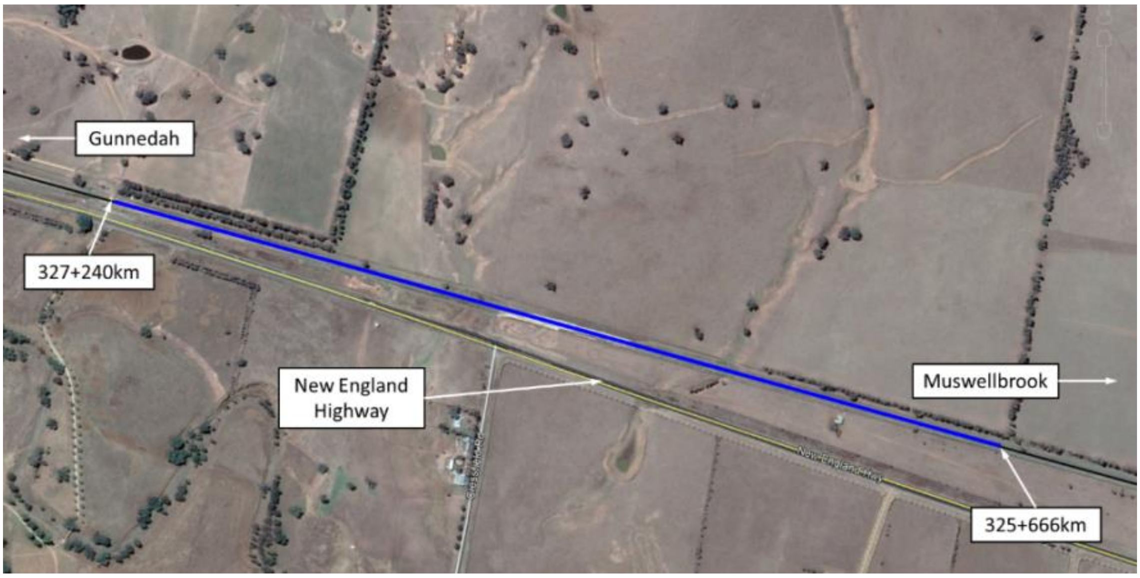

Figure 6-1 - Proposed Wingen loop

- Review and update track and civil designs
- Review and update designs associated with Transport for NSW (TfNSW)
- Negotiate and execute a new major works licence with TfNSW
- 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 1 completed March 2013
Time to complete	31 months
Cost estimate (unescalated)	$20 m
Cost estimate basis	As at end of Phase 1

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 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	32 months
Cost estimate (unescalated)	$21 m
Cost estimate basis	As at end of Phase 2

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 1 completed January 2013
Time to complete	26 months
Cost estimate (unescalated)	$21 m
Cost estimate basis	As at end of Phase 1

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 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)	$42 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

Figure 6-1 - Proposed Togar North loop

Figure 6-10- Proposed Bells Gate South loop extension

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)	$27m
Cost estimate basis	As at end of Phase 1

Figure 6-11- Proposed Werris Creek North loop

7

MAINTENANCE STRATEGY

Context

In this section ARTC aims to provide high level insight into the asset management objectives aimed at improving the customer value proposition of the existing asset along with a summary of the asset management framework and work programs. It reflects ARTC's major focus on the network service offering through long-term asset safety and reliability.

Asset Management Strategy and Objectives

At a high level, ARTC's overall asset management strategic objective is to provide safe and reliable rail infrastructure and capacity to deliver the train path required by its customers. To achieve this objective, ARTC's asset management program and plans balance the following inter-related elements:

Safety: to minimise rail infrastructure risk through compliance to ARTC's Safety Management System, including engineering standards and risk management framework.

Network Condition and Reliability: to maintain rail infrastructure condition and reliability in accordance with its Lease and Access Undertaking obligations in order to minimise disruptions including performance measures and Temporary Speed Restriction (TSR) and deliver the contracted rail infrastructure capacity.

Customer Outcomes: to manage network assets to meet current customer priorities, contracted requirements and forecasted future network demands. This includes working with the HVCCC and other stakeholders to align the capacity of the rail infrastructure, trains and ports with coal production demands through coordinated network closedowns for maintenance and sustaining capital projects.

These elements guide development and delivery of the rail infrastructure asset management plans.

- **Safety**: to minimise rail infrastructure risk through compliance to ARTC's Safety Management System, including engineering standards and risk management framework.

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- **Customer Outcomes**: to manage network assets to meet current customer priorities, contracted requirements and forecasted future network demands. This includes working with the HVCCC and other stakeholders to align the capacity of the rail infrastructure, trains and ports with coal production demands through coordinated network closedowns for maintenance and capital upgrades.

These elements guide development and delivery of the rail infrastructure asset management plans.

Asset Management Planning Process

ARTC has established processes to identify, plan, schedule, approve and execute required maintenance on its network infrastructure to deliver its safety and commercial objectives. Figure 7-1 outlines ARTC's overall asset management planning process.

The annual asset management program is divided into three main areas of expenditure; Routine Corrective and Reactive Maintenance (RCRM), Major Periodic Maintenance (MPM) and Sustaining Capital (CAP). The RCRM and MPM programs are an operating expense and considered to be Maintenance (or OPEX). The CAP program of works is subject to the RCG consultation and endorsement process under the HVAU. Table 7-1 provides a description of each work type.

There is an inter-relationship between Sustaining Capital activities and maintenance expenditure and other operating costs. The maintenance plan is

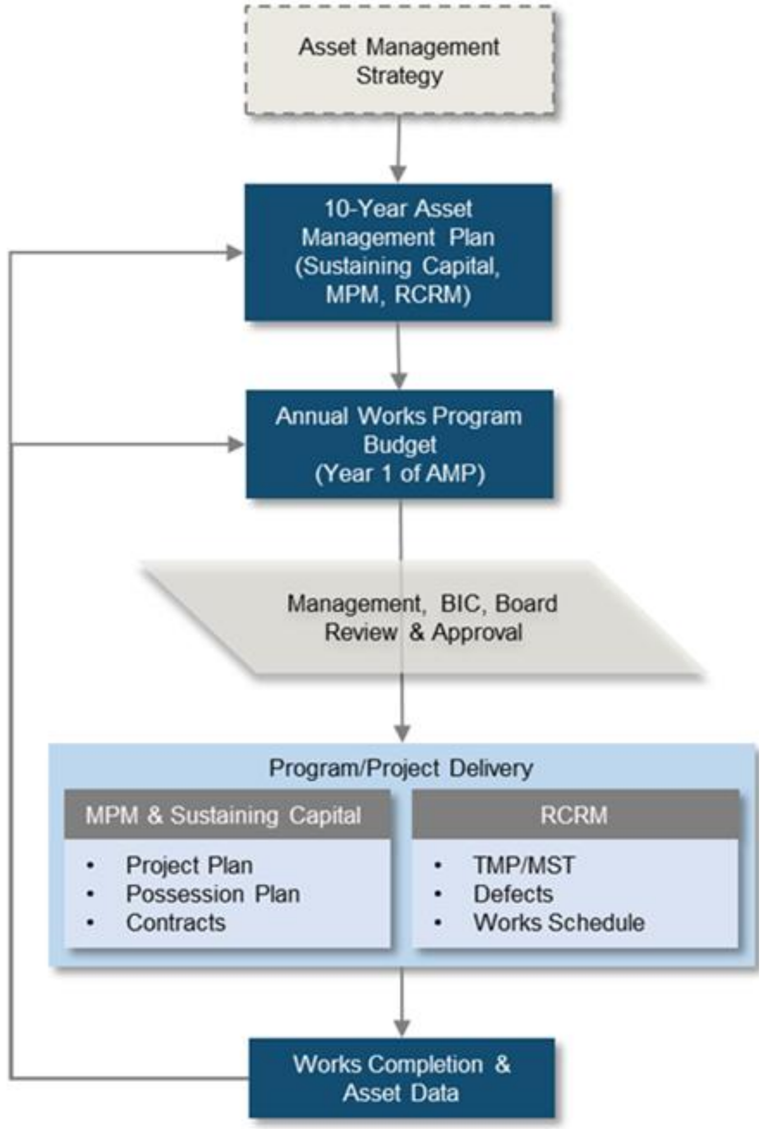

Figure 7-1 - ARTC Asset Management Planning Process

dependant up the delivery of the Sustaining Capital program.

