AUSTRALIAN RAIL TRACK CORPORATION LTD

ARTC HUNTER VALLEY ACCESS UNDERTAKING

SPECIFICATION OF FINAL INDICATIVE SERVICE (EFFICIENT TRAIN CONFIGURATION)

CONSULTATION PAPER

OCTOBER 2013

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EXECUTIVE SUMMARY

CONTEXT

The ARTC's Hunter Valley Rail Access Undertaking (**HVAU**) provides for access by Coal Trains to the Hunter Valley rail network (**Network**). Pricing for access is by way of published prices for an indicative service, with prices for non-indicative services determined with reference to the price for the indicative service and incremental cost and capacity impacts.

At the time of commencement of the HVAU, insufficient information was available to definitively establish the indicative service specification and an Interim Indicative Service and later, an Initial Indicative Service, were specified. The Final Indicative Service (**FIS**) is intended to be the configuration of Hunter Valley Coal Train services which delivers the optimum utilisation of Coal Chain Capacity, given certain System Assumptions.

HVAU section 4.18 sets out the process for the determination, approval and implementation of the FIS. The proposed characteristics of the FIS are to be developed in consultation with the Hunter Valley Coal Chain Coordinator (**HVCCC**), Access Holders and Operators. This paper sets out ARTC's proposed FIS configuration and seeks stakeholder comment prior to ARTC submitting a variation of the HVAU to the Australian Competition & Consumer Commission (**ACCC**) for approval of the FIS and resulting changes to the HVAU.

CONSULTATION

A key requirement of HVAU section 4.18 is that ARTC consult with stakeholders on the determination of the FIS. As part of that consultation process, ARTC convened a Stakeholder Reference Group (**SRG**). This group consisted of 9 industry representatives from Access Holders, Operators & Terminal Operators in addition to delegates from the HVCCC & ARTC. The SRG initially met in July 2012 where several key issues were addressed to achieve a consensus on how to progress the FIS review. The topics included;

- Modelling methodology and analysis
- Parameters & constraints
- Basis of measurement of 'optimal'

The SRG met a total of 4 times during the period of review with modelling updates and scenarios being presented for comment and feedback.

Following on from that consultation, this paper represents the next step, giving all stakeholders the opportunity to comment on the FIS prior to a submission being made to the ACCC to incorporate the FIS into the HVAU.

MODELLING

The determination of what train configuration delivers the optimum utilisation of Coal Chain Capacity is complex and requires whole of coal chain modelling. ARTC is not in a position to carry out this modelling and has been assisted by the HVCCC which does have such a capability, albeit that this capability has its limitations. The HVCCC model simulates the movement of coal through the coal chain from load point to ship.

Using the HVCCC model a number of train configurations were tested to determine the volume of coal that could be delivered. In order to define a set of configurations, ARTC considered the possible future configuration of the Network and direction of rolling stock options over the medium term. This included the possible increase in axle load, train speed, train length and structure gauge. Some of these possible changes have been discounted on the grounds of pragmatism as being unlikely to occur within the foreseeable future. As a consequence of these considerations, ARTC has come to the view that practical enhancements to existing constraints are most likely to occur in either increasing axle load limits or length limits. This view has then determined the set of train configurations to be tested. As a further complication, the modelling needed to take into account the likelihood that the Gunnedah Basin trains could not achieve the larger configurations being tested for the remainder of the network, although this possibility was tested.

MODELLING RESULTS

The modelling considered each train configuration in two states,

- with an unrestricted shipping queue, and
- with a queue restricted to 20 ships, the so called 'demurrage neutral' queue.

ARTC considers the restricted queue is the more realistic view. In all cases, the restriction of the queue lowered the total coal chain throughput.

The tests were also run with the Gunnedah Basin trains set at one of three options:

Option 1: mass for all Gunnedah trains limited to the current maximum, ie at 25 tonne axle load (**TAL**).

Option 2: mass for all Gunnedah trains at 30TAL, a configuration that is likely to be achieved in the next few years. Option 2 was only tested for two train configurations to confirm intuitive expectations.

Option 3 mass for all Gunnedah trains set equivalent to the same as for central and western Hunter Valley trains.

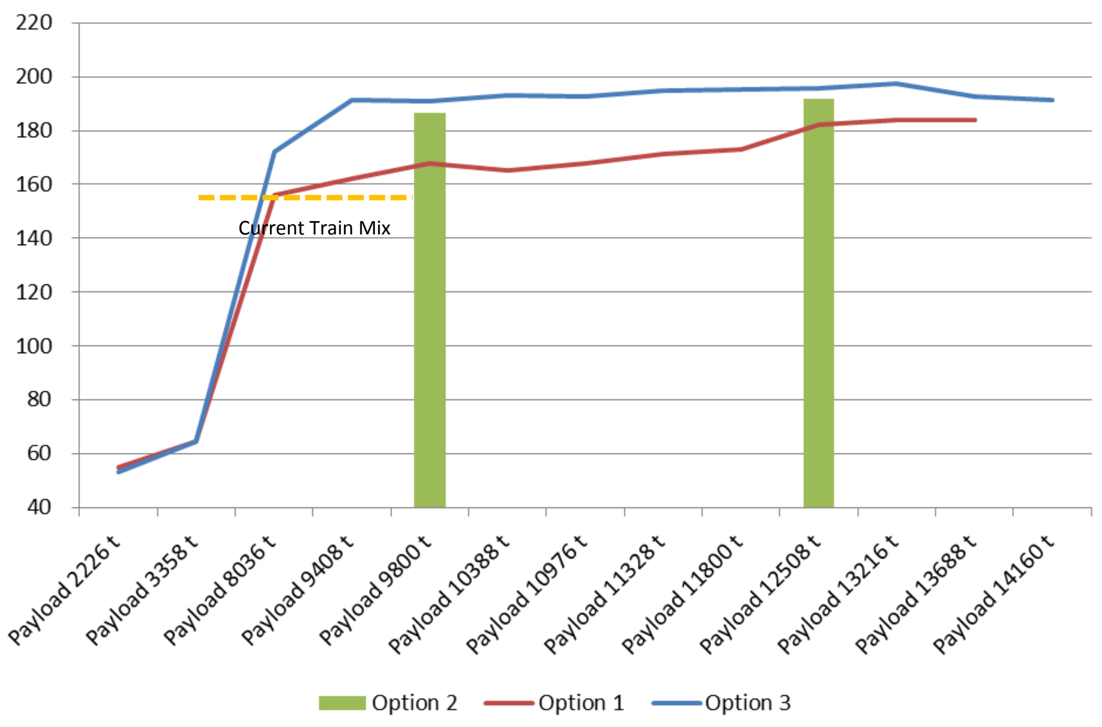
The results of the tests for the restricted shipping queue are set out in Figure 1.

The results demonstrate the large gains in Coal Chain Capacity as train payload increases. These gains are then capped as demand approaches the modelled maximum of 208 million tonnes per annum (**mtpa**) which reflects current contracted volumes.

The HVCCC was not able to carry out modelling for larger volume demand profiles as neither ARTC nor the two Terminal Operators have contracts in excess of 208 mtpa. The modelling is dependent on a precise location and profile of demand and it is known that the model is very sensitive to demand location. Therefore, it was not possible to gain a reliable indication from the model how the various train configurations might perform under circumstances in excess of 208 mtpa.

It should be noted that the fact that none of the train configurations delivered the full 208 mtpa is an artefact of the modelling and does not reflect any likely shortfall in capacity in reality. The results should be viewed merely as demonstrating the relative performance of the train configurations only.

Figure 1: Volumes Delivered With Adjusted Shipping Queue (20 ships) (mtpa)



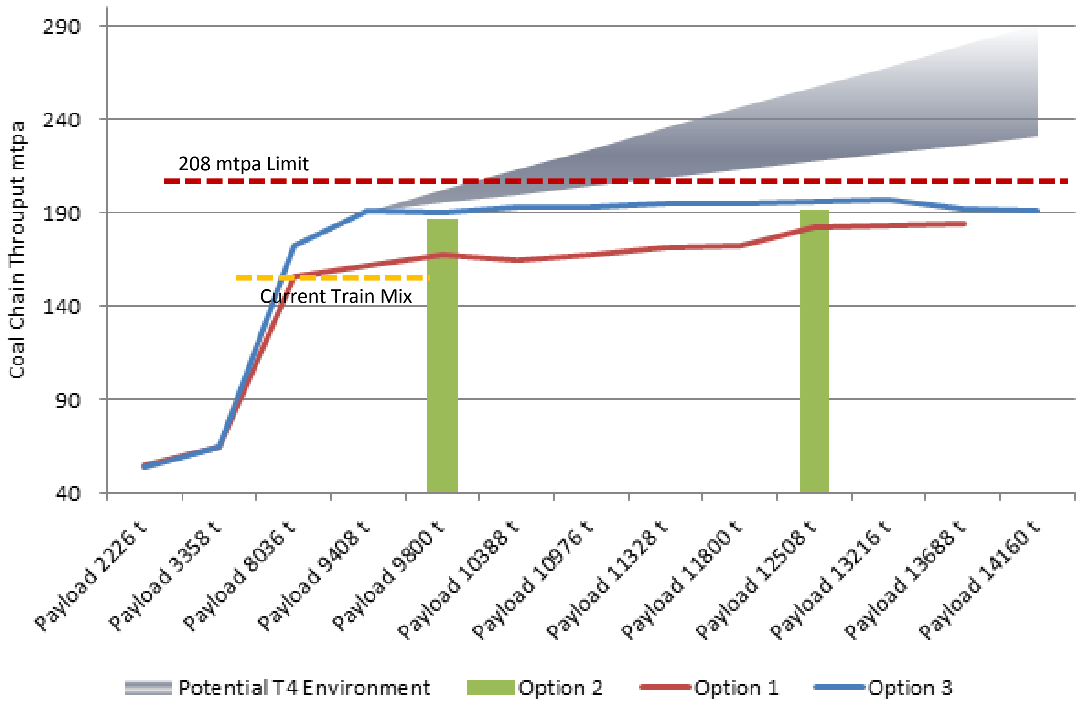
BEYOND 208 MTPA

ARTC is of the view that volumes have a potential to continue to expand beyond the currently contracted 208 mtpa within the medium term but is not in a position to the confidently predict either the size or the location of additional volumes. However, ARTC believes that it is more likely that coal hauls will become progressively longer as mines move further west and north with the exhaustion of existing mines and the commencement of new ones further afield. This suggests that the rail task will continue to increase, placing further stress on available capacity and favouring the use of higher payload trains.

As train payload increases, for any given total volume the number of trains will decrease. This has important implications for reducing capacity requirements and forestalling expensive additional track construction to the Network.

Notwithstanding the limitations of existing modelling, the HVCCC and ARTC have considered what the impact of higher volumes would have on Coal Chain Capacity and the selection of the FIS configuration. As a qualitative view only, Figure 2 attempts show the anticipated range of benefits in Coal Chain Capacity that would result from the operation of the larger train sizes at volumes above 208 mtpa. This is shown as the grey cone labelled 'Potential T4 Environment' and reflects the expectation that larger trains will use Coal Chain Capacity more efficiently at volumes above 208 mtpa. It must be stressed that this depiction is qualitative only and should not be taken to represent a quantitative assessment.

Figure 2: Indicative Benefit Beyond 208 mtpa



OTHER CONSIDERATIONS

Train configurations within the Network continue to evolve, successfully pushing the boundaries of train payloads. Over the foreseeable future, it can be expected that this will continue, regardless of the FIS, given the benefits to Operators and Access Holders from higher payload trains.

ARTC is aware that the differentiation of access charges that arise from the adoption of the FIS seeks to provide a pricing signal that will encourage adoption of the more efficient FIS, but that the economics of other factors will compete with this pricing signal. ARTC cannot influence those other pricing signals; nevertheless, providing a signal that encourages adoption of, or moving closer to, the FIS will be one step towards promoting efficient use of Coal Chain Capacity.

CONCLUSION

The modelling places emphasis on train payload, and existing infrastructure limitations were deliberately assumed to be avoidable. In considering the various means by which train efficiency could be enhanced, ARTC has come to the conclusion that either one of two parameters would achieve the desired result; either trains could be lengthened or axle loads increased, or potentially a combination of both.

With these considerations in mind, ARTC is proposing two configurations for an FIS. Both configurations are future focussed, ie they are train configurations that might not be able to be operated on the Network as it is presently configured. The proposed FIS configurations both have a payload of 11,800 t. This can be achieved by:

- a train of 30TAL with a length of 1,914 m, or
- a train of 35TAL with a length of 1,606m.

The 'Long FIS' could currently operate only to the NCIG coal terminal and could run to selected load points as far west as Mangoola. To extend the operation of this train configuration to all central and western load points would require infrastructure enhancements to the two PWCS coal terminals and crossing loops west of Mangoola. It would also require some load points and other facilities to be modified.

The 'Axle Load FIS' configuration is not currently permitted to operate on the Network and would require upgrading of much of the Network but would fit within the length constraints currently standard across the central and western Hunter Valley Network.

These configurations both have the potential to decrease train movements by up to 20% compared to the current Initial Indicative Service.

The adoption of these FIS configurations will require an as yet unknown level of capital expenditure and may also have operating cost impacts for various service providers. However, the level of productivity increase and cost benefits to coal chain participants suggests that the adoption of the proposed configurations have the potential to be economically feasible.

Notwithstanding that the FIS may not currently be operated or may only be operated in limited circumstances, the HVAU pricing mechanism will provide for pricing to reward incremental changes to train configurations that move towards more efficient use of the Coal Chain Capacity.

1 INTRODUCTION

1.1 Purpose

The purpose of this consultation paper is to set out the process undertaken by Australian Rail Track Corporation (**ARTC**) to select a Final Indicative Service (**FIS**) as required under section 4.18 of ARTC's Hunter Valley Coal Network Access Undertaking (**HVAU**). Once approved by the Australian Competition & Consumer Commission (**ACCC**) and implemented, the FIS will supersede the earlier 'Initial Indicative Service'.

1.2 Context

ARTC operates the Hunter Valley coal rail infrastructure (**Network**) in central and northern New South Wales. The economic and commercial aspects of the network are regulated by the ACCC through operation of the HVAU. The HVAU was approved by the ACCC on 23 June 2011 and came into operation 1 July 2011. An amended version prescribing the Initial Indicative Service was approved by the ACCC on 17 October 2012.

Of relevance to this consultation paper, the pricing for access to the network under the HVAU is determined by reference to an Indicative Service. Prices are published for trains operating in accordance with the relevant Indicative Service. Train configurations may vary from the Indicative Service and prices for such trains are determined through an assessment of the relative cost impact, either directly or through impacts on Capacity and Coal Chain Capacity, compared to those of the Indicative Service.

At the time of the commencement of the HVAU, modelling of the optimal train configuration for the Indicative Service had not been completed. Such modelling is complex and requires a view of the whole of the Hunter Valley coal chain. Therefore, an Interim Indicative Service was identified, based on train configurations in operation at that time. Subsequently, preliminary modelling was used to determine the optimal train configuration given existing infrastructure constraints. This was implemented as the Initial Indicative Service. Further modelling has now been undertaken by the Hunter Valley coal chain Coordinator (**HVCCC**) and additional consideration undertaken by ARTC, in consultation with others, in order to allow this paper to set out the FIS, which is intended to be the optimal train configuration that will deliver the optimum utilisation of Coal Chain Capacity.

1.3 Requirements Of The HVAU

HVAU section 4.18 sets out the process for the determination, approval and implementation of the FIS. For ease of reference, section 4.18 has been included in this consultation paper in Appendix A.

In summary, within 30 months of the commencement of the HVAU, ie by 31 December 2013, ARTC is required to:

a) in consultation with the HVCCC, Access Holders and Operators, develop the proposed characteristics of the indicative service which ARTC considers will deliver the optimum utilisation of Coal Chain Capacity, given certain System Assumptions, including scenarios under which System Assumptions are also varied in addition to the Coal Train configurations.

b) consult with the HVCCC, Access Holders and Operators as to whether gtkm is the appropriate pricing unit to encourage efficient consumption of Capacity.

c) once the consultation process is complete, submit an amendment to the HVAU to incorporate the FIS and any proposed change to the pricing structure to the ACCC for approval.

This consultation paper sets out the proposed FIS and the process undertaken to date (ie task (a)). ARTC will issue a separate consultation paper discussing the appropriate pricing unit (ie task (b)).

1.4 Consultation

A key requirement of HVAU section 4.18 is that ARTC consult with various coal chain stakeholders. In order to fulfil this requirement, the project was set up so that, not only would ARTC work closely with the HVCCC to determine the FIS, but that a representative group of stakeholders (the Stakeholder Reference Group or **SRG**) would participate from the early stages of the work. The SRG provided a forum in which industry could guide the work for the determination of the FIS and provide feedback on the modelling as work progressed.

Participation in the project by various stakeholder groups is set out in Figure 3.

In June 2012 ARTC sought nominations from stakeholders to form the SRG. The SRG consisted of 9 industry representatives from Access Holders, Operators & Terminal Operators. In addition there were delegates from HVCCC & ARTC. The SRG met for the first time in July 2012 where several key issues were addressed to achieve a consensus on how to progress the FIS review. The topics included;

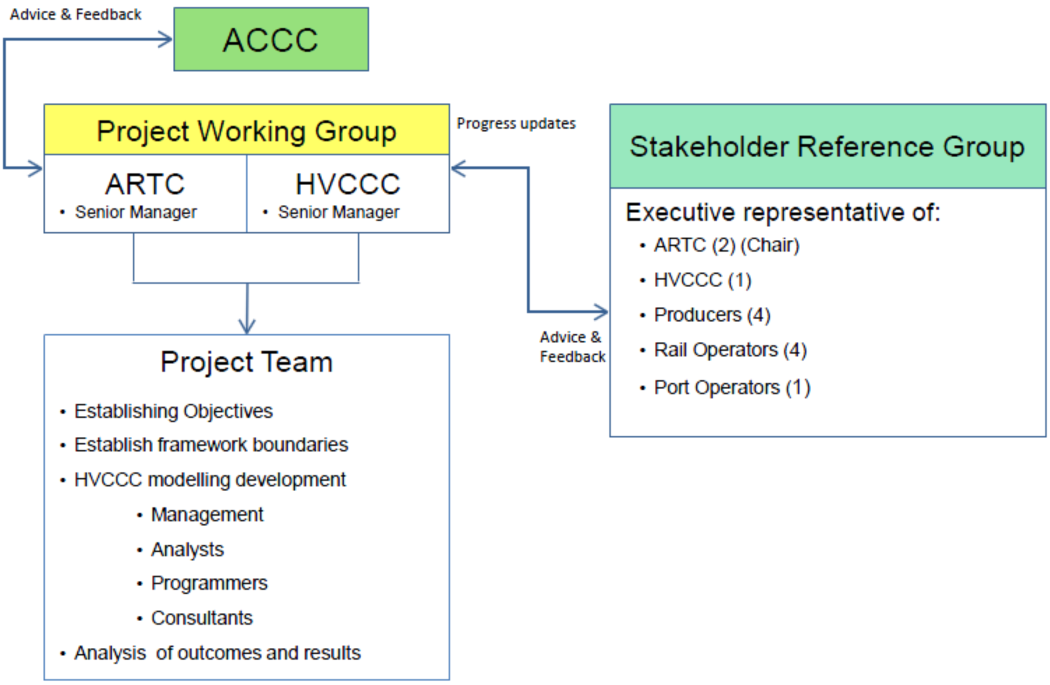
- Modelling methodology & Analysis
- Parameters & Constraints
- Basis of Measurement of “optimal”

The SRG met a total of 4 times during the period of review with modelling updates and scenarios being presented for comment and feedback.

In addition, ARTC made available the minutes and presentations from these meetings to all other coal chain participants and also provided a briefing of progress at the quarterly meetings held with each Access Holder.

The work is now at a stage that it is appropriate to consult more broadly with all stakeholders and this discussion paper provides an opportunity for comment on ARTC's proposed FIS.

Figure 3: Participants In The FIS Selection Process



1.5 Request For Comments

ARTC invites submissions from stakeholders on the proposed FIS. In particular, ARTC is seeking comments on whether the stakeholder supports the adoption of the proposed FIS, or if not, the alternative characteristics that the stakeholder proposes should be adopted and the related reasons. Submissions may refer to any relevant issue.

Any proposed alternative FIS should be sufficiently described so as to allow ARTC and the HVCCC to evaluate the proposal, and should include any analysis undertaken by the proponent to demonstrate why the alternative is to be preferred.

Submissions should be made in writing and preferably submitted electronically to the email address below. Hard copies are not required. Recognising the level of consultation that has already taken place with stakeholders and the information previously provided, and also the timing constraints of the HVAU, a relatively short period is allowed for submissions. The closing date for submissions is close of business Friday 22nd November, 2013.

Submissions should be addressed to:
Mr Martin Jones
General Manager Operations and Logistics
Australian Rail Track Corporation
33 Newton Street
Newcastle, NSW 2292

Email: Martin.Jones@artc.com.au

2 FACTORS FOR CONSIDERATION

Determination of the FIS requires consideration of the impact on Coal Chain Capacity. Specifying a train configuration that maximises efficient use of the Network in isolation from the impacts on the coal chain could lead to a reduction in the efficiency of the coal chain as a whole, which would be contrary to the interests of industry, notwithstanding that this might make best use of the Network.

2.1 Background To Scenario Choice

The FIS is intended to be the most efficient train configuration for the consumption of Coal Chain Capacity. Considering what is efficient requires a view as to matters such the period of time to be considered and the technological and infrastructure configuration that will apply over that time scale. With this in mind, the selection of the FIS requires consideration of:

a) the appropriate timeframe over which the FIS is to apply,

b) the likely volume task within that timeframe,

c) infrastructure constraints, now and in the future, and

d) technological constraints and opportunities within the timeframe.

These factors are discussed below.

2.2 Timeframe

The FIS is potentially an aspirational target, ie it is intended to be determined taking into account possible future coal chain infrastructure configurations – this is the reference to System Assumptions and the variation of System Assumptions in HVAU section 4.18(a). Thus, depending on the optimal train configuration chosen, it may be that it is not possible to adopt the FIS immediately.

The expectation is that Operators will, over time, either move towards or adopt the FIS and therefore the most efficient train configuration. There are several factors that will tend to make the adoption of the FIS a gradual process. These include:

- The cost of network access is only one part of the cost of providing train services and therefore, regardless of the differential prices charged for the use of train configurations that do not conform to the FIS, the effect of differential prices will only be one consideration. So while a pricing signal may encourage either a move towards or adoption of the FIS, it may not always be sufficient to achieve change towards the FIS depending on the level of differentiation compared to other supply chain cost impacts.

ARTC is not privy to the prices paid by Access Holders for other components of the coal transport task, and therefore is not in a position to speculate on the relative cost of access nor the impact of differentiations within the access charge. However, anecdotally, it is understood that the Network access charge is not the most expensive component of the overall transport task.

- There is an installed base of rolling stock that has a long remaining economic life. Ideally, Operators will replace life-expired equipment and expand their fleets with train sets based on the FIS. Assuming that this happens, the nature of the fleet is likely to evolve over an extended period. ARTC would not expect that the differentiation in access prices compared to the FIS would be sufficient to make it economic for Operators to discard existing fleets in favour of the new configuration en masse.
- While much of the Hunter Valley is capable of accommodating certain train configurations, there are, and will remain for the foreseeable future, certain hauls that are subject to atypical limitations, eg lower axle loads or length limitations. Even if the majority of the Hunter Valley coal chain is capable of adopting the FIS, these hauls are likely to require non-FIS train configurations for the foreseeable future.
- It may be necessary to modify existing infrastructure or build new infrastructure including modifications to coal loading and unloading terminals. The making of such infrastructure modifications will be the responsibility of parties other than ARTC and ARTC is unlikely to able to significantly influence the timing of such modifications by itself.

In addition to it being likely that the adoption of the FIS will be an evolutionary process, it is necessary that Operators and other rolling stock owners have confidence that once they have purchased equipment, the FIS will not significantly change within the lifetime of those assets. If the FIS has a short timeframe, this may make Operators reluctant to commit to the new standard and not provide sufficient direction to developing producers. In contrast, if the FIS is too aspirational and based on too long a timeframe, this has the potential to discourage the adoption of new technologies that could bring benefit to the coal chain.

The current life of rolling stock is of the order or 20 years, noting that this can be extended, depending on the duty cycle and maintenance regime adopted. The remaining economic life of the Network, based on weighted current anticipated lives for the mines serviced by the Network, is 19 years. Notwithstanding that this life might be extended if new mines come into production, this would suggest an upper limit for consideration of the FIS. It also suggests that, unless significant new volumes arise, operators may find it progressively more difficult to justify the purchase of new rolling stock.

On the other hand, the current HVAU terminates in 2016. While it might be expected that the HVAU will be renewed in terms similar to the current document, including the specification of the FIS, there is no guarantee that this will be the case. Even if the replacement to the HVAU remains consistent, there is a risk that regulatory or technical standards may change over the medium term and thus invalidate the FIS. This would suggest that a shorter timescale should be considered than the remaining economic life of the network.

Taking these competing considerations into account, ARTC has adopted a pragmatic view when considering the FIS and the likely intermediate steps towards the FIS and has adopted a medium term view. This suggests that volumes might exceed the current contracted 208 million tonnes per annum (**mtpa**), that technologies may continue to develop and that the installed infrastructure may be augmented. The adoption of the medium term allows for some degree of stability without locking in the train configuration beyond the reasonably foreseeable future nor locking out as yet unknown future technologies.

2.3 Traffic Volume & Location

Recent years have seen substantial fluctuations in coal tonnage forecasts over the medium term. There is no doubt that the Hunter Valley is experiencing very substantial growth, but the pace of that growth and the ultimate limits of the coal chain are unclear. Growth beyond the currently contracted export coal volume of 208 mtpa will be dependent on a number of factors including the long term expectations on coal price, the availability and location of suitable coal resources, the cost of providing the required infrastructure and changes in the global carbon economy (and hence cost and demand).

ARTC's 2013 Hunter Valley Corridor Strategy recognises that volumes in the coal chain are likely to continue to grow well beyond the existing contracted volumes.[1] ARTC is not in a position to know with any certainty where, or how much, volume will be added to the coal chain within the foreseeable future. However, ARTC is of the view, supported by coal producer forecasts, that volumes in the coal chain will continue to move west and north, both because of new resources being developed and existing resources in the central Hunter Valley becoming exhausted. This view is supported by the work carried out for the evaluation of mine life for the initial HVAU in 2009.[2]

As discussed in section 2.4.2, there is a rule of thumb for heavy haul railways that the longer the haul, the higher the train payload should be. This suggests that a train that is efficient under current circumstances may no longer be the most efficient as coal volumes move further from the port. This would be so even if volumes remained at current contracted levels, ie if the volumes merely move further from port without increasing.

ARTC has adopted the HVCCC modelling capped at 208 mtpa, recognising that the currently available modelling is unable to produce reliable results without reliable data on specific demand locations and profiles for additional volumes. The proposed FIS balances the resulting modelled results with the potential that the

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[1] The 2013 ARTC Hunter Valley Corridor Strategy document is available at http://www.artc.com.au/library/2013%20HV%20Strategy%20-%20Final.pdf

[2] Booz & Co Mine Life Assessment - Hunter Valley Region, February 2009 available at http://transition.accc.gov.au/content/item.phtml?itemId=917947&nodeId=98914ae09986d371f60347f3279d58e7&f.

coal chain will continue to expand beyond the currently contracted 208 mtpa and that the volumes will move further from port. This view favours the adoption of a pathway towards the FIS which is a higher payload train rather than a lower payload train.

2.4 Infrastructure Constraints

There are several aspects of current infrastructure constraints that it may be possible to modify over the medium term. These include, in particular:

- train maximum speed,
- train length,
- rolling stock axle load, and
- network structure gauge.

2.4.1 Speed

An increase in maximum train speed has the potential to improve cycle times, which in turn increase the productivity of train sets, ie for a given volume of coal to be moved, the shorter the cycle time, the fewer train sets required (though the number of trains operated remains the same).[3]

However, this potential benefit will only be achieved if other factors permit. For example, if the coal terminals are at capacity, then increasing train speed will merely cause an increase in queuing at the terminal or load point, to no advantage. For the same reason, an increase in speeds will only be effective if it can be applied on the ruling section. The ruling section is the portion of track, ie between two sets of signals, which is occupied the longest in the journey. As well as the distance of the section, the time taken to traverse the section will be influenced by the topography, so increasing the maximum speed on the ruling section may not yield a benefit if the terrain causes the train to travel below the maximum. Speeding up trains on shorter sections again merely queues trains to enter the longest section if the increased speed cannot be effectively used on the long section.

While increasing speeds may provide benefits, these come at a cost. Track and structure degradation and therefore maintenance costs are driven by a number of factors. Inter alia, these include the speed of trains and the axle load. In simple terms, the higher the combination of speed and axle load, the higher the track degradation and hence cost. In order to manage this, track owners typically reduce maximum speeds as axle load increases.[4]

Currently, in the Hunter Valley, maximum speeds are limited to 80 kph for all empty Coal Trains, 80 kph for 25 tonne axle load (**TAL**) loaded Coal Trains and 60 kph for 30 TAL loaded Coal Trains. This means that the majority of the existing coal movements have a maximum of 60 kph when loaded but some movements, eg

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[3] A further consideration is that additional locomotive horsepower may be required to achieve the increase in maximum speeds.

[4] It is for this reason that the relatively light axle load passenger trains and intermodal freight trains are permitted to travel at higher speeds.

the Gunnedah Basin trains, may operate at 80 kph on some parts of the network. In considering possible train configurations for the FIS, ARTC has investigated the possibility of increasing maximum permitted speeds in the Hunter Valley.

These investigations have shown that the adoption of 80 kph for 30 TAL trains yields a reduction from 11 minutes to 10.5 minutes in the headways on the critical line section. This would be equivalent to adding approximately 7 paths/day, moving from the current 130 to 137, an increase of 5%.

The adoption of 100 kph results in a reduction of headways on the critical line section to 9.5 minute headways, yielding an increase to 151 paths per day or approximately a 16% increase in pathing opportunities.

However, adopting either of these increases, and particularly in the case of 100 kph would lead to excessive dynamic loading on the track, track formation and associated structures. This would lead to a tightening of the maintenance standards around track geometry and rolling stock wheel profiles. It would also increase safety risks for work on adjacent lines which in turn would require the imposition of speed restrictions, limiting the application of the higher speeds. High axle loads and speeds, in combination, will increase the frequency of incidents such as broken rails. The increased maintenance task would not only significantly increase costs,[5] but would also increase the periods of 'track possession' by maintenance teams, ie the time when traffic is not permitted on the relevant portion of the network to allow for track maintenance. This increased possession time would need to be deducted from the increased pathing opportunities to understand the real benefit in pathing opportunities.

It is ARTC's view that given the modest benefits of increasing permitted speeds, particularly at the 80 kph level and the likely practical and engineering limitations associated with 100 kph, in selecting the FIS a pragmatic approach should be adopted. For the purposes of this paper, it has been assumed that existing speed limits will continue to apply.

2.4.2 Train Length & Load

Maximum train length is governed on the Network by the ability to manage traffic, ie for trains to pass or cross each other. On duplicated track this is often considered to be regulated by signal spacings, though this restriction is somewhat malleable;[6] ultimately the constraining factor will be the ability of the origin and destination to accommodate the train off the main line. On single lines eg Muswellbrook to Ulan and Muswellbrook to Narrabri the constraint is generally

[5] Increases in overall speed and axle load have an exponential effect on costs, hence the increase in costs to maintain the network at 80 kph would be substantially more than a linear increment of 80/60, ie 33% and the exponential effect of 100 kph would increase costs by a massive amount.

[6] Allowing trains of length greater than signal spacings may or may not cause a problem on duplicated tracks depending on the expected flow of following trains, ie the spacing between trains. If the spacing is greater than the time required to traverse two sections of signalling, then allowing a train length greater than can be accommodated within a single section may not impact on other trains. There may still be an impact when it is necessary to 'stack' trains eg if there is an incident or queuing on the Network.

crossing loop lengths.[7] Again, train length will also be constrained by the lengths of load point and terminal infrastructure.

The main benefit of longer trains is the increased payload per train. This reduces the number of trains required to haul any given tonnage. In turn, this potentially increases track availability and reduces congestion. However, in order to benefit from this, further important considerations are:

- The loading and recharge rates of load points – it may reduce the benefit of longer trains if a load point is unable to load the train efficiently.
- The discharge capability of terminals – similarly, if the receival terminal infrastructure is not capable of receiving the additional volume of coal efficiently, the benefit of the larger train may be reduced.

Although not an infrastructure constraint as such, a related aspect of train length is the efficiency of rolling stock design. This is discussed below, but improved design of wagons in recent years has led to shorter wagons capable of moving the same amount of coal. This has the potential to increase train payloads without increasing train length, thereby avoiding some of the potential negatives.

Another constraint on train length is the hauling capacity of locomotives. There is little point in increasing the mass of a train by adding additional wagons, if the locomotive power is unable to haul the train. While additional locomotives can usually be added, this may be an inefficient use of rolling stock capital if the additional train mass is not sufficient to make full use of an additional locomotive. Balancing locomotive hauling capacity, drawgear[8] strength, train forces and train length are all important considerations in determining train configuration. However, these lie beyond ARTC's consideration for the FIS as they evolve over time and they are dependent on engineering and cost decisions that lie with Operators rather than the track owner.

As alluded to earlier, there is a rule of thumb that the longer the haul, the higher the train payload should be. This arises because the productivity of a train stems from its movement from one point to another. This must be set off against the time that the rolling stock is effectively stationary[9] at the load and discharge points. On a short haul, the load and discharge tasks take up relatively larger portions of the entire cycle time than for longer hauls. Reducing the time spent 'stationary' generally improves the cycle time and therefore productivity of the train set. The Hunter Valley system covers a variety of hauls from the very short (20 km) to quite long (380 km). If these hauls were operating in isolation, it is likely that the most efficient train would be very different for each one. As the Hunter Valley operates

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7 This constraint is also malleable to some extent. It is possible to allow 'over-length' trains in one direction so long as all the trains it crosses on the journey fit within the crossing loops. However, this often impacts negatively on overall Network capacity and would be impractical for Coal Trains. The constraint may also be relaxed, as has been done on the Gunnedah Basin line, where some trains may fit into some, but not all, crossing loops on the journey. The extent to which this can be applied depends on the specifics of the various crossing loop lengths, the number of trains to which the longer length applies and the surrounding traffic base.

8 Drawgear is the connection between each component of the train. In some cases this is a pair of couplers, in some cases it may be a solid 'drawbar'.

9 In fact, coal trains in the Hunter Valley are loaded and discharged whilst in motion at low speed, but for the purposes of this discussion, the trains are effectively stationary.

as a system of interconnected hauls,[10] other factors come into play to determine the most efficient train configuration.

2.4.3 Rolling Stock Axle Load

Axle load has been discussed earlier in association with the consideration of speed. Though constrained by other factors, the higher the axle load:

- the heavier the locomotive, and consequently the higher the hauling power, and
- the higher the payload that the wagon is capable of hauling.

As always, in reality there are trade-offs that must be taken into account. While locomotive hauling capacity increases with axle load, due to being permitted to carry additional mass which increases adhesion to the track, without a corresponding increase in power, train speed will reduce.[11] Thus higher axle load locomotives in and of themselves do not necessarily benefit overall throughput. There is also a limitation imposed by the structure gauge, ie the three-dimensional space within which rolling stock must fit. Larger locomotives with larger motors must also work within this limitation. Nevertheless there is the potential for higher axle loads to yield benefits.

A higher axle load wagon can carry a heavier payload. This is subject to two constraints:

- the wagon and its cargo must fit within the structure gauge. Where the payload is very dense this may not be a constraint, but, existing Hunter Valley wagons can be near the maximum achievable with existing designs.
- the wagon must be structurally capable of bearing the increased load, including the drawgear forces that an increased train mass will impose.

As a corollary to the discussion in section 2.4.1 above on speed, increasing axle loads, without reducing speed will increase track, track formation and structure degradation and hence increase maintenance requirements and costs. Also there is a limit to how much an existing track standard can be 'pushed' to handle higher axle loads and it is quite likely that investment would be required to make any substantial increase in the majority of the Hunter Valley rail infrastructure.

Also, as discussed under section 2.4.2 above on train length, additional payload on a train requires the loading and discharge infrastructure to be capable of handling the additional volume for the increase to deliver an effective increase in efficiency. These facilities would also need to be able to accommodate the increased axle load limits, which, while likely given the low speeds typically travelled within these facilities, would need to be considered. Again, as with increased train length, increased coal volumes may impact loading and discharge capabilities.

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[10] The hauls are interconnected because, in the main, they share common discharge terminals and train sets (at least some hauls share some train sets).

[11] The load lifting capability of a locomotive is distinct from its speed. In simple terms, the speed is governed by horsepower whereas load is governed by adhesion which, in turn is assisted by higher locomotive mass, amongst other things.

Therefore, increased axle load has the potential to yield increases in rolling stock productivity and therefore increase overall coal chain capacity, while acknowledging it is likely that there will offsetting costs.

2.4.4 Network Structure Gauge

As indicated above, the structure gauge determines the physical dimensions of rolling stock that may operate on the railway. For example, this determines the minimum height of bridges under which the track passes and also such things as ground clearances. The curved sided coal wagons that are commonly seen in the Hunter Valley (and also in the central Queensland coal hauls) are so designed as to maximise the achievable payload volume given the requirements of the structure gauge.[12]

One consideration for a more efficient Network would be to move to what is known as the Association of American Railroads (**AAR**) standard. The adoption of such a standard would mean that Operators could access standard 'off the shelf' American rolling stock that is considerably cheaper than the specially designed equipment required to operate in Australia which generally has a smaller structure gauge.[13]

Unfortunately, adopting the AAR standard in a brownfields system would be expensive, requiring substantial modifications to all infrastructure that would currently encroach on the new structure gauge. This would include not only bridges and tunnels. It would also require the widening of spaces between duplicated tracks and crossing loops, realignment of platforms and modifications to load and unload points. In all likelihood, there will be some constraints that just cannot be sensibly modified. ARTC has not conducted a detailed study of the requirements but is of the view that substantial modification to the structure gauge for the Network is not practical.

Thus, while it would make excellent sense to build any new network to the AAR standard (or higher), ARTC discounts this as an option for the Hunter Valley for consideration in determining the FIS.

2.5 Rolling Stock Technological Constraints & Opportunities

In recent years, the evolution of wagon design for the Hunter Valley has resulted in new wagons that are shorter while still carrying the same payload and having a reduced tare mass, allowing more wagons per train and more payload per wagon and hence increasing overall train payload. As noted above, such improvements are limited not only by the inherent constraints on wagon design itself but also the need to match available locomotive power. While it is noted there have been changes up to now, and it is likely that there will continue to be modest

[12] This design concept requires substantial engineering to deal with the complex forces that arise and is expensive compared to the straight sided wagons typically used in USA coal hauls, but it delivers more wagon payload than would otherwise be the case.

[13] A notable exception is the north-western iron ore railways which have a structure gauge suitable for USA standard rolling stock designs.

improvements within current constraints, it is not anticipated that dramatic changes in wagon characteristics will arise in the foreseeable future.

Similarly, locomotive designs continue to evolve, making better use of available power by increases in adhesion. However, since the advent of AC traction in the 1990s, improvements in hauling capacity have come from the evolution of existing technologies rather than the availability of radically new ones. Technologies such as electrically controlled pneumatic brakes (known as ECP brakes) continue to become the modern standard and deliver improvements in train handling and dynamics, fuel consumption and rolling stock maintenance, but will not of themselves lead to significant improvements in Coal Chain Capacity, though ECP technology will assist in the operation of longer trains.

There remains the potential for the Network to be electrified. Several of the central Queensland coalfields networks were electrified in the 1980s, and with the likelihood that diesel fuel prices will continue to climb, it is possible that consideration may be given to the electrification of the Hunter Valley network at some point in the future. Were this to happen, it would most likely have a significant impact on the choice of the FIS. However, when the central Queensland networks were electrified, the then Queensland Rail was a unified entity that was able to take a 'whole of railway' view of the costs and benefits of electrification. This situation does not apply to the Hunter Valley and given the institutional framework that now applies it would be very difficult to justify electrification.[14] ARTC is of the view that electrification of the Network should not be a consideration for the FIS.

3 MODELLING

3.1 Description Of Model

ARTC does not have the modelling tools nor the data required to carry out an analysis of whole of coal chain impacts arising from the choice of the FIS. Therefore, ARTC has relied on the modelling capability of the HVCCC, to the extent that this is available, to determine the impact of various train configurations on the coal chain as a whole.

The model used to analyse the options for the FIS is managed by the HVCCC. The model is a whole of coal chain, discrete event simulation. The version used for the modelling is the 'uncongested' version. This was chosen as a conservative approach such that the benefits of larger payload trains and subsequently less trains movements were not amplified by the congestion mitigation impacts these changes may generate.

[14] It is noted that Aurizon Network has expressed significant concerns about the stranding of its electrical traction energy infrastructure as there has not, to date, been a uniform take up of electric traction; with train operators in some cases preferring to use diesel. This places pressure on the remaining electrical infrastructure users and threatens the economics of electricity as a traction energy source. As ARTC is a network owner only, it would be very difficult for ARTC to take on the risk of an electric traction energy system without a commitment from all Operators to use it for its economic life.

It is a detailed simulation model of the Hunter Valley coal chain from load point to ship loading and despatch. The model has been used and modified over a number of years to assist the HVCCC in its long term planning role and is the best currently available tool to analyse the FIS and its effects on the whole coal chain.

The primary goal of the model is to determine the maximum volume of coal delivered through the coal chain over a year, given certain assumptions about:

- the distribution of volumes (ie the availability of coal) across the various load points throughout the system,
- the capabilities of load points, coal terminals (train discharging, stockpiling and ship loading), and
- the capabilities of the available train fleet and rail infrastructure.

By holding the infrastructure components constant while varying the train configuration, the model can determine the variation in the volume of delivered coal, along with other metrics, such as the average length of the ship queue waiting to be loaded.

To enable a comparison between each train configuration tested, a 'train fleet adjustment' factor is required. There are a number of approaches that could have been used for the development of an adjustment factor, including;

a) No. of train consists: This approach was rejected as it can lead to a skewing of results and it is difficult to determine a 'like for like' comparison due to variation in consist size.

b) No. of wagons: This approach was also rejected as it does not allow for an analysis of differing wagon carrying capacity options.

c) Total fleet capacity: This is based on the number of consists and a generic cycle time for each consist type. The generic cycle time is held constant for each scenario.

Option (c) was used in the analysis as it allowed for a more accurate and robust fleet adjustment for each scenario and was sensitive to changes in wagon carrying capacity.

3.2 Modelling Assumptions

The model has been set up using the likely near term infrastructure. Table 1 sets out the infrastructure and operating assumptions used in the modelling.

Table 1:

Track	Completion of Minimbah to Maitland 3rd Track Completion of Nundah Bank 3rd Road Introduction of 10 minute (UP) & 8 minute (DOWN) timetable 2012 Planned Maintenance Regime Sensitivity

Terminals	Completion of PWCS 145 Master Plan Completion of NCIG Stage 2F 92%-94% train unloading efficiency at KCT & NCIG for large trains 2012 Planned Maintenance Regime sensitivity
Trains	57 Train Consists as a base, adjusted where necessary to avoid unintended contracted capacity loss. Train speeds are assumed to match existing speeds across the network.
Port Operations	Ability to sail 3 Cape vessels on the tide 8 available manned tugs Adequate pilots and linesmen
Load Points	Load points are unconstrained in terms of the size of train they can accommodate, but the performance of train loading reflects current capabilities.
Kooragang Coal Terminal Refuelling	No Kooragang Coal Terminal refuelling impacts and no train provisioning delays.

The model is capable of providing results that either allow the shipping queue to be unlimited, or to limit the queue to a certain level. The modelled outcomes without managing the queue resulted in unacceptably long queues. Therefore, the model was constrained to achieve an average queue of 20 ships. This length of queue is expected to be 'demurrage neutral' and reflects a target that would achieve maximum coal chain throughput while keeping demurrage cost to a minimum.

Adjustments were made to load point daily capacity limits for each of the larger train configurations tested to ensure that the daily maximum equivalent peaking capacity of each load point was aligned to increments of 'whole consist size'. While this might not be capable of being achieved in reality, it is unlikely to have a significant negative impact on the results whereas the alternative is likely to under-report load point performance and hence coal chain throughput.

Trains that exceeded existing infrastructure capabilities, either in length or axle load were treated as though the infrastructure was capable of handling the train, ie it was assumed that the rail network would be modified to cater for the train requirements.

3.3 Modelling Limitations

As with all models, the HVCCC capacity model has some limitations. A key limitation for the FIS work is that the HVCCC has not been, at this time, in a position to provide accurate modelling for scenarios beyond the currently contracted 208 mtpa. The model is particularly sensitive to the locations and distributions of coal volumes and without a high level of confidence of the source of coal beyond 208 mtpa, the modelled results are unreliable. To provide a model capable of dealing with a range of volumes and demand profiles is beyond the available time and resources of the HVCCC. This means that, while the 208 mtpa modelling results are informative, the model cannot inform conclusions about a larger task except by inference. Such modelling exercises as have been attempted at volumes above 208 mtpa support the intuitive expectation that larger payload trains continue to deliver benefits to Coal Chain Capacity, all other things being equal.

Aside from this key limitation, other limitations include:

- The model cannot easily modify signalling distances as the signalling constraints are 'hard-coded'. For modelling purposes, this does not generally affect comparison of different train configurations as the model can assume that trains 'fit' within signalling constraints. As the purpose of this exercise is not to evaluate the effect of different signal spacings, this simplifying assumption does not impact the results. However, this limitation did prevent consideration of the effect of the adoption of ATMS, ARTC's proposed moving block signalling system. That is, it was not possible from the current model to determine whether ATMS would, of itself, lead to an increase in Coal Chain Capacity.
- For the larger consist scenarios, no adjustment was made to cargo parcel sizes to better match whole consist increments. Were this adjustment to be made, it would likely further improve the delivered throughput performance of the larger consists.
- Where train path utilisation reduced, this version of the model could not quantify the benefit, notwithstanding that intuitively there would be some benefit from operating the Network under a lower level of stress.

While not a limitation, it should be understood that the analysis takes no account of the requirement for, nor cost to provide, the infrastructure necessary to allow any particular train configuration. Neither does the analysis attempt to quantify the benefit that might accrue to Operators through the use of different train sizes; the HVCCC modelling is purely based on the coal chain delivered tonnage.

Although the modelled results are directed towards delivering a targeted 208 mtpa, none of the scenarios tested actually deliver this volume. It is important to understand that this should not be taken as predicting a shortfall in the provision of contracted tonnages. The model in this exercise has been constrained by limiting the number of train sets available in order to be able to distinguish the differences in Coal Chain Capacity delivered by the different train configurations. The model is further limited in that it constrained to an infrastructure set that would in fact be augmented to deliver the contracted 208 mtpa. Thus the modelled results should be seen as reflecting the relative performance of the train configurations only.

3.4 Description Of Scenarios

Taking into account the existing network constraints, the potential for these to be relaxed and the resulting Coal Chain Capacity benefits, ARTC, in consultation with the HVCCC tested 15 different combinations of train size and axle load under three different scenarios for the Gunnedah Basin trains:

1) The Gunnedah Basin network will remain at 25 TAL.

2) The Gunnedah Basin network will move at 30 TAL, a likely near term scenario.

3) The Gunnedah Basin network will move to the same axle load and train length configurations as the central and western Hunter Valley.

The reason for treating the Gunnedah Basin traffics separately is that the infrastructure challenges on that corridor are likely to be different to those in the central and western Hunter Valley.

In order to test the ideal train size, a variety of sizes were tested from the very small, 2,226 tonne (**t**) payload through to a very large 19,352 t payload. The train sizes also incorporated a variety of different maximum axle loads and lengths.

For each test, apart from the fixed small hauls alluded to earlier, all central and western Hunter Valley hauls were assumed to use the train configuration under test. For the Gunnedah Basin 25 TAL scenario, the Gunnedah Basin trains were held at 6,150 t payload, reflecting the average of the larger 25 TAL trains currently operating. Under the Gunnedah Basin 30 TAL scenario, the trains are the set at approx. 8,000 t payload. For the 'same axle load' scenario, the same train configuration as for the remainder of the Hunter Valley was used; this included where the main Hunter Valley is assumed to move to 35 TAL.

In practice, Option 2 delivers results very similar to Option 3 for train sizes operating at 30 TAL. In order to keep the modelling task manageable, only two examples of Option 2 were actually modelled. These two examples conformed to the intuitive expectation that Option 2 performs better than Option 1 and worse than Option 3. It also demonstrates that there is a capacity cost associated with operating trains of different capabilities within the same network.

The train configurations tested are set out in Table 2.

Table 2: Description Of Scenarios

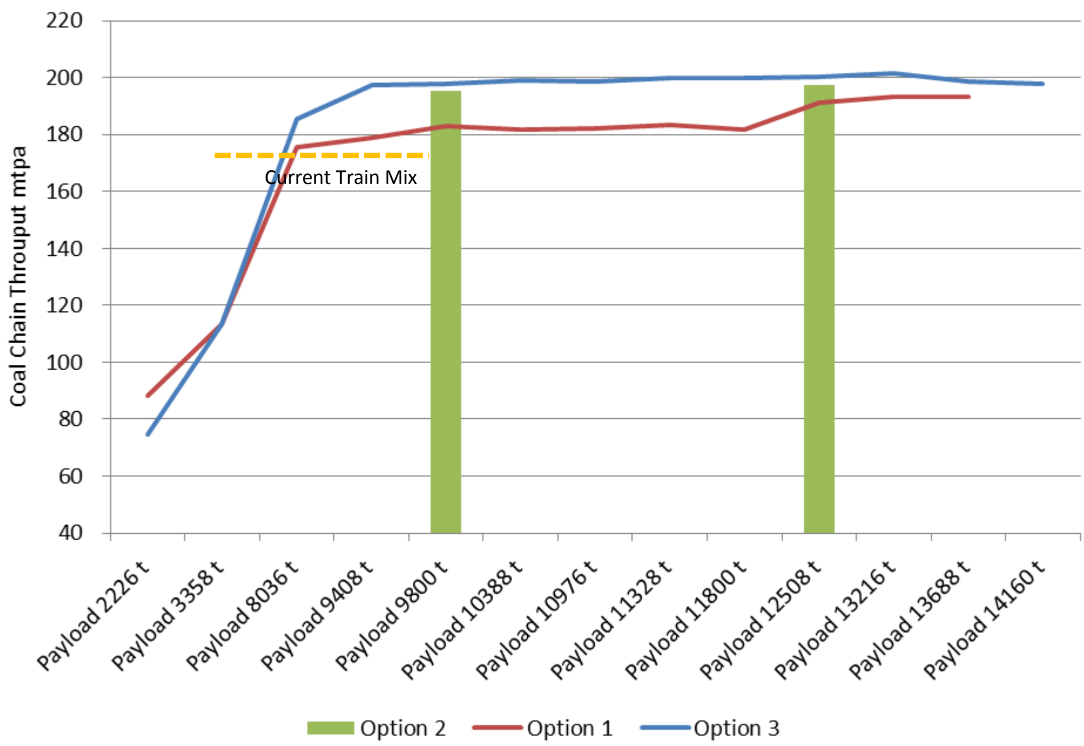
Test	# Locos	# Wagons	TAL	Wagon Payload (t)	Train Length (m)	Train Payload (t)
1	2	42	15	53	691	2,226
2	4	46	25	73	824	3,358
3	2	82	30	98	1,307	8,036
4a	3	96	30	98	1,545	9,408
4b	3	82	35	118	1,307	9,676
5	3	100	30	98	1,606	9,800
6	3	106	30	98	1,699	10,388
7	3	112	30	98	1,791	10,976
8a	3	116	30	98	1,853	11,368
8b	3	96	35	118	1,545	11,328
9a	3	120	30	98	1,914	11,760
9b	3	100	35	118	1,606	11,800
10	3	106	35	118	1,699	12,508
11	3	112	35	118	1,791	13,216
12	4	116	35	118	1,875	13,688
13	4	120	35	118	1,936	14,160
14	4	164	30	98	2,614	16,072
15	4	164	35	118	2,614	19,352

4 MODELLING RESULTS

4.1 Unadjusted Queue Results

The results for the unadjusted queue are presented in tabular form in Appendix C and graphically in Figure 4 below. For test 4a and b, 8a and b, 9a and b the results are shown as a single output for each pair (9,408 t, 11,328 t and 11,800 t payloads respectively) as, from the perspective of the model, they are effectively equivalent in terms of Coal Chain Capacity.

Figure 4: Volumes Delivered With Unadjusted Shipping Queue (mtpa)



For comparison, the modelled output of the train fleet currently in operation is shown as a dotted orange line. The current train fleet is a mix of different train configurations.

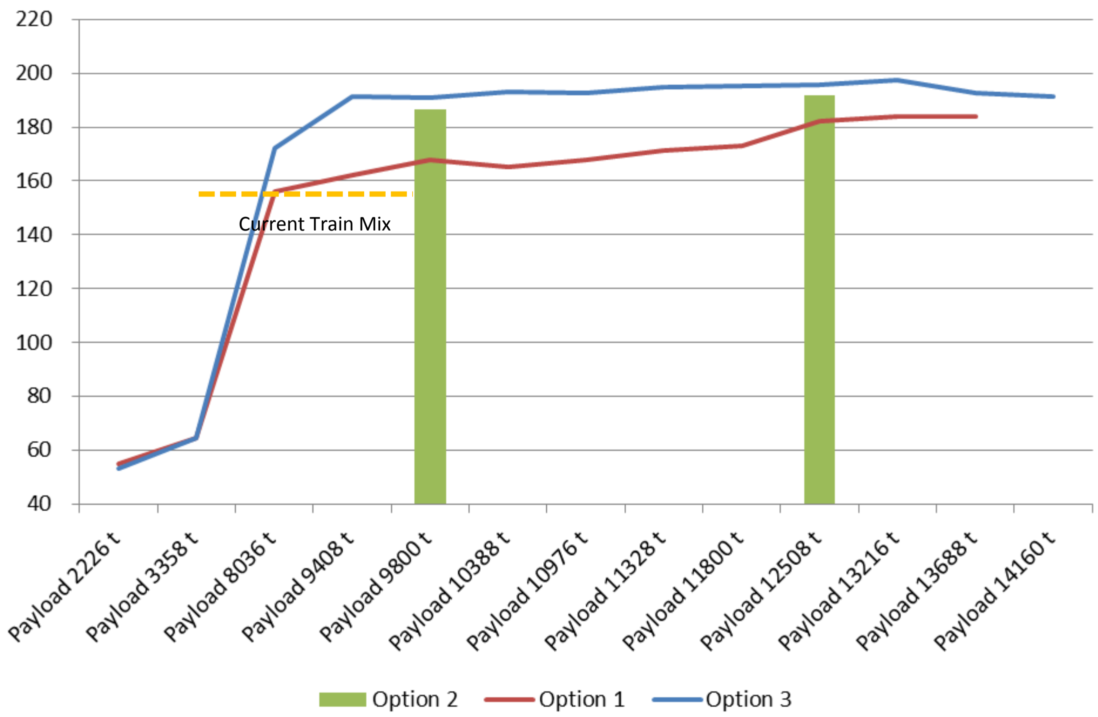
It is readily apparent from Figure 4 that the efficiency of trains, in terms of delivered coal volume, increases rapidly from the small train sizes (Trains of 2,226 t and 3,358 t respectively) but reaches a fairly stable plateau. In particular, gains for trains with a payload of more than 9,400 t under Option 3, are small. The results for Option 1 (Gunnedah Basin remains at 25 TAL) is very similar with a plateau being reached at the 8,036 t train and small gains arising beyond this.

The results demonstrate the large gains in Coal Chain Capacity as train payload increases. These gains are then capped as demand approaches the modelled maximum of 208 mtpa.

4.2 Adjusted Queue Results

The adjusted queue option restricts the shipping queue to a maximum of 20 vessels. The results for the various train sizes under this option are set out in tabular form in Appendix C and presented graphically in Figure 5.

Figure 5: Volumes Delivered With Adjusted Shipping Queue (20 ships) (mtpa)



Again, for comparison, the modelled output of the current train fleet is shown as a dotted orange line.

The results are similar to the uncapped results in the shapes of curves, but the total volumes delivered are reduced. Again, there is a marked plateauing, driven by impact of the capping of volumes at 208 mtpa, though the increments above the 8,036 t train continue to deliver an incremental benefit that is larger than in the unrestricted queue case.

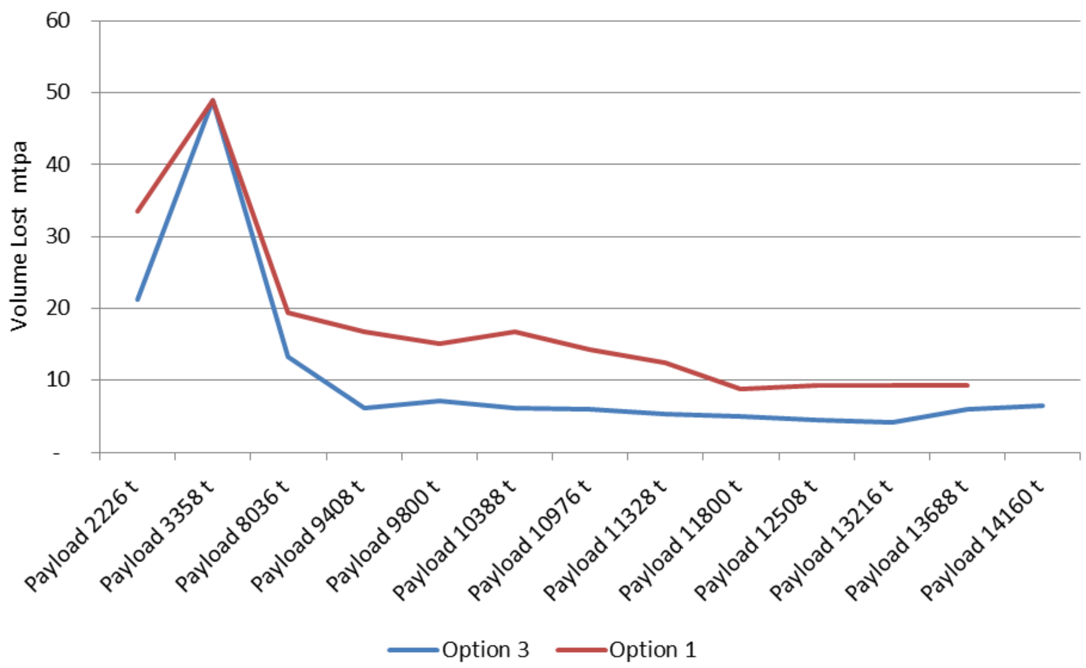
The differences between Option 1 and Option 2 also demonstrate that the adoption of 30 TAL operations on the Gunnedah Basin hauls provides a significant benefit to Coal Chain Capacity. For almost all the tested configurations, the movement of Gunnedah Basin trains closer to the central and western Hunter Valley standard yields a substantially higher volume compared to maintaining the Gunnedah Basin operations at 25 TAL (ie Option 1).

It is again noted that the results must be viewed as demonstrating relative rather than absolute performance, and the modelling should not be interpreted as demonstrating an inability of the coal chain to deliver the contracted 208 mtpa.

4.3 Effect Of Restricting The Queue

Restricting the shipping queue to the 'demurrage neutral' level of 20 ships results in a reduction in total volumes achieved. Figure 6 shows the volume reductions for both Options 1 and 3 for each train size as a result of restricting the shipping queue. As with the total throughput measure, this difference reduces and then plateaus as train sizes increase for both options. The difference between the capped and uncapped queues is roughly half for Option 3 compared to Option 1.

Figure 6: Difference Between Unrestricted & Restricted Queuing By Train Configuration, Options 1 & 3 (mtpa)



4.4 Beyond 208 MTPA

Notwithstanding the inability to currently model beyond the contracted 208 mtpa with any precision due to uncertainty as to the location and distribution of additional volumes, the HVCCC has attempted to model the effect of different train sizes at higher volumes at least on an indicative basis. While there is insufficient confidence in the value of this modelling to allow it to be published, it does tend to confirm the intuitive expectations and inferences drawn from the 208 mtpa modelling that larger train sizes, supported by appropriate infrastructure, will continue to increase Coal Chain Capacity as volumes increase.

Figure 7: Indicative Benefit Beyond 208 mtpa

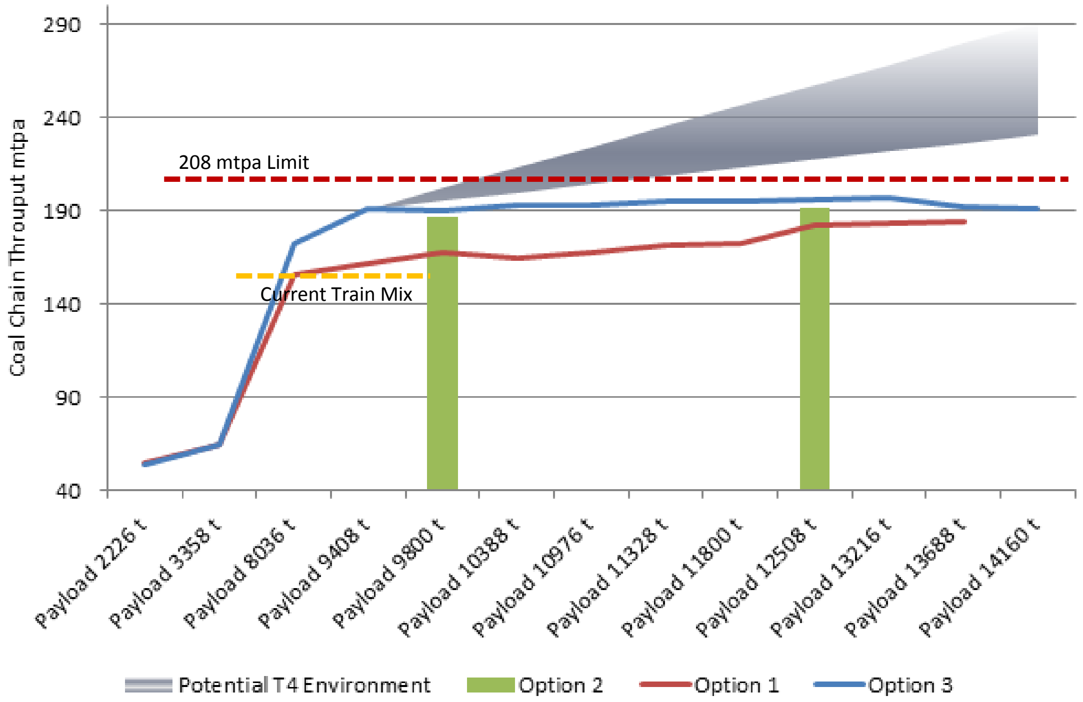


Figure 7 attempts show, in qualitative terms only, the anticipated range of benefits in Coal Chain Capacity that would result from the operation of the larger train sizes at volumes above 208 mtpa. This is shown as the grey cone labelled 'Potential T4 Environment'. It must be stressed that this depiction is qualitative only and should not be taken to represent a quantitative assessment. It should also be noted that the grey cone increases in size as an attempt to reflect the potentially increasing volume cap that might apply that could be serviced by the increasingly larger trains; again this is provided for illustrative purposes only.

It is ARTC's view that the modelling of volume demand profiles greater than 208 mtpa were this capable of being down with confidence, would show a continuing benefit from adopting larger train payloads. The existing 208 mtpa modelling would suggest that this would be the case but this support is by inference only rather than being directly observable from modelling over which the HVCCC has confidence. The 'indicative' modelling beyond 208 mtpa also supports this view.

ARTC's view is also supported by the intuitive benefits to capacity that arise from the operation of fewer trains on the Network for any given task. As long as the train is sufficiently powered to maintain scheduled speed and is capable of efficiently refuging (ie it is able to fit within locations where it is required to cross or pass other trains), and its payload and length do not exceed the capabilities of loading and unloading infrastructure, then it will consume less overall track capacity than a smaller payload train for any given level of volume.

5 DETERMINING THE FIS

The existing Initial Indicative Service of 96 wagons with a payload of 9,400 t, was chosen because, at the time, it was the largest and most efficient train generally capable of operating on the Network, given existing rolling stock at the time, in accordance with the parameters defined by the HVAU. Since the adoption of the Initial Indicative Service, Operators have successfully tested a train of 100 wagons with a payload of 9,800 t. At 1,606 m, this train is at the limit of train lengths capable of operating on the Ulan line west of Mangoola.[15]

One Access Holder and its Operator are currently investigating 110 wagon train of 10,700 t payload. This train could only operate on a restricted number of hauls east from Mangoola to the port due to the constraints imposed by the rail infrastructure on the Network, at some coal terminals and at load points. Yet for those hauls where this configuration could operate, it would be highly efficient for the individual Access Holders and/or Operators, delivering a 14% payload benefit over the existing Initial Indicative Service.

This latter example demonstrates the difficulty in trying to 'tie down' a particular train configuration as the one to which the coal chain should aspire, given the propensity for Operators to, quite appropriately, continue to 'push the envelope' to achieve operational efficiencies. It is also a demonstration that what may be most efficient for the coal chain as a whole may not necessarily be the most efficient for any particular Operator and/or Access Holder, nor for ARTC or the ports. What may suit one Operator, given a particular set of installed equipment may not suit another, and it is not ARTC's intention to set a standard, nor a pricing mechanism, that would advantage one over another except to the extent that this drives towards a common goal, which is to maximise efficient use of Coal Chain Capacity. There is a trade-off between seeking to maximise Coal Chain Capacity and allowing Operators to manage their train operations through the use of different train configurations.

It is not unrealistic to expect that the access price will be but one of several determinants in an Operator's decision as to which configuration(s) to use in operating its trains. At best, price differentiation of access charges will help in a decision to adopt the desired outcome, but in all likelihood, this would only be where other factors, eg rolling stock efficiency, align.

With this in mind, and also being mindful of the limitations of the available modelling, ARTC is proposing to adopt an aspirational target which is reflective of a future train configuration that might be achieved within the medium term future.

As discussed earlier in this paper, ARTC envisages that Network capability over the medium term might be enhanced in two dimensions, maximum train length and maximum axle load. At this time ARTC does not have a fixed view as to which of these is the more likely to be pursued; indeed it is possible that a combination of axle load and length enhancements might be the most appropriate. A substantial amount of analysis, consultation and planning would be required before such a direction could be determined with confidence.

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[15] With limitations; this train length does not fit into two existing crossing loops on the Ulan line.

However, it entirely feasible to set an FIS based on each of these two directions at this time, recognising that the actual movement towards one, other or both infrastructure solutions will unfold as demand and customer support dictate.

5.1 'Axle Load' FIS

ARTC's recent work towards raising the allowable axle load in the Gunnedah Basin, still in progress but partially completed, suggests that the infrastructure improvements required in the central Hunter Valley to deliver an increment above 30 TAL may be less prohibitive than previously thought. It must be stressed that any incremental increases are at their earliest consideration.

ARTC's preliminary considerations have included 3 increments of track standard, 32.4 TAL, 35 TAL and 40 TAL. Of these, ARTC is aware that the new Fortescue iron ore railway in Western Australia has been purpose built to a 40 TAL, 80 kph standard, and is currently looking to move this to 42 TAL. This is at the cutting edge of heavy haul operations and it was feasible to build as a greenfield, purpose built railway. However, ARTC's pragmatic view is that it would be a 'step beyond' to attempt to retrofit this operating criteria to the Hunter Valley. A 40 TAL operation would require a wholesale replacement of structures and major strengthening of the track and its formation, even at the slower 60 kph operation of the Hunter Valley Coal 30 TAL trains. It is also unlikely that existing wagon designs could make full use of the additional axle load as it is not possible to fit the additional volumes of coal in currently sized wagons, so the benefit would be potentially less than might otherwise appear.

32.4 TAL is the AAR standard and in use on the main lines across the USA and other countries. Adopting the AAR standard would have real benefits to Operators as they could potentially purchase 'off the shelf' rolling stock designs, with the caveat that this would require ARTC to also modify the structure gauge to AAR standards – itself a potentially expensive undertaking. Moving to 32.4 TAL would give a potential wagon payload increase of around 10%.

35 TAL has been in operation on the north-west Western Australian iron ore railways for some years and represents a useful benchmark for a heavy haul operation. Preliminary conceptual consideration by ARTC's engineering staff suggests that-while 35 TAL may be a possibility worth exploring, many questions remain about the annual maintenance task and resulting increases in annual cost and capacity lost due to increased track maintenance possessions. However, the potential to increase wagon payloads by up to 20% represents a substantial operational benefit that has the potential to be economic despite the increased capital and ongoing operating costs. It must be stressed that ARTC is not in a position, at this time, to say that the achievement of 35 TAL would be technically or economically achievable, but initial consideration suggests that this might be the case.

ARTC's choice of aspirational axle load is 35 TAL, with 32.4 TAL providing a useful 'fall back' should 35 TAL prove to be too expensive or technically too challenging.

The FIS that would be achievable for a 35 TAL train that would fit (more or less) within current length limitations is a train of 100 wagons up to 1,606 m. This length would fit in the 3 existing export terminals (and Macquarie Generation domestic terminal). This configuration has a payload of 11,800 t.

5.2 'Long' FIS

For the 'length enhancement' scenario, ARTC has considered what length restriction could realistically be achieved. The current maximum length that could operate from Ulan to the port is a 100 wagon train at 1,606 m. Apart from two crossing loops on the Ulan Line, a train of this length could fit in all existing load points, terminals and the Network generally (excluding the Gunnedah line).[16]

The longest train that could fit into the NCIG coal terminal is 1,914 m. This length train could not currently be accommodated at the Kooragang or Carrington terminals and at least some roads in these terminals would need to be extended.

A 1,914 m train can operate on the Network as far west as the Mangoola load point. A number of crossing loops west of Mangoola would need to be lengthened in order to allow operation of this size train to Ulan.

A 1,914 m train at 30 TAL would have a payload of almost 11,800 t which would be equivalent in terms of Coal Chain Capacity to the 35 TAL FIS being proposed. Therefore, ARTC is proposing a 'Long' FIS of 30 TAL, 120 wagons, maximum length of 1,914 m and payload 11,800 t.

6 CONCLUSION

ARTC is proposing two configurations for the FIS, one based on increasing train length, the other increasing axle load. The proposed configurations are:

'Axle Load' FIS	35 TAL, 1,606 m length, payload 11,800 t
'Long' FIS	30 TAL, 1,914 m length, payload 11,800 t

These configurations both have the potential to increase train payloads by 25% and decrease train movements by up to 20% over the current Initial Indicative Service for a given haulage task.

ARTC is aware that the proposed FIS is outside of the assumptions contained in the existing Hunter Valley Corridor. However, the following points suggest that this aspirational target is appropriate:

- Increments in train size have continued over the last several decades, usually in an ad hoc and unplanned manner, responding to incremental changes in technology and opportunity. There is no reason to anticipate that further incremental change will not occur, and setting an aspirational FIS will assist to focus development efforts towards a particular goal.

[16] Notwithstanding the 2 crossing loops being under-length, the train can operate from Ulan currently, though with some pathing restrictions.

- Volumes have a potential to grow beyond the currently contracted 208 mtpa. As they do, Network congestion will increase, requiring substantial new infrastructure in mitigation. The quantum of improvement in train productivity provided by the FIS would significantly reduce the number of trains on the Network, lowering the relative congestion and stress on the Network and potentially removing the need for some capital projects, albeit that to achieve the FIS specification will require other capital works.
- The improvement in rolling stock productivity will have flow-on benefits to Operators, beyond the reduction in Network congestion and increased haulage task.
- The setting of an aspirational target for the FIS will also mean that the Final Indicative Access Charge (**FIAC**) will be aspirational. Pricing for existing Coal Train configurations will be differentiated against the FIAC having regard to the FIAC and the differentiation factors prescribed in the HVAU. As the FIS represents a higher payload Coal Train configuration (resulting from longer length and/or axle load) than existing Coal Train configurations, it could be expected that pricing for existing Coal Train configurations will be higher than the FIAC (on a per GTK or tonne basis) and, as a rule of thumb, longer, higher payload Coal Train configurations will be priced at a lower price (on a GTK or tonne basis) than shorter, lower payload Coal Train configurations.

APPENDIX A HVAU FINAL INDICATIVE SERVICE PROVISIONS

Below is reproduced section 4.18 of ARTC's Hunter Valley Access Undertaking, which sets out the requirements for the determination of the Indicative Service.

"**4.18 Determination of the Final Indicative Services (efficient train configuration)**

(a) ARTC will develop, in consultation with the HVCCC, the proposed characteristics of the indicative services which ARTC considers will deliver the optimum utilisation of Coal Chain Capacity, given certain System Assumptions ("Final Indicative Services"). The intention is that this process will be a more robust modelling exercise than that used for selecting the Initial Indicative Services and will include scenarios under which System Assumptions are also varied in addition to the Coal Train configurations.

(b) Within 30 months of the Commencement Date, ARTC will:

(i) consult with the HVCCC, Access Holders and Operators on the proposed characteristics of the Final Indicative Services and whether gtkm is the appropriate pricing unit to encourage efficient consumption of Capacity;

(ii) submit to the ACCC proposed characteristics of the Final Indicative Services developed in consultation with the HVCCC and, having reasonable regard to submissions arising from the consultation at subsection (i) above, if ARTC considers that gtkm is not an appropriate pricing unit to encourage efficient consumption of Capacity, an alternative pricing unit that ARTC considers will encourage efficient consumption of Capacity; and

(iii) seek the approval of the ACCC to vary this Undertaking to provide for the adoption of the proposed characteristics as those of the Final Indicative Services and the alternative pricing unit (if any).

(c) In consulting with the HVCCC, Access Holders and Operators, ARTC will:

(i) assist the HVCCC to undertake modelling; and

(ii) will follow the principles of consultation set out in Schedule F, with the objective of determining the Coal Train configuration which will deliver optimum utilisation of Coal Chain Capacity and ARTC will use its best endeavours to agree with the HVCCC the characteristics to be submitted to the ACCC as the proposed Final Indicative Services.

(d) In support of its application to vary the Undertaking for the adoption of the characteristics proposed in section 4.18(b) as the Final Indicative Services, ARTC will submit to the ACCC:

(i) proposed characteristics of the Final Indicative Services which it considers will deliver optimum utilisation of Coal Chain Capacity including:

(A) maximum train axle load;

(B) maximum train speed;

(C) train length; and

(D) section run times;

(ii) the proposed indicative access charges for the proposed Final Indicative Services; and

(iii) supporting documentation.

(e) If the ACCC accepts the characteristics proposed by ARTC in consultation with the HVCCC as the Final Indicative Services, and accepts the variation sought by ARTC to this Undertaking, ARTC will:

(i) promptly publish on its website:

(A) the characteristics proposed under section 4.18(b) as the Final Indicative Services; and

(B) the indicative access charges accepted by the ACCC for the Final Indicative Services as the Indicative Access Charges, in the format set out in section 4.14(c);

(ii) offer the Indicative Access Charges to Applicants seeking Coal Access Rights for the Final Indicative Services (including Access Holders seeking to vary their Access Holder Agreements so as to operate Final Indicative Services on existing contracted Train Paths) to apply in the year immediately following the date the variation to the Access Undertaking accepting the Final Indicative Services and Indicative Access Charges comes into effect and the annual process for the finalisation of Indicative Access Charges under section 4.20 will not apply to the determination of Indicative Access Charges for that year; and

(iii) determine Charges for Coal Access Rights other than Access Rights for the Final Indicative Services to apply in the year immediately following the date the variation to the Access Undertaking accepting the Final Indicative Services and Indicative Access Charges comes into effect, in accordance with section 4.15 and in doing so will take into account the Indicative Access Charges accepted by the ACCC in determining those Charges.

(f) If the ACCC does not accept the characteristics proposed by ARTC as the Final Indicative Services, ARTC will, within a timeframe reasonably specified by the ACCC (not to be less than 3 months) having regard to the need for further modelling and industry consultation, submit revised characteristics to the ACCC and seek the approval of the ACCC to vary this Undertaking to provide for the adoption of the revised characteristics as the Final Indicative Services."

APPENDIX B DICTIONARY OF TERMS

The following specific terms or abbreviations have been used in this paper. In some instances, the definitions may differ from the corresponding definition in the HVAU and are provided for ease of interpreting this consultation paper in a non-technical sense. If in doubt about the meaning of a term, readers should consult the definition in the HVAU directly.

AAR	Association of American Railroads
ACCC	Australian Competition & Consumer Commission
Access Holder	An entity that has entered into an Access Holder Agreement with ARTC. Typically this will be a coal producer, but in some cases may be a coal consumer (eg a power station).
Accredited	In relation to an Operator, having accreditation as an operator as defined under the Rail Safety Act in New South Wales and "Accreditation" bears a corresponding meaning.
ARTC	Australian Rail Track Corporation. ARTC manages the Network and the interstate network.
Capacity	The capability of the Network for Services … based on and applying: (a) Relevant System Assumptions; and (b) other assumptions related to operating the Network for non-coal Services as reasonably determined by ARTC.
Coal Chain Capacity	The system wide capacity of the Hunter Valley coal chain, including below rail, above rail and port services as agreed with the HVCCC from time to time based on the System Assumptions.
Coal Train	A Train, the sole purpose of which is transporting coal in open coal wagons whether loaded, empty, operating in or transiting through the Network, or any part thereof.
FIAC	Final Indicative Access Charge, the access price that will apply to the FIS train configuration.

FIS	Final Indicative Service
HVAU	The Hunter Valley Coal Network Access Undertaking as approved by the ACCC which came into operation 1 July 2011. The HVAU regulates access arrangements for the Network.
HVCCC	The Hunter Valley coal chain Coordinator, a body that is responsible for coordinating planning across the Hunter Valley coal chain.
Indicative Service	A train configuration that forms the basis of pricing for access to the Network. Trains that deviate from the Indicative Service are priced in accordance with differential cost imposed on the Network. There have been several Indicative Services, the Interim Indicative Services and the Initial Indicative Service. To differentiate from these, next Indicative Service is termed the Final Indicative Service.
mtpa	million tonnes per annum
Network	The ARTC Hunter Valley rail network covered by the HVAU, specifically as defined in the HVAU Schedule B.
Operator	An Accredited Operator seeking to operate Trains in accordance with the relevant Access Agreement and, where applicable, Operator Sub-Agreement.
Relevant System Assumptions	The following assumptions provided to, or agreed with, the HVCCC and published on ARTC's website (subject to any confidentiality restrictions) or as determined under HVAU section 5.1: (a) ARTC track including path numbers, (b) live run management, (c) ARTC system losses, (d) maintenance intervention, (e) train parking capacity (for shut downs), (f) section run times;

	(g) maximum train length, (h) maximum train axle load, (i) maximum train speed, and (j) any other assumptions reasonably determined by ARTC from time to time as necessary for the purposes of determining Capacity.
Rolling Stock	A locomotive, carriage, wagon or other vehicle for use on a railway.
SRG	Stakeholder Reference Group; a group of industry representatives with whom issues relating to the FIS were discussed on a number of occasions.
System Assumptions	means the assumptions for the Hunter Valley coal chain as detailed in the System Assumption Document as varied from time to time, including: (a) interface and live run losses between each element in the Hunter Valley coal chain; (b) agreed operating mode of the Hunter Valley coal chain; (c) surge and tolerance requirements; (d) capacities of fixed infrastructure; (e) rolling stock requirements; and (f) vessel requirements, except if not agreed to by ARTC, then those System Assumptions reasonably determined by ARTC from time to time and published on its website in accordance with HVAU section 5.1(c)(iii), unless otherwise determined in accordance with HVAU section 5.1(g).
System Assumptions Document	The document prepared by the HVCCC in consultation with ARTC and operators of coal terminals at the Port of Newcastle that details System Assumptions and simulation model outputs for the relevant Coal Chain Capacity scenarios.

t	tonnes
Train	One or more units of Rolling Stock coupled together, at least one of which is a locomotive or other self-propelled unit.
Train Path	An instance of a time based path available for a train to operate between specific locations on the Network. Note that this equates to the term Train Path Usage in the IAHA/IOSA where the term Train Path has a slightly different meaning.
Terminal Operator	The operator of a coal terminal, principally PWCS and NCIG, but could include the operator of a domestic receival facility such as a power station.

APPENDIX C MODELLING RESULTS

The volumes delivered by each train configuration under the three options at the 208 mtpa level without restricting the shipping queue are set out in Table C1.

Table C1: Volumes Delivered With Unadjusted Shipping Queue

Test	Axle Load (t)	Train Length (m)	Train Payload (t)	Option 1 (mtpa)[#1]	Option 2 (mtpa)[#2]	Option 3 (mtpa)[#3]
1	15	691	2,226	88		75
2	25	824	3,358	114		114
3	30	1,307	8,036	176		185
4a	30	1,544	9,408	179		197
4b	35	1,307	9,676	179		197
5	30	1,606	9,800	183	196	198
6	30	1,698	10,388	182		199
7	30	1,791	10,976	182		199
8a	30	1,544	11,368	184		200
8b	35	1,853	11,328	184		200
9a	30	1,914	11,760	182		200
9b	35	1,606	11,800	182		200
10	35	1,698	12,508	191	198	200
11	35	1,791	13,216	193		202
12	35	1,874	13,688	193		199
13	35	1,936	14,160	not run		198

#1 Option 1: Gunnedah Basin trains at 6,100 t payload

#2 Option 2: Gunnedah Basin trains at approx. 8,000 t payload

#3 Option 3: Gunnedah Basin trains the same configuration as other Hunter Valley trains

The volumes delivered by each train configuration under the three options at the 208 mtpa level with the shipping queue restricted to 20 vessels are set out in Table C2.

Table C2: Volumes Delivered With Adjusted Shipping Queue (20 ships)

Test	Axle Load (t)	Train Length (m)	Train Payload (t)	Option 1 (mtpa)#1	Option 2 (mtpa)#2	Option 3 (mtpa)#3
1	15	691	2,226	55		53
2	25	824	3,358	65		65
3	30	1,307	8,036	156		172
4a	30	1,544	9,408	162		191
4b	35	1,307	9,676	162		191
5	30	1,606	9,800	168	187	191
6	30	1,699	10,388	165		193
7	30	1,791	10,976	168		193
8a	30	1,853	11,368	171		195
8b	35	1,544	11,328	171		195
9a	30	1,914	11,760	173		195
9b	35	1,606	11,800	173		195
10	35	1,699	12,508	182	192	196
11	35	1,791	13,216	184		197
12	35	1,875	13,688	184		193
13	35	1,936	14,160	not run		191

#1 Option 1: Gunnedah Basin trains at 6,100 t payload

#2 Option 2: Gunnedah Basin trains at approx. 8,000 t payload

#3 Option 3: Gunnedah Basin trains the same configuration as other Hunter Valley trains