THE CONTEXT FOR ARTC’S ROLE IN THE HUNTER VALLEY COAL CHAIN

Submission to the ACCC, prepared by Gattorna Alignment
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This report has been prepared on an independent basis to provide supply chain context for the ACCC’s assessment of ARTC’s operating costs in 2015.

Gattorna Alignment is the trading name of Gattorna Ellis Advisory Pty Ltd.
Introduction

The Hunter Valley Coal Chain (HVCC) is an example of a sophisticated ‘industry level’ shared supply chain. It is based on the principle that assets, although owned by different parties, are operated in concert to achieve an overall best result for both the industry and, in the long run, for each of the asset owners and their customers.

ARTC plays a key role in this supply chain, connecting 40 coal mines to the Port of Newcastle and the three terminal operations that load export coal, and to domestic end users. This role is defined by a set of constructs that have been developed over the last fifteen years, which aim to protect the individual competitive and commercial interests of the mining companies, rail providers, terminal operators, port and ARTC while providing the industry with an effective, internationally competitive supply chain to move coal.

A key aspect of the industry-level solution is maintenance alignment. As a bulk resource supply chain, it is capital intense, and asset maintenance must be factored into the operating regime of each participant with a resulting loss of available capacity. The major capacity lift that was achieved when the early version of a coordinated supply chain commenced in 2003, resulted from the alignment of major maintenance activities between the terminal assets and the track. Maintenance alignment, now extended to include load points and above rail, continues to underpin the benefits delivered by the cooperative model, and the approach to achieving it continues to be refined.
The Hunter Valley Coal Chain

The Hunter Valley Coal Chain extends considerably beyond the Hunter Valley and now includes mines in the Gunnedah Basin up to 364 km to the north west of the port, and in the Ulan region of the Sydney Basin up to 276km to the west. Currently 11 producers, operating 40 mines through 27 load points are served by the Coal Chain - the largest mine owners currently being Glencore, Yancoal, Whitehaven and BHP. Refer Figure 1.

Despite the coal price fluctuation over recent years, the export tonnes shipped from Newcastle have remained relatively stable (but with a shift towards the lower emissions, higher quality coal from the newer mines at the extremity of the network). See Figure 2 for an overview of export volumes and prices from the Port of Newcastle. Much of this stability derives from the historically very steady demand for Hunter Valley coal from Japan, Korea and Taiwan, which together represent approximately 70% of exports.

The value of annual coal exports from Newcastle averaged $13B from 2015 to 2017 or 5% of total Australian export revenue. The majority of coal mined in the region is thermal coal (+85%). The Hunter Valley typically produces high grade thermal coal that is valued by quality-focused buyers. To support this branding assurance, approximately 125 specific coal blends are sold from the Hunter Valley.
ARTC’s role in the Hunter Valley

ARTC operates approximately 560 kms of track in the catchment for Newcastle Port. The network supporting coal consists of a complex system of branch lines and loops linking to the main line and servicing the 27 load points. The track system for coal converges on three coal-loading terminals at the Port of Newcastle: Kooragang Coal Terminal (KCT), Carrington Coal Terminal (CCT) and Newcastle Coal Infrastructure Group (NCIG).

In addition to export shipments, approximately 6-7% of the tonnes moved by rail are destined for domestic power stations within the region.

The Hunter Valley track also supports passenger services, grain shipments from the Central West to Newcastle port, and intermodal freight.

For the coal industry in the region, ARTC as the track owner, provides a key linkage from mine to terminal; and the viability of the mines in the region, including the newer mines in the Gunnedah basin, have been dependent on their ability to access track capacity.

Track capacity without corresponding capacity at the terminal, however, provides no benefit. This interconnected nature of the coal chain became very clear after a crisis period from about 2007, where infrastructure constraints were holding back coal export sales and undermining the Hunter Valley’s reputation for supply reliability. At this stage there were changes made to align the capacity contracts between service providers in the coal chain, to embed processes to trigger new investment, and to formalise the cooperation between the major asset owners. These are the underpinning of the current mode of operation.
The constructs that govern the HV Coal Chain

The concept of managing the coal chain as an integrated, shared supply chain has been evolving since 2003, but became formalised from 2009. There are two key constructs that inform, or govern, ARTC’s role in this arrangement.