Asset Management Decision Framework

The development of the Hunter Valley Asset Maintenance program involves a detailed process using a number of 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 7-2 outlines the basis of the process.

ARTC is continuing to manage its assets based on a Risk and Condition approach and moving away from a Time and Tonnes approach where appropriate. ARTC is continuing to enhance the available condition related data sets through use of technology to provide objective reference points for condition related information.

Maintenance Program	Description
RCRM	RCRM are scheduled activities used to inspect or service asset condition on a routine basis. RCRM extends to include reactive and corrective activities that are required as a result of inspections or defect identification.
MPM	MPM are cyclical or planned activities that maintain the operating performance and asset life of operational infrastructure. These activities aim to reduce the level of defects and corrective maintenance required.
Sustaining Capital	Generally characterised as an activity that will create or extend the useful life of the asset and/or provide additional functionality or increase the operating standard.

Table 7-1 - *RCRM, MPM and Sustaining Capital Descriptions*

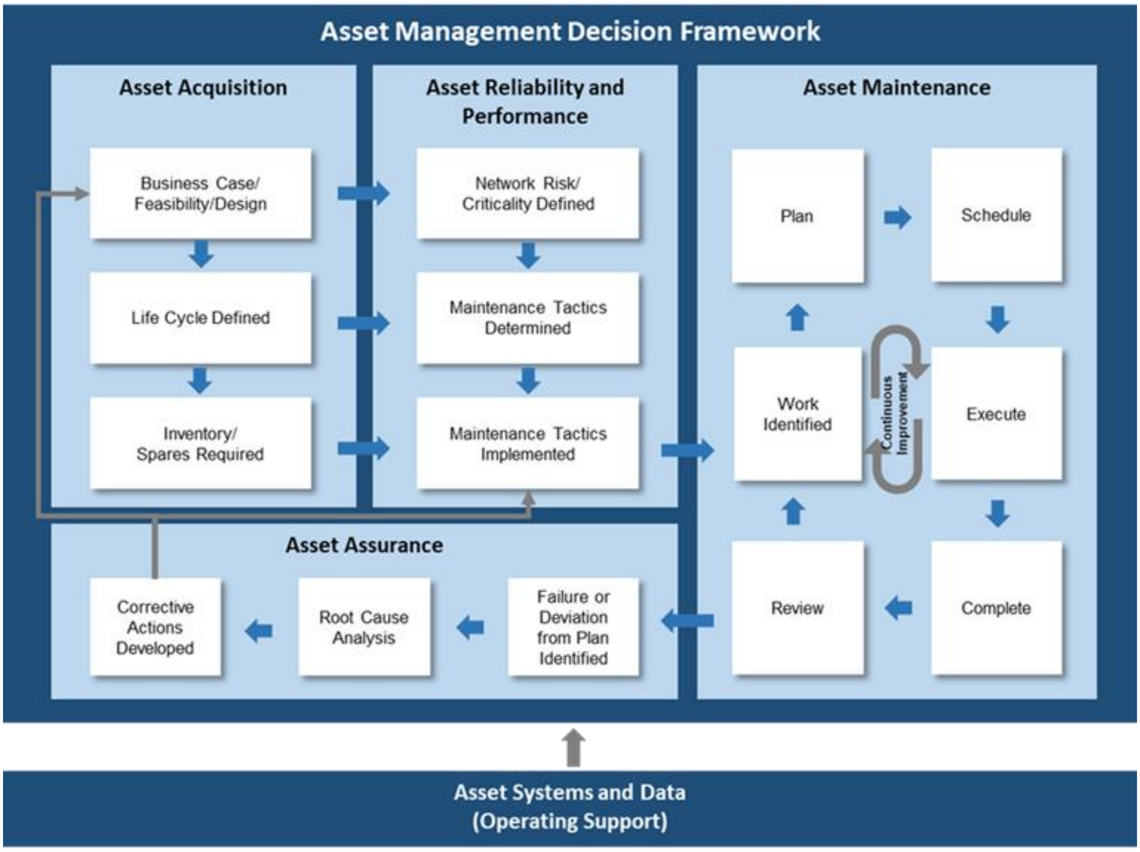

Figure 7-2 - Asset Management Framework

ARTC's asset lifecycle decision making framework incorporates the Plan-Do-Check-Act (PDCA) cycle and considers:

ARTC's asset lifecycle decision making framework incorporates the Plan-Do-Check-Act (PDCA) cycle and considers:

- **Acquisition** – ensures evidence-based decision-making through business cases, feasibility and lifecycle considerations before acquisition, including consideration of spares.
- **Reliability and performance** – covers risk management, criticality and tactical decision-making for maintenance based on an assessment of available condition-based information.
- **Asset maintenance** – a 'Plan, Do, Check, Act' cycle to plan for, undertake, review and continually improve maintenance activities.
- **Asset assurance** – the processes to identify, analyse and develop actions for failures that may occur, and feed this back into the planning and reliability processes.

Asset Performance Monitoring

ARTC is committed to increasing the understanding of condition and risk to the network and enhancing ARTC's whole of life asset management systems.

In addition to asset inspection regimes, the following suite of monitoring tools are used as key inputs to the asset strategy, planning and maintenance processes.

Track Recording Vehicle (AK Car)

The AK car provides for both mandatory inspection and additional condition monitoring and runs approximately every four months. The vehicle provides track geometry measurements, rail profile measurements, digital video, LiDAR and Ground Penetrating Radar (GPR).

Ultrasonic Inspection Car (UIC)

The Ultrasonic Inspection Car provides mandatory ultrasonic rail testing to identify internal rail flaws. The frequency of testing is set out in the Civil TMP and is based on the management of tonnage demand, rail break frequencies and rail flaw frequencies.

Instrumented Coal Wagons (ICW)

ARTC have four ICW units operating on the Hunter Valley Coal network. The ICW platform delivers; daily track condition data; notifications to relevant stakeholders for urgent repairs; allows for identification and early intervention of track condition issues; data analysis with long and short-term trends monitored to optimise planned maintenance programs; and assists in avoiding unnecessary maintenance.

Ground Penetrating Radar (GPR)

The AK Car is newly fitted with GPR equipment. GPR is an inspection process using ground penetrating radar equipment to detect Ballast Fouling Index, free draining layer, ballast pockets, fouled ballast, mud spots and wet track beds. The data produced from this process is a key input to decisions and justification for formation and ballast maintenance work. The target frequency is a two-year cycle however this is still being established.

Digital Mapping (LiDAR)

The AK Car is fitted with LiDAR equipment. The use of this data is currently focussed on clearance infringement checks and track centre measurements however its purpose may be expanded in the future. Future uses may include using digital terrain contour data for concept planning and estimating purposes. Further uses may also include level crossing sighting checks and for the validation of asset locations.

Real Time Bridge Monitoring

ARTC have installed bridge mounted electronic monitoring systems on several critical steel bridges on the Hunter Valley Network. The electronic monitoring systems will provide real□time monitoring and flag issues by way of exception reports for detailed investigation by the structures team.

Points Condition Monitoring (PCM)

Points failures are the second biggest contributor to infrastructure reliability issues (after rail breaks). PCM provides detailed diagnosis of points machine behaviour; drive proactive maintenance interventions thereby reducing the number of failures; and will allow our asset management teams to aggregate data sets to identify deeper insights into required maintenance. These may include identification of track, civil or signalling issues.

Level Crossing Monitoring

Level crossing monitors are installed at actively protected level crossings and provide alarms and in most cases remote diagnostics for faulty lamps, booms, batteries and signalling logic. The alarms and data allow emergency response teams to diagnose problems before attending site and hence allowing for the fastest possible return to service. Failure records also assist in the prioritisation of longer-term work programs.

Geographic Information System (GIS) Visualisation

The Geographic Information System (GIS) is a framework for gathering, managing, and analysing data spatially. ARTC collects and maintains large datasets necessary to manage the asset. ARTC also uses datasets produced by various government organisations. In order to make effective use of this data, it must be available to users in a clear, accurate and consistent manner, ARTC's GIS Platform provides this function.

Decision Support Platform

The DSP rationalises the many models and data sources on the asset into a single analysis system, thereby enabling efficient, reliable, objective and robust asset management decision-making. This includes data from inspections, monitoring systems and work activity history to deliver more efficient maintenance and improve asset reliability. The DSP has been utilised to identify and refine scope for activities such as tamping, ballast cleaning, grinding and track upgrades. Additionally, the DSP is also utilised daily to determine network priorities and identify sections with rapid deterioration, as well as determining the maintenance effectiveness.

Maintenance Works Forecast

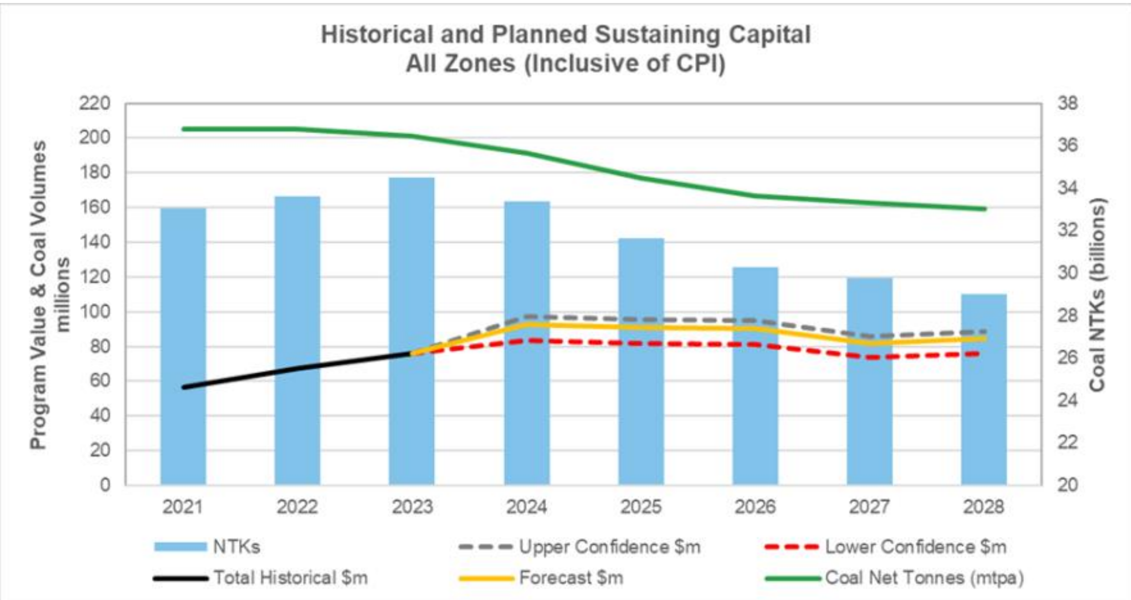

Figure 7-3 - Historical and Planned Sustaining Capital

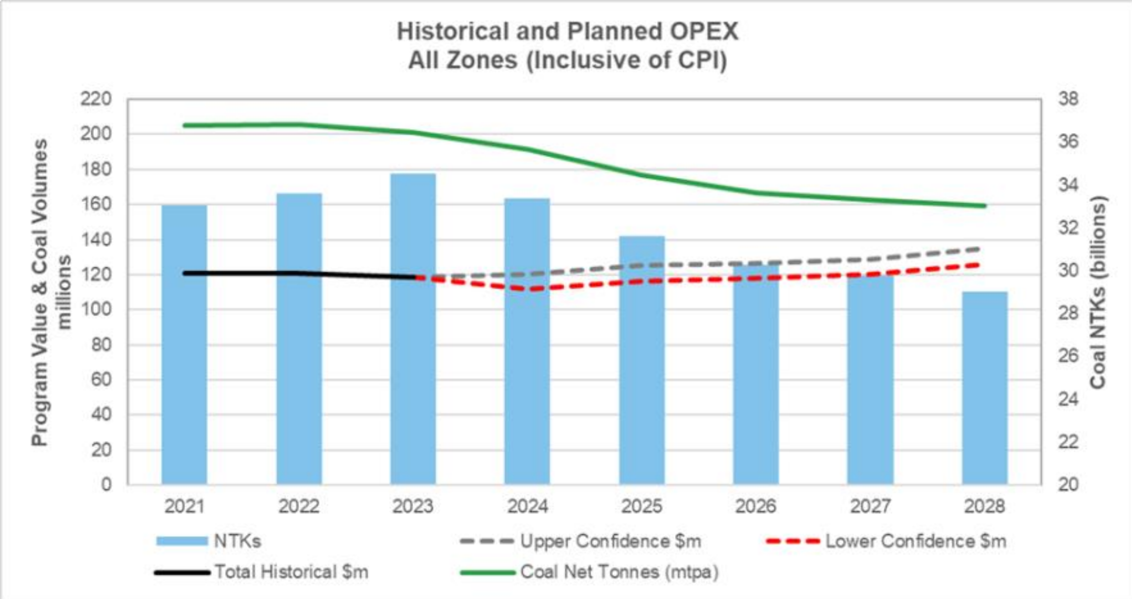

Figure 7-4 - Historical and Planned OPEX

Each year, coal Customers provide forecast tonnage volumes on an individual basis for each of their load points for a most likely and high scenario. The volume forecasts are utilised each year to inform the development of the Hunter Valley Corridor Capacity Strategy and the Asset Management Plans.

The current forecast program of works for both MPM and Capital is presented in the following sections and shown in terms of escalated annual costs. The charts 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 charts include the total Net Tonne Kilometres (NTK's) 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 historical expenditure is also shown.

Sustaining Capital Program

The current forecast of the sustaining capital program for all Pricing Zones is shown in Figure 7-3.

This historical spend profile includes the 30 tonne axle load program of works being delivered in Zone 3 which concluded at the end of 2017. Increases in outer year costs are mostly due to significant steel bridge replacements. The timing of this work will be reviewed during the feasibility phase.

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 normally represent over 70% of capital works plan in any given year.

RERAILING: This program is calculated using a model which 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. The scope of this activity is not steady from year to year and depends on the timing of asset wear. While there is an annual rerailing requirement across all zones there is a significant amount of rail requiring in Pricing Zone 1 and 2.

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: is the reconstruction of the track formation (track bed) arising from formation failure and persistent track geometry issues. Track strengthening includes subgrade treatment, the installation of structural earthworks, a capping layer and new ballast, followed by track and drainage restoration. The purpose being to effectively manage the risk to rail operations from track geometry deterioration. Key drivers of this activity include track failure rates and type of failure; track performance; maintenance effectiveness intervals; and formation and subgrade configuration.

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: This 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.

The majority of turnout replacements performed in the Hunter Valley are replacing turnouts of poor condition or older designs not suitable to withstand the ongoing demands of a heavy haul network.

OPEX Maintenance Program

The forecast spend profile of the OPEX program (RCRM and MPM combined) for all zones is shown in Figure 7-4.

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 70% of the annual OPEX spend in any given year.

ROUTINE CORRECTIVE REACTIVE MAINTENANCE: RCRM are scheduled activities used to inspect or service asset condition on a routine basis. RCRM extends to include reactive and corrective activities that are required as a result of inspections or defect identification that, because of their nature, are dealt with on the spot or as soon as is reasonably practical thereafter.

BALLAST CLEANING: is the mechanical excavation of deteriorated track ballast up to 500mm below the bottom of the sleeper across the entire track cross-section. The activity's purpose is to reinstate the function of the ballast as a free-draining medium that holds the track to its correct geometry under the passage of trains. Ballast cleaning is a cyclical maintenance activity across the network, with timing driven by condition and the cumulative tonnages over specific segments of track. It is a large component of the recurrent operating costs at an aggregate level, recognising that the activity will move through the zones across a number of years. The ballast cleaning activity is outsourced achieving approximately 30km per year.

BALLAST UNDERCUTTING: addresses localised defects on track sections (typically less than 100m in length) and involves a small crew using an excavator and cutter bar to remove a mud-hole and/or area of highly fouled ballast which impedes drainage. Ballast undercutting provides a lower cost and short-term solution to mud hole removal where the track condition does not require a full track reconditioning.

RAIL GRINDING: is the periodic grinding of rail to manage its profile and stress-related fatigue. Grinding improves wheel and rail interaction to reduce rail and wheel wear and rail defects. The frequency of rail grinding is dependent upon rail and traffic type, tonnages (in Million Gross Tonnes (MGT)) and track geometry. In determining the optimal rail grinding frequency a detailed analysis of rail performance is undertaken to maximise rail life and minimise the development of rail defects.

TURNOUT GRINDING: is the periodic grinding of turnouts to manage the wheel/rail interface and minimise whole of life costs. Turnout components interface closely with signalling assets and can cause low network reliability and high costs if in poor condition. In determining the optimal grinding frequency, a detailed assessment and review of turnout performance is undertaken annually for all turnouts. Frequency is determined by consideration of factors including tonnage, location and condition.

RESURFACING (TAMPING): restores the track geometric parameters of top, line, superelevation and alignment by mechanised on-track machinery. Similar to ballast cleaning, the accumulated gross tonnage over the line segment determines the initial resurfacing scope. Frequency is also influenced by the environment, track structure and condition, train axle loads and speeds.

TURNOUT RESURFACING (TAMPING): restores the track geometric parameters of top, line, superelevation and alignment by mechanised on-track machinery. Historical track condition data for each track line segment is used to determine suitable tamping cycles for the purpose of planning. During the delivery year tamping scope is based on the current track condition data from the DSP to determine priority scope locations. Frequency is also influenced by the environment, track structure and condition, train axle loads and speeds.

TURNOUT STEEL COMPONENT REPLACEMENT: reduces the risk of turnout rail component failure and derailment. Sites are identified by field staff based on a condition assessment. Data for the upcoming year is submitted showing individual turnout requirements. Turnout performance varies due to track formation, design issues, drainage and tonnage. The scope of this activity is not steady from year to year and depends on the timing of asset wear and the complexity of the location.

STEEL BRIDGE MAINTENANCE: relates to a range of repair and maintenance activities designed to maintain the operation and safety of steel bridge structures. Steel bridge maintenance does not have a steady year on year spend rate as it is dependent on condition and scope specific to the site requiring work. These works can range from minor to significant projects and are part of an asset maintenance plan for the structure which may also include the eventual replacement of the asset via the Sustaining Capital program.

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, $2022-23 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 projects in tables 8-1, 8-6 and 8-11 assume ANCO and a 73.5% utilisation between Q1 2022 and Q4 2026.

Recommended projects - Contracted Volume	2022 Strategy – Proposed by	2023 Strategy – Required by	2023 Strategy – Proposed by	Estimated Cost ($m) Present Value
Gunnedah Line				
Nil				
Ulan Line				
Nil				
Muswellbrook - Port				
Nil				
Productivity Projects				
Advanced Train Management System (ATMS) [1]				
Turrawan—Werris Creek	Q4 2026	-	Q4 2027	$21
Werris Creek—Koolbury	Q1 2027	-	Q1 2028	$22
Ulan—Mangoola	Q2 2026	-	Q2 2027	$26
Mangoola / Koolbury—Singleton	Q2 2028	-	Q2 2029	$30
Singleton—Maitland	Q1 2030	-	Q1 2031	$15
Maitland—Port	Q4 2030	-	Q4 2031	$35
Trainborne units (270) [2]	Progressive	-	Progressive	$53
System, development and project management	Progressive	-	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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.4	4.4	4.4	4.4	4.4	4.4
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	14.4	14.4	14.4	14.4	14.4	14.4
Vickery - Gunnedah	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.6	16.5	16.5	16.7	16.7	16.7	16.7
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.0	10.0	10.0	10.0	10.0	10.0
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.0	12.0	12.0	12.0	12.0	12.0
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	11.4	11.4	11.4	11.4	11.4	11.4
Scone - Dartbrook	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.6	11.8	11.8	11.7	11.7	11.7	11.7
Dartbrook - Muswellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	42.4	42.4	42.4	42.4	42.4
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	9.6	9.6	9.8	10.4	10.4
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	9.6	9.6	9.8	10.4	10.4
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	15.6	15.6	15.6	15.7	15.7
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	13.7	13.7	13.7	13.7	13.7
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.8	20.7	20.7	21.3	21.3	21.2	21.2
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	27.6	27.5	27.5	27.7	27.7
Mt Pleasant - Bengalla	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.1	19.2	18.1	18.1	17.7	17.4	17.8	17.8
Bengalla - Muswellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	29.8	29.0	28.7	31.3	31.3
Muswellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Drayton - Newdell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2
Newdell - Mt Owen	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1
Mt Owen - Camberwell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Camberwell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	12.8	12.8	12.8	12.8	12.8	12.8
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	41.7	41.7	41.7	41.7	41.7	41.7
Vickery - Gunnedah	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	51.0	47.9	47.9	48.5	48.5	48.5	48.5
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	29.2	29.2	29.2	29.2	29.2	29.2
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	34.8	34.8	34.8	34.8	34.8	34.8
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	33.2	33.2	33.2	33.2	33.2	33.2
Scone - Dartbrook	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	36.7	34.2	34.2	34.0	34.0	34.0	34.0
Dartbrook - Muswellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	123.1	123.1	123.1	123.1	123.1
Ulan - Moolarben	32.1	32.1	32.1	32.1	32.4	32.4	32.4	32.4	32.8	33.8	31.8	31.8	31.8	32.5	34.5	34.5
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.8	33.8	31.8	31.8	31.8	32.5	34.5	34.5
Wilpinjong - Bylong	53.7	53.7	53.7	53.7	53.8	53.8	53.8	53.8	53.9	54.1	51.4	51.4	51.4	51.4	51.9	51.9
Bylong - Ferndale	47.4	47.4	47.4	47.4	47.5	47.5	47.5	47.5	47.5	47.5	45.2	45.2	45.2	45.2	45.2	45.2
Ferndale - Mangoola	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.5	71.1	71.6	67.9	67.9	70.0	70.0	70.1	70.1
Mangoola - Mt Pleasant	95.2	95.2	95.2	95.2	95.3	95.3	95.3	95.3	95.3	95.7	91.0	91.0	90.5	90.4	91.6	91.6
Mt Pleasant - Bengalla	63.0	63.0	63.0	63.0	63.1	63.1	63.1	63.1	62.9	63.2	59.5	59.6	58.2	57.3	58.7	58.7
Bengalla - Muswellbrook	99.9	99.9	99.9	99.9	100.4	100.4	100.4	100.4	100.9	103.8	97.6	97.6	94.6	93.6	102.3	102.3
Muswellbrook -Drayton	292.6	292.6	292.6	292.6	292.7	292.7	292.7	292.7	292.3	293.1	292.7	292.8	292.2	291.1	289.4	289.4
Drayton - Newdell	256.7	256.7	256.7	256.7	256.7	256.7	256.7	256.7	256.7	257.4	257.1	257.2	256.8	255.5	253.4	253.4
Newdell - Mt Owen	366.4	366.4	366.4	366.4	366.0	366.0	366.0	366.0	366.0	366.9	366.7	366.7	366.5	365.4	363.8	363.8
Mt Owen - Camberwell	281.4	281.4	281.4	281.4	281.0	281.0	281.0	281.0	280.5	281.2	281.0	281.0	280.9	280.0	278.8	278.8
Camberwell - Whittingham	281.7	281.7	281.7	281.7	281.2	281.2	281.2	281.2	280.7	281.4	281.2	281.2	281.1	280.3	279.2	279.2
Whittingham - Maitland	296.8	296.8	296.8	296.8	296.2	296.2	296.2	296.2	295.8	296.3	296.1	296.2	296.1	295.5	294.6	294.6
Maitland - Bloomfield	473.3	473.3	473.3	473.3	477.8	477.8	477.8	477.8	477.1	477.9	477.6	477.7	477.6	476.6	475.2	475.2
Bloomfield - Hexham	473.2	473.2	473.2	473.2	477.8	477.8	477.8	477.8	477.1	477.9	477.6	477.7	477.6	476.6	475.2	475.2

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.4	6.1	6.1	6.1	6.1	6.1
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	14.4	20.2	20.2	20.2	20.2	20.2
Vickery - Gunnedah	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.6	16.5	21.7	22.0	22.0	22.0	22.0
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.0	13.2	13.2	13.2	13.2	13.2
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.0	17.0	17.0	17.0	17.0	17.0
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	11.4	15.1	15.1	15.1	15.1	15.1
Scone - Dartbrook	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.6	11.8	15.6	15.6	15.6	15.6	15.6
Dartbrook - Muswellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	53.5	53.5	53.5	53.5	53.5
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.4	11.4	11.8	12.6	12.6
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.4	11.4	11.8	12.6	12.6
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	19.5	19.5	19.5	19.6	19.6
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	16.9	16.9	16.9	16.9	16.9
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.8	20.7	26.2	27.0	27.0	26.9	26.9
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	36.8	36.6	36.6	37.0	37.0
Mt Pleasant - Bengalla	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.1	19.2	18.1	22.7	22.2	21.9	22.5	22.5
Bengalla - Muswellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	39.7	38.3	37.9	42.1	42.1
Muswellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Drayton - Newdell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	195.9
Newdell - Mt Owen	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	195.9
Mt Owen - Camberwell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Camberwell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	12.8	17.7	17.7	17.7	17.7	17.7
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	41.7	58.5	58.5	58.5	58.5	58.5
Vickery - Gunnedah	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	51.0	47.9	63.1	63.8	63.8	63.8	63.8
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	29.2	38.4	38.4	38.4	38.4	38.4
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	34.8	49.3	49.2	49.2	49.2	49.2
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	33.2	43.8	43.8	43.8	43.8	43.8
Scone - Dartbrook	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	36.7	34.2	45.3	45.2	45.2	45.2	45.2
Dartbrook - Muswellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	155.3	155.3	155.3	155.3	155.3
Ulan - Moolarben	32.1	32.1	32.1	32.1	32.4	32.4	32.4	32.4	32.8	33.8	31.8	37.9	37.9	39.2	42.0	42.0
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.8	33.8	31.8	37.9	37.9	39.2	42.0	42.0
Wilpinjong - Bylong	53.7	53.7	53.7	53.7	53.8	53.8	53.8	53.8	53.9	54.1	51.4	64.1	64.1	64.2	64.9	64.9
Bylong - Ferndale	47.4	47.4	47.4	47.4	47.5	47.5	47.5	47.5	47.5	47.5	45.2	55.7	55.7	55.7	55.7	55.7
Ferndale - Mangoola	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.5	71.1	71.6	67.9	86.1	88.8	88.8	88.8	88.8
Mangoola - Mt Pleasant	95.2	95.2	95.2	95.2	95.3	95.3	95.3	95.3	95.3	95.7	91.0	121.3	120.5	120.4	122.2	122.2
Mt Pleasant - Bengalla	63.0	63.0	63.0	63.0	63.1	63.1	63.1	63.1	62.9	63.2	59.5	74.8	73.0	72.0	74.4	74.4
Bengalla - Muswellbrook	99.9	99.9	99.9	99.9	100.4	100.4	100.4	100.4	100.9	103.8	97.6	129.9	125.2	123.7	137.5	137.5
Muswellbrook -Drayton	292.6	292.6	292.6	292.6	292.7	292.7	292.7	292.7	292.3	293.1	292.7	292.8	292.2	291.1	289.4	611.5
Drayton - Newdell	256.7	256.7	256.7	256.7	256.7	256.7	256.7	256.7	256.7	257.4	257.1	257.2	256.8	255.5	253.4	611.5
Newdell - Mt Owen	366.4	366.4	366.4	366.4	366.0	366.0	366.0	366.0	366.0	366.9	366.7	366.7	366.5	365.4	363.8	619.0
Mt Owen - Camberwell	281.4	281.4	281.4	281.4	281.0	281.0	281.0	281.0	280.5	281.2	281.0	281.0	280.9	280.0	278.8	619.0
Camberwell - Whittingham	281.7	281.7	281.7	281.7	281.2	281.2	281.2	281.2	280.7	281.4	281.2	281.2	281.1	280.3	279.2	619.9
Whittingham - Maitland	296.8	296.8	296.8	296.8	296.2	296.2	296.2	296.2	295.8	296.3	296.1	296.2	296.1	295.5	294.6	622.5
Maitland - Bloomfield	473.3	473.3	473.3	473.3	477.8	477.8	477.8	477.8	477.1	477.9	477.6	477.7	477.6	476.6	475.2	684.3
Bloomfield - Hexham	473.2	473.2	473.2	473.2	477.8	477.8	477.8	477.8	477.1	477.9	477.6	477.7	477.6	476.6	475.2	684.3

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	2022 Strategy – Proposed by (Without ATMS)	2023 Strategy – Required by (Note 1)	2023 Strategy – Proposed by without ATMS	2023 Strategy—Proposed by with ATMS	Estimated Cost ($m) Present-Value
Scope as per contracted volume, plus					
Gunnedah Basin Line					
South Gunnedah loop	Q1 2026	Q1 2026	Q1 2026	-	$24
414 km loop (Werris Creek North)	-	Q1 2027	Q1 2027	-	$40
407 km loop (Werris Creek South)	-	-	-	-	-
Bells Gate south extension	-	Q1 2028	Q1 2028	-	$52
Braefield north extension	-	-	-	-	-
Kankool—Ardglen	-	-	-	-	-
Pages River North extension	-	-	-	-	-
Blandford loop	-	-	-	-	-
Wingen loop	Q1 2028	Q1 2027	Q1 2027	-	$24
Togar North Loop	-	Q1 2027	Q1 2027	-	$24
Aberdeen	-	-	-	-	-
Ulan Line					
Widden Creek	-	-	-	-	-
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

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.8	4.8	4.3	4.3	4.3	4.3	4.3	4.3
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.1	14.9	13.8	13.6	13.6	13.6	13.6	13.6
Vickery - Gunnedah	17.5	17.5	17.5	17.5	17.6	17.6	17.6	17.6	17.5	17.6	16.5	16.5	16.5	16.5	16.5	16.5
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	19.0	17.9	17.9	17.9	17.9	17.9	17.9
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	17.2	17.2	17.2	17.2	17.2	17.2
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	13.1	13.9	13.9	13.9	13.9	13.9
Scone - Dartbrook	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.8	12.9	14.5	14.5	14.5	14.5	14.5	14.5
Dartbrook - Muswellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	42.4	42.4	42.4	42.4	42.4
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	9.6	9.6	9.8	10.1	10.3
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	9.6	9.6	9.8	10.1	10.3
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	15.6	15.6	15.6	15.7	15.7
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	13.7	13.7	13.7	13.7	13.7
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.3	20.5	20.6	20.6	20.5	20.6	21.0
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	27.6	27.5	27.5	27.7	27.7
Mt Pleasant - Bengalla	19.1	19.1	19.1	19.1	19.0	19.0	19.0	19.0	19.0	19.1	18.0	17.7	17.5	17.3	17.6	17.4
Bengalla - Muswellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	29.8	29.0	28.7	31.3	31.3
Muswellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Drayton - Newdell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2
Newdell - Mt Owen	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1
Mt Owen - Camberwell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Camberwell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.7	14.7	14.7	14.7	14.4	14.4	14.4	14.4	14.0	14.0	12.3	12.3	12.3	12.3	12.3	12.3
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	43.9	43.3	40.0	39.4	39.4	39.4	39.4	39.4
Vickery - Gunnedah	50.8	50.8	50.8	50.8	51.0	51.0	51.0	51.0	50.9	51.0	47.9	48.0	48.0	48.0	48.0	48.0
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	55.1	51.9	51.9	51.8	51.8	51.8	51.8
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	50.0	50.0	50.0	50.0	50.0	50.0
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	37.9	40.5	40.5	40.5	40.5	40.5
Scone - Dartbrook	36.9	36.9	36.9	36.9	37.0	37.0	37.0	37.0	37.2	37.4	42.0	42.0	42.0	42.0	42.0	42.0
Dartbrook - Muswellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	123.1	123.1	123.1	123.1	123.1
Ulan - Moolarben	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.9	31.8	32.0	32.6	33.6	34.2
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.9	31.8	32.0	32.6	33.6	34.2
Wilpinjong - Bylong	53.8	53.8	53.8	53.8	53.9	53.9	53.9	53.9	54.0	54.1	51.4	51.4	51.5	51.4	51.3	51.2
Bylong - Ferndale	47.5	47.5	47.5	47.5	47.6	47.6	47.6	47.6	47.6	47.5	45.2	45.2	45.3	45.2	44.7	44.6
Ferndale - Mangoola	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	71.1	70.2	67.6	67.7	67.8	67.5	67.3	68.4
Mangoola - Mt Pleasant	95.3	95.3	95.3	95.3	95.5	95.5	95.5	95.5	95.6	95.6	90.9	91.0	90.6	90.4	90.5	90.1
Mt Pleasant - Bengalla	62.7	62.7	62.7	62.7	62.6	62.6	62.6	62.6	62.6	63.0	59.3	58.3	57.6	56.8	57.6	56.5
Bengalla - Muswellbrook	100.1	100.1	100.1	100.1	100.6	100.6	100.6	100.6	101.1	103.7	97.5	97.4	94.6	93.6	101.6	101.2
Muswellbrook -Drayton	292.7	292.7	292.7	292.7	292.1	292.1	292.1	292.1	291.6	290.9	289.8	289.1	289.1	288.3	286.5	284.9
Drayton - Newdell	256.4	256.4	256.4	256.4	255.8	255.8	255.8	255.8	256.1	255.5	254.6	253.7	253.4	252.4	250.4	248.7
Newdell - Mt Owen	365.8	365.8	365.8	365.8	365.0	365.0	365.0	365.0	365.3	364.5	363.4	362.3	362.1	361.0	359.0	357.5
Mt Owen - Camberwell	280.8	280.8	280.8	280.8	280.1	280.1	280.1	280.1	280.4	279.7	278.9	278.0	277.7	276.6	275.1	273.9
Camberwell - Whittingham	281.0	281.0	281.0	281.0	280.3	280.3	280.3	280.3	280.6	279.9	279.1	278.2	277.9	276.9	275.5	274.3
Whittingham - Maitland	289.5	289.5	289.5	289.5	288.9	288.9	288.9	288.9	291.4	295.2	294.4	293.7	293.4	292.5	291.4	290.6
Maitland - Bloomfield	466.2	466.2	466.2	466.2	465.7	465.7	465.7	465.7	469.9	476.1	474.9	473.6	473.2	471.8	470.0	468.7
Bloomfield - Hexham	466.2	466.2	466.2	466.2	465.7	465.7	465.7	465.7	469.9	476.1	474.9	473.6	473.2	471.8	470.0	468.7

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.8	4.8	4.3	5.9	5.9	5.9	5.9	5.9
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.1	14.9	13.8	19.0	19.0	19.0	19.0	19.0
Vickery - Gunnedah	17.5	17.5	17.5	17.5	17.6	17.6	17.6	17.6	17.5	17.6	16.5	21.7	21.7	21.7	21.7	21.7
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.0	13.2	13.2	13.2	13.2	13.2
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.0	17.0	17.0	17.0	17.0	17.0
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	11.4	15.1	15.1	15.1	15.1	15.1
Scone - Dartbrook	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.8	12.9	12.1	16.0	16.0	16.0	16.0	16.0
Dartbrook - Muswellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	53.5	53.5	53.5	53.5	53.5
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.5	11.5	11.8	12.3	12.6
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.5	11.5	11.8	12.3	12.6
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	19.5	19.5	19.5	19.6	19.6
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	16.9	16.9	16.9	16.9	16.9
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.3	20.5	26.1	26.1	26.0	26.1	26.6
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	36.8	36.6	36.6	37.0	37.0
Mt Pleasant - Bengalla	19.1	19.1	19.1	19.1	19.0	19.0	19.0	19.0	19.0	19.1	18.0	22.2	21.9	21.6	22.3	22.0
Bengalla - Muswellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	39.7	38.3	37.9	42.1	42.1
Muswellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Drayton - Newdell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	195.9
Newdell - Mt Owen	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	195.9
Mt Owen - Camberwell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Camberwell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.7	14.7	14.7	14.7	14.4	14.4	14.4	14.4	14.0	14.0	12.3	17.1	17.1	17.1	17.1	17.1
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	43.9	43.3	40.0	55.2	55.2	55.2	55.2	55.2
Vickery - Gunnedah	50.8	50.8	50.8	50.8	51.0	51.0	51.0	51.0	50.9	51.0	47.9	63.1	63.1	63.1	63.1	63.1
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	29.2	38.4	38.4	38.4	38.4	38.4
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	34.8	49.3	49.2	49.2	49.2	49.2
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	33.2	43.8	43.8	43.8	43.8	43.8
Scone - Dartbrook	36.9	36.9	36.9	36.9	37.0	37.0	37.0	37.0	37.2	37.4	35.2	46.5	46.5	46.5	46.5	46.4
Dartbrook - Muswellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	155.3	155.3	155.3	155.3	155.3
Ulan - Moolarben	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.9	38.0	38.2	39.3	40.9	41.7
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.9	38.0	38.2	39.3	40.9	41.7
Wilpinjong - Bylong	53.8	53.8	53.8	53.8	53.9	53.9	53.9	53.9	54.0	54.1	51.4	64.2	64.3	64.2	64.2	64.0
Bylong - Ferndale	47.5	47.5	47.5	47.5	47.6	47.6	47.6	47.6	47.6	47.5	45.2	55.8	55.8	55.7	55.1	54.9
Ferndale - Mangoola	70.8	70.8	70.8	70.8	70.8	70.8	70.8	70.8	71.1	70.2	67.6	85.9	85.9	85.7	85.4	86.7
Mangoola - Mt Pleasant	95.3	95.3	95.3	95.3	95.5	95.5	95.5	95.5	95.6	95.6	90.9	121.3	120.7	120.4	120.7	120.2
Mt Pleasant - Bengalla	62.7	62.7	62.7	62.7	62.6	62.6	62.6	62.6	62.6	63.0	59.3	73.0	72.0	71.1	72.7	71.5
Bengalla - Muswellbrook	100.1	100.1	100.1	100.1	100.6	100.6	100.6	100.6	101.1	103.7	97.5	129.6	125.2	123.6	136.6	136.1
Muswellbrook -Drayton	292.7	292.7	292.7	292.7	292.1	292.1	292.1	292.1	291.6	290.9	289.8	289.1	289.1	288.3	286.5	602.0
Drayton - Newdell	256.4	256.4	256.4	256.4	255.8	255.8	255.8	255.8	256.1	255.5	254.6	253.7	253.4	252.4	250.4	600.2
Newdell - Mt Owen	365.8	365.8	365.8	365.8	365.0	365.0	365.0	365.0	365.3	364.5	363.4	362.3	362.1	361.0	359.0	608.2
Mt Owen - Camberwell	280.8	280.8	280.8	280.8	280.1	280.1	280.1	280.1	280.4	279.7	278.9	278.0	277.7	276.6	275.1	608.2
Camberwell - Whittingham	281.0	281.0	281.0	281.0	280.3	280.3	280.3	280.3	280.6	279.9	279.1	278.2	277.9	276.9	275.5	609.1
Whittingham - Maitland	289.5	289.5	289.5	289.5	288.9	288.9	288.9	288.9	291.4	295.2	294.4	293.7	293.4	292.5	291.4	613.9
Maitland - Bloomfield	466.2	466.2	466.2	466.2	465.7	465.7	465.7	465.7	469.9	476.1	474.9	473.6	473.2	471.8	470.0	674.9
Bloomfield - Hexham	466.2	466.2	466.2	466.2	465.7	465.7	465.7	465.7	469.9	476.1	474.9	473.6	473.2	471.8	470.0	674.9

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 tonnage capacity is equal to table 8-9 times average train size times 365.

Recommended projects - Prospective Volume Scenario	2022 Strategy – Proposed by (Without ATMS)	2023 Strategy – Required by (Note 1)	2023 Strategy – Proposed by without ATMS	2023 Strategy—Proposed by with ATMS	Estimated Cost ($m) Present Value
Scope as per contracted volume, plus					
Gunnedah Basin Line					
South Gunnedah loop	Q3 2024	Q1 2025	Q1 2025	Q1 2025	$24
Burilda north extension	-	-	-	-	-
414 km loop (Werris Creek North)	Q1 2026	Q1 2027	Q1 2027	-	$40
407 km loop (Werris Creek South)	-	-	-	-	-
Bells Gate south extension	Q1 2026	Q1 2028	Q1 2028	-	$52
Braefield north extension	-	-	-	-	-
Kankool—Ardglen	-	-	-	-	-
Pages River North extension	-	-	-	-	-
Blandford loop	Q1 2027	-	-	-	-
Wingen loop	Q1 2025	Q1 2027	Q1 2027	-	$24
Togar North Loop	Q1 2025	Q1 2027	Q1 2027	-	$24
Aberdeen	-	-	-	-	-
Ulan Line					
Murrumbo west extension	-	-	-	-	-
Widden Creek	-	-	-	-	-
Port—Muswellbrook					
Nil	-	-	-	-	-
Congestion Projects					
Train Parkup	TBM	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

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.3	4.3	4.3	4.3	4.3	4.3
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.1	14.9	13.8	13.6	13.6	13.6	13.6	13.6
Vickery - Gunnedah	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.6	16.5	16.5	16.5	16.5	16.5	16.5
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	19.0	19.0	17.9	17.9	17.9	17.9	17.9	17.9
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	17.2	17.2	17.2	17.2	17.2	17.2
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	13.1	13.9	13.9	13.9	13.9	13.9
Scone - Dartbrook	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	15.5	12.9	14.5	14.5	14.5	14.5	14.5	14.5
Dartbrook - Muswellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	42.4	42.4	42.4	42.4	42.4
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.8	9.8	9.8	9.8	9.9	10.2	9.6	9.5	9.6	9.8	10.0	10.0
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.8	9.8	9.8	9.8	9.9	10.2	9.6	9.5	9.6	9.8	10.0	10.0
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	15.6	15.6	15.6	15.7	15.7
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	13.7	13.7	13.7	13.7	13.7
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.4	20.5	20.5	20.6	20.6	20.6	21.0
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	27.6	27.5	27.5	27.7	27.7
Mt Pleasant - Bengalla	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.3	18.1	17.9	17.6	17.4	17.7	17.6
Bengalla - Muswellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	29.8	29.0	28.7	31.3	31.3
Muswellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Drayton - Newdell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2
Newdell - Mt Owen	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1
Mt Owen - Camberwell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Camberwell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.0	14.0	12.3	12.3	12.3	12.3	12.3	12.3
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	43.9	43.3	40.0	39.4	39.4	39.4	39.4	39.4
Vickery - Gunnedah	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	51.0	47.9	48.0	48.0	48.0	48.0	48.0
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	55.1	55.1	51.9	51.9	51.8	51.8	51.8	51.8
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	50.0	50.0	50.0	50.0	50.0	50.0
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	37.9	40.5	40.5	40.5	40.5	40.5
Scone - Dartbrook	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	45.1	37.5	42.0	42.0	42.0	42.0	42.0	42.0
Dartbrook - Musw ellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	123.1	123.1	123.1	123.1	123.1
Ulan - Moolarben	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.8	31.7	31.8	30.9	32.8	33.3
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.9	33.9	31.8	31.7	31.8	31.2	33.1	33.3
Wilpinjong - Bylong	53.7	53.7	53.7	53.7	53.8	53.8	53.8	53.8	53.9	54.0	51.3	51.2	51.3	47.0	37.6	37.7
Bylong - Ferndale	47.4	47.4	47.4	47.4	47.5	47.5	47.5	47.5	47.5	47.4	45.1	45.1	45.1	41.4	32.7	32.8
Ferndale - Mangoola	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.8	70.3	67.4	67.3	67.6	61.8	49.3	50.4
Mangoola - Mt Pleasant	95.1	95.1	95.1	95.1	95.3	95.3	95.3	95.3	95.3	95.5	90.7	90.7	90.3	68.8	56.5	62.7
Mt Pleasant - Bengalla	62.8	62.8	62.8	62.8	62.9	62.9	62.9	62.9	62.8	63.2	59.4	58.7	57.8	43.4	36.1	39.8
Bengalla - Musw ellbrook	99.9	99.9	99.9	99.9	100.5	100.5	100.5	100.5	100.9	103.6	97.4	97.2	94.4	72.0	69.8	74.3
Musw ellbrook -Drayton	292.0	292.0	292.0	292.0	291.7	291.7	291.7	291.7	290.9	291.1	289.8	289.2	289.1	199.5	182.8	189.1
Drayton - New dell	256.2	256.2	256.2	256.2	255.9	255.9	255.9	255.9	255.5	255.7	254.7	254.2	254.1	175.7	164.6	172.4
New dell - Mt Ow en	365.8	365.8	365.8	365.8	365.1	365.1	365.1	365.1	364.6	364.7	363.5	362.8	362.9	269.7	259.8	269.6
Mt Ow en - Camberw ell	281.0	281.0	281.0	281.0	280.3	280.3	280.3	280.3	280.1	280.1	279.3	278.7	278.6	201.2	193.2	200.2
Camberw ell - Whittingham	281.3	281.3	281.3	281.3	280.6	280.6	280.6	280.6	280.4	280.4	279.6	279.0	278.9	200.8	192.9	199.8
Whittingham - Maitland	288.6	288.6	288.6	288.6	287.8	287.8	287.8	287.8	287.7	295.6	294.8	294.3	294.2	217.2	210.2	216.2
Maitland - Bloomfield	460.9	460.9	460.9	460.9	463.8	463.8	463.8	463.8	464.0	476.8	475.5	474.7	474.6	350.3	339.1	348.7
Bloomfield - Hexham	460.9	460.9	460.9	460.9	463.8	463.8	463.8	463.8	464.0	476.8	475.5	474.7	474.6	350.3	339.2	348.8

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.3	5.9	5.9	5.9	5.9	5.9
Boggabri - Vickery	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.1	14.9	13.8	19.0	19.0	19.0	19.0	19.0
Vickery - Gunnedah	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.6	16.5	21.7	21.8	21.8	21.8	21.8
Gunnedah - Watermark Jct	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	19.0	19.0	17.9	23.7	23.7	23.7	23.7	23.7
Watermark Jct - Werris Creek	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.0	17.0	17.0	17.0	17.0	17.0
Werris Creek - Scone	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	11.4	15.1	15.1	15.1	15.1	15.1
Scone - Dartbrook	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.9	12.9	12.1	16.0	16.0	16.0	16.0	16.0
Dartbrook - Musw ellbrook	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	44.9	42.4	53.5	53.5	53.5	53.5	53.5
Ulan - Moolarben	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.4	11.4	11.7	12.2	12.2
Moolarben - Wilpinjong	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.9	10.2	9.6	11.4	11.4	11.7	12.2	12.2
Wilpinjong - Bylong	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	15.6	19.5	19.5	19.5	19.6	19.6
Bylong - Ferndale	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.4	13.7	16.9	16.9	16.9	16.9	16.9
Ferndale - Mangoola	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.6	21.4	20.5	26.0	26.1	26.1	26.1	26.6
Mangoola - Mt Pleasant	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.1	27.6	36.8	36.6	36.6	37.0	37.0
Mt Pleasant - Bengalla	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.1	19.3	18.1	22.4	22.0	21.7	22.3	22.2
Bengalla - Musw ellbrook	30.6	30.6	30.6	30.6	30.7	30.7	30.7	30.7	30.8	31.7	29.8	39.7	38.3	37.9	42.1	42.1
Musw ellbrook -Drayton	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Drayton - New dell	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	81.2	195.9
New dell - Mt Ow en	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	115.1	195.9
Mt Ow en - Camberw ell	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Camberw ell - Whittingham	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	195.9
Whittingham - Maitland	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	92.7	195.9
Maitland - Bloomfield	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3
Bloomfield - Hexham	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	149.5	215.3

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.

	2023				2024				2025	2026	2027	2028	2029	2030	2031	2032
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	Q1	Q1	Q1	Q1
Narrabri - Boggabri	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.0	14.0	12.3	17.1	17.1	17.1	17.1	17.1
Boggabri - Vickery	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	43.9	43.3	40.0	55.2	55.2	55.2	55.2	55.2
Vickery - Gunnedah	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	50.7	51.0	47.9	63.1	63.1	63.1	63.1	63.1
Gunnedah - Watermark Jct	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	55.1	55.1	51.9	68.8	68.8	68.8	68.8	68.8
Watermark Jct - Werris Creek	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	34.8	49.3	49.2	49.2	49.2	49.2
Werris Creek - Scone	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	33.2	43.8	43.8	43.8	43.8	43.8
Scone - Dartbrook	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.6	37.5	35.2	46.5	46.5	46.5	46.5	46.5
Dartbrook - Muswellbrook	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	130.3	123.1	155.3	155.3	155.3	155.3	155.3
Ulan - Moolarben	32.1	32.1	32.1	32.1	32.4	32.4	32.4	32.4	32.8	33.8	31.8	37.7	37.9	37.1	39.9	40.4
Moolarben - Wilpinjong	32.2	32.2	32.2	32.2	32.4	32.4	32.4	32.4	32.8	33.8	31.8	37.7	37.9	37.5	40.3	40.4
Wilpinjong - Bylong	53.7	53.7	53.7	53.7	53.8	53.8	53.8	53.8	53.9	54.0	51.3	64.0	64.0	58.7	47.0	47.1
Bylong - Ferndale	47.4	47.4	47.4	47.4	47.5	47.5	47.5	47.5	47.5	47.4	45.1	55.5	55.5	51.0	40.3	40.4
Ferndale - Mangoola	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.5	70.8	70.3	67.4	85.3	85.7	78.4	62.5	63.9
Mangoola - Mt Pleasant	95.1	95.1	95.1	95.1	95.3	95.3	95.3	95.3	95.3	95.5	90.7	120.9	120.2	91.6	75.4	83.6
Mt Pleasant - Bengalla	62.8	62.8	62.8	62.8	62.9	62.9	62.9	62.9	62.8	63.2	59.4	73.3	72.2	54.3	45.5	50.3
Bengalla - Muswellbrook	99.9	99.9	99.9	99.9	100.5	100.5	100.5	100.5	100.9	103.6	97.4	129.4	124.9	95.2	93.9	99.9
Muswellbrook -Drayton	292.0	292.0	292.0	292.0	291.7	291.7	291.7	291.7	290.9	291.1	289.8	289.2	289.1	199.5	182.8	399.6
Drayton - Newdell	256.2	256.2	256.2	256.2	255.9	255.9	255.9	255.9	255.5	255.7	254.7	254.2	254.1	175.7	164.6	416.0
Newdell - Mt Owen	365.8	365.8	365.8	365.8	365.1	365.1	365.1	365.1	364.6	364.7	363.5	362.8	362.9	269.7	259.8	458.7
Mt Owen - Camberwell	281.0	281.0	281.0	281.0	280.3	280.3	280.3	280.3	280.1	280.1	279.3	278.7	278.6	201.2	193.2	444.5
Camberwell - Whittingham	281.3	281.3	281.3	281.3	280.6	280.6	280.6	280.6	280.4	280.4	279.6	279.0	278.9	200.8	192.9	443.5
Whittingham - Maitland	288.6	288.6	288.6	288.6	287.8	287.8	287.8	287.8	287.7	295.6	294.8	294.3	294.2	217.2	210.2	456.8
Maitland - Bloomfield	460.9	460.9	460.9	460.9	463.8	463.8	463.8	463.8	464.0	476.8	475.5	474.7	474.6	350.3	339.1	502.1
Bloomfield - Hexham	460.9	460.9	460.9	460.9	463.8	463.8	463.8	463.8	464.0	476.8	475.5	474.7	474.6	350.3	339.2	502.2

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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