The 2011 Hunter Valley Access Undertaking reflects the commitment made by ARTC to the ACCC regarding how, as long-term lessee of the network, it manages and prices access to track capacity for the Hunter Valley coal industry in the best interests of the public, the industry, and ARTC’s shareholders. It positions ARTC’s role within the overall coal chain by specifying that Coal Access Rights are made available to a producer subject to the Hunter Valley Coal Chain Coordinator’s recommendations on the impact on the overall coal chain; and that an access holder must also have sufficient Network Exit capacity at the coal terminals to unload the tonnes indicated by its train path capacity.

The Hunter Valley Coal Chain Coordinator (HVCCC) was incorporated in 2009 as a central planning body. It is an independent, member-owned company operating under a ‘not for profit’ model, with a role defined in its Constitution to:

‘plan and co-ordinate the co-operative operation and alignment of the Coal Chain in order to maximise the volume of coal transported through the Coal Chain, at minimum total logistics cost in accordance with the agreed collective needs and contractual obligations of Producers and Service Providers’.

The body it emerged from (the Hunter Valley Coal Chain Logistics Team, formed in 2003), a collaborative centralised planning body formed by the service providers, was ground-breaking. Both incarnations have been widely referenced as models of how to achieve industry level efficiencies in complex supply chains.

The current members include all the key service providers and all coal producers in the Hunter Valley.

<table>
<thead>
<tr>
<th>PORT</th>
<th>TERMINAL OPERATOR</th>
<th>RAIL</th>
<th>ABOVE RAIL</th>
<th>COAL PRODUCERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Authority of NSW</td>
<td>Port Waratah NCIG</td>
<td>ARTC</td>
<td>Aurizon Freightliner (Genesee &amp; Wyoming) Pacific National Southern Shorthaul Railroad</td>
<td>Bengalla Bloomfield Centennial Coal Drayton Coal Sales (Anglo American) Glencore Hunter Valley Energy Coal (BHP Billiton) Idemitsu MACH Energy Peabody Whitehaven Coal Yancoal</td>
</tr>
</tbody>
</table>

The HVCCC provides the mechanism for aligning long-term capacity planning, as well as the annual, medium-term and day-to-day maintenance planning across the service providers.
Features of the end-to-end coal chain that impact ARTC’s operation

1. A complex multi-user network
ARTC supports passenger, grain and general freight movement through the Hunter Valley network, in addition to coal. The Hunter Valley network also joins the Sydney Trains network at Islington. Non-coal movements, including passenger, account for **approximately half the train movements** within the lower Hunter Valley network (including those running on dedicated non-coal lines between Maitland and Newcastle).

This multi-use dimension creates considerable complexity and distinguishes the Hunter Valley from the predominantly resource track systems such as those supporting iron ore in Western Australia. Passenger services are prioritised pursuant to ARTC’s lease conditions and reflected in the HV Access Undertaking, and the need to work with these scheduled services requires ARTC to minimise schedule disruption by conducting maintenance in condensed and planned time windows.

The other aspect of this inherently complex system is the limited visibility of future demand on the coal network. Actual demand, in the form of vessel nominations, is only known 14 days prior to arrival of a vessel. And on the supply side, the network is subject to the natural variability of the mining operation.

2. Track configuration and the funnel to port
The preponderance of **single track and single-direction track** is a key factor in the development of maintenance possession plans, and on the overall planning of maintenance across the coal chain. A closedown of a single-track line prevents movements either way, as does the dual track sections where the tracks are too close for a crew to safely operate adjacent to the open track. The single direction track also prevents a return journey so train fleets can be stranded at their initial destination if the return line is under ARTC possession for maintenance.
As shown above, the layout of the network itself is a constraint in the way the coal chain is operated and maintained. The tracks used for coal effectively form a **funnel into the port**. All export coal transits the lower reaches of Zone 1 to reach the terminals. Thus, most of the 159M\textsuperscript{th} tonnes/annum loaded through the three terminals at the Port of Newcastle in recent years, passes through Sandgate.

In contrast, the track supporting Central Queensland coal is more extensive and devolved. It comprises 2,670kms of track, servicing three distinct ports, delivering 200M tonnes in 2016-17.

### 3. Capacity restricted Zones

The two furthest source areas, Zone 2 and Zone 3 are **critical constraints** at both the track and overall system level. Their significance in the coal network has been growing, particularly as the large Maules Creek mine start coming online from 2015 in Zone 3 as shown in Figure 4 (this figure excludes domestic volumes, which have also been increasing out of Zone 2).
Both Zone 2 and Zone 3 are operating close to their available rail path capacity, so there is pressure to minimise the time lost through either planned or unplanned maintenance. Due to the need for coal from these zones to transit Zone 1, this has implications for the whole network.

The distance from port of these two zones is also a factor impacting maintenance planning in the network. The longer travel time to position crews and equipment drives more concentrated maintenance activity in the same way that longer changeover times in manufacturing drive larger batch sizes and less frequent product runs. There is also an incentive to maximise preventative maintenance in these zones to minimise any unplanned disruption. If trains are stranded in the constrained zones due to track-caused outages, the knock-on effect on above-rail and terminals is considerable.

The implications of the tight capacity in Zone 2 and 3 translates into reduced flexibility across the network, flowing on to the day-to-day planning and operations of the track, train and terminals and to maintenance planning.

4. Planned Maintenance Alignment
A key tenet of the cooperative supply chain model employed for Hunter Valley coal is alignment of maintenance planning and activity along the chain. The basis for pursuing this objective is that:

- Maintenance on one part of the coal chain system can preclude another part from carrying any flow. As seen in the discussion above, the terminal can be prevented from receiving coal if key parts of the track are unavailable. And train movements stop if all terminals are closed.
- There are also key inter-linked relationships that determine the level of impact, and which thus must be factored into planning to resolve a best solution. The stockpile capacity and configuration at the terminal, for example, determines the number of days of vessel loading that can continue with no inbound flow. Currently the practical limit at Port Waratah terminals is about 3 days. The available space for parking up trains can also be a constraint on the extent of the track network closedown.
- There are natural lulls in coal supply and demand that can be utilised for maintenance within a coordinated approach. When a longwall finishes in an underground mine, for example, there is a 6-8 week window without supply while it is moved.
It is clear that there is a significant **direct benefit from aligning planned maintenance**. At the simplest level, assuming only the capacity loss if the major shutdowns of terminal and track happened at different times, this would represent approximately **10% less system capacity**. But after factoring in rail provider and load point maintenance, and the smaller planned maintenance events that happen outside of system closedown, it is believed to be significantly higher.

The indirect benefit is the **predictability it delivers for end users**. The long term major markets for Hunter Valley coal, Japan, Korea and Taiwan, are predominantly FOB buyers and use regular shipping patterns, and some dedicated vessels, to supply their own stockpiles. Transparency and minimising outage time is valued. Many of them also use the information provided by HVCCC to plan their schedule around closedowns.

The current process for aligning major planned maintenance starts with each provider. An initial schedule of maintenance is developed according to standard equipment requirements and recommended time intervals. The sequencing then becomes important. ARTC’s initial Possession Programme, produced by end June for the coming year, becomes the base from which HVCCC works with the terminals and load point owners to create a system-wide plan. The output from this process, a 12-month coal chain major maintenance plan, has clear alignment between track and major terminal closedowns, and some smaller maintenance events and load points.

The snapshot of part of the Coal Chain Maintenance Plan shown below in Figure 5 highlights the track and terminal alignment of timing for major closedowns.

**Figure 5: Extract from HVCCC Maintenance Plan (source HVCCC)**
Modelling and analysis to date have supported the system-wide closedowns as the most effective way to align major maintenance. The current regime utilises six major aligned closedowns of 62-72 hours (related to terminal stockpile levels), and the number and duration of these are reviewed regularly as conditions change.

ARTC manages this short window by using mainly outsourced resources in ‘campaign’ style operations with long notice periods. They assemble equipment and materials at the various worksites across the network in advance to enable full use of the closedown window. A closedown typically involves 1100-1200 contractors at work sites across the network. As the time window has been set and all parties have factored it into their planning, ARTC’s obligation is to push as much maintenance as can safely be delivered into the shutdown period.

The interdependencies, both in the longer term and on the day of operations, have been compared to multicomponent system maintenance problems in production. But it is also recognised that the complexity of the convergence of several ‘sub-systems’ into an overall system is a particularly difficult practical and theoretical problem even beyond most manufacturing cases. Several teams led by Newcastle University have studied the maintenance alignment problem in recent years, and work continues within HVCCC and ARTC to develop sophisticated decision support to further optimise both the process and the outcome.

Unplanned disruptions are also a significant part of the coal chain operating environment. Most major disruptions are weather related. In April 2015 major flooding impacted the track; and there are frequent instances of vessels not being able to enter or leave the port for several days. On these occasions, HVCCC attempts to opportunistically coordinate and bring forward smaller planned maintenance events across coal chain participants, and ARTC attempts to position work crews quickly to take advantage of the situation and thus release track capacity after the event for recovery.

5. Blending impact
Blending is a particularly important instrument for revenue maximisation for producers operating in the Hunter Valley. It allows different coal qualities from across the region to be combined to meet end user specifications, thus leveraging higher quality coal and minimising the impact of lower quality, the latter usually coming from older mines. The two terminal operators use different stockpile strategies, which impact how blending is achieved. Port Waratah terminals operate as cargo assembly terminals – with stockpiles being built for a vessel on a just-in-time basis. In this case blending is usually undertaken at ship-loading by combining layers of coal from across discrete quality stockpiles. NCIG operates mainly dedicated stockpiles, which consist of coal blended from multiple train journeys. For both terminals, but particularly for Port Waratah, the timing and sequencing of trains from across the various locations is critical to achieving an accurate blend and timely assembly of complete cargoes for vessel loading.

This is a contributory factor influencing the way maintenance needs to be planned and managed in the Hunter Valley. As the table below indicates, almost 60% of the tonnes loaded at PWCS are sourced from more than one zone. And many cargoes are built from three or more load points. The implication of this for ARTC is the difficulty of taking only part of the network down at any time. There could be repercussions across several vessels if even one load point is not accessible.
6. Short notice maintenance

Whereas planned maintenance can be built into the capacity plans developed by HVCCC, unplanned track maintenance involves either a ‘short notice possession’ (SNP) schedule change or for ARTC staff to conduct ‘as time permits’ (ATP) maintenance, where the line is accessed between trains. In both cases there is pressure on ARTC to minimise maintenance time and any resulting capacity loss. To facilitate rapid response in these situations, ARTC maintains teams of maintenance staff and equipment at strategic points across the network.

The impacts of day-of-operation system losses flow through to the rest of the coal chain and end users. Delayed vessels caused by coal not getting to port on time translates into reduced reliability for end users, and demurrage costs for producers. The demurrage cost between 2015 and 2017 is estimated to have ranged from $A20-50 Million, even with relatively low vessel queues, and in peak queues in 2007 was known to be close to $A500 Million. For some of the closer mines to port it can be the largest component of their logistics costs.

The other activity that staff positioned at provisioning centres along the network enables is opportunistic maintenance to minimise possessions. When events such as train breakdowns occur, staff are able to take advantage of the window and bring forward maintenance that would have otherwise involved schedule changes and capacity loss.

Supply chain principles supported by the constructs

Several aspects of the Hunter Valley Coal Chain construct, and the current methods of operating and maintaining the assets within it, are rooted in established supply chain principles and some are considered to be leading edge practice.

System optimisation vs component optimisation

Within the constructs that have been developed since 2003, HVCC logistics is effectively planned as an end-to-end supply chain (or system) as depicted in Figure 7 below. Although the several interacting sub-systems, such as the mines, track, trains, terminals and vessel arrivals and the individual producer sub-systems, conduct independent planning regarding the logistics task, these decisions come together under the broader planning umbrella managed by the HVCCC.

The development of this collaborative, system-level approach, and the mechanisms to support it, arose from the realisation that independent and competitive decision making within the shared infrastructure...
environment was losing day-to-day capacity and also gave no clear path to capacity expansion. It was also apparent that the investment in parallel supply chains to port was never going to be viable or economically desirable for NSW.

FIGURE 7: THE HUNTER VALLEY COAL CHAIN ‘SYSTEM’ AND SOME OF THE ‘SUB-SYSTEMS’ WITHIN IT

This approach is consistent with the concepts that have emerged around systems thinking, and the lessons from supply chain optimisation projects regarding complex, interconnected supply chains:

- For integrated supply chains, the overall **optimal system solution** is invariably better than the sum of the sub-system solutions. So, for example, in a consumer goods supply chain, to minimise transport, inventory and warehouse costs in isolation of each other will give a poorer overall result than to seek to minimise the sum of their cost, because of the **trade-offs** involved. So higher transport costs may be warranted because of the reduction in inventory it allows. Thus, the concept of managing **Total Logistics costs vs component costs** has become well established.

- Supply chains should be clearly designed to **support an outcome**. This is usually to support revenue, and thus the ‘system’ includes the customer. Leading supply chain practice is for network design projects to optimise the end-to-end supply chain for least cost at a given service level (that which is thought to be needed to maintain or grow revenue). In the Hunter Valley the producer and the end user are both customers of the system, but where end customers value reliability, meeting expected vessel loading time is a proxy for both. The ultimate outcome for the coal chain to port is the **$13B in export revenue** it supports.

- The broader the scope of integrated decision making the greater the opportunity for minimising capital investment and cost, and for maximising outcomes. This is at the heart of many years of academic support for improving **collaboration along the supply chain**.

**Synchronisation and constraint management**

The second, well established, principle being pursued in the operation of the HVCC is the concept of synchronisation. This is the **harmonising of material flow between the nodes of a supply chain** via sharing information and coordinating activity. The aim is to operate smoothly across operational boundaries responding to a common signal, the ‘takt’ time of customer demand. Uncoordinated activity, and lack of visibility to the stage before, requires buffers in inventory and capacity to protect against variability and risk. Thus, the smoother the flow, the less investment required to support it. This is most relevant for the
stable part of the demand and supply profile, but with many long-established mines and end-customers this is a sizeable proportion of volume in the Hunter Valley.

Associated with the objective of smoothing flow, is the **management of constraints**. Goldratt’s work on the Theory of Constraints has been fundamental in its influence on the management of operational systems and is a focus in the planning of the coal chain. It identified that at any point in time there is a key constraint that defines the overall capacity of a system or sub-system; and advocates finding this constraint and focusing on ‘exploiting’ and protecting it to maximise system throughput. In the HVCC this has meant concerted attention to maximise and protect rail path availability on constrained sections of track; and a focus on buffering the ship-loading operation at the terminals so that the vessel turnaround is never impacted by a lack of appropriate coal.

**Shared supply chains**

The collaborative supply chain model operating in the Hunter Valley has largely been driven by the high capital requirements to move bulk resources from mine to port. The coal chain that has developed in response, however, is consistent with emerging trends for ‘shared supply chains’ - collaborating on logistics activity and sharing of assets, mainly driven by the need to reduce CO2 emissions, reduce energy costs and address urban congestion issues. The phrase ‘collaborate to compete’ is also often used to describe this model.

In the Australian context, shared supply chains are particularly relevant as industry-level solutions can bring scale opportunities unavailable to individual companies.

**Next stage of development for the coal chain**

The focus in the next couple of years across the HVCC is the increasing use of decision support systems in key aspects of planning. ARTC is developing a dynamic train scheduling system (ANCO) for the day-of-operations. This is expected to enable faster adjustments as variations occur across the network, to provide load points and train drivers with more information and to provide better visibility to opportunities for short notice maintenance without impacting capacity. For ARTC to respond to these opportunities they will need to maintain a pool of flexible resources.

HVCCC are also in the process of implementing a capacity planning decision support system (RACE), which will produce an optimised plan to guide assignment of resources in the period prior to the day of operations (1-30+ days). They also have projects earmarked on improving forecast accuracy. Both of these are expected to assist ARTC to plan and position planned maintenance activity so as to minimise impact on the network.

Maintenance alignment in general is such a key part of maximising the capacity of the coal chain that both HVCCC and ARTC have had regular engagement with academics and consultants to consider and test options, with current projects once again exploring alternatives, particularly those that could open up with the additional capability of RACE and ANCO.
Conclusion: The implications of the integrated supply chain

The HVCC is a complex, highly interdependent supply chain. This is a function of the shared track, coal loading terminals and port assets, and of the history and geography that concentrated so much coal volume in one region, converging on one river port. But it is also a result of the decisions made, over the last 15 years, to operate the assets involved in moving coal to port in a coordinated way in order to maximise utilisation of current capacity, and thus minimise capital investment and overall operating cost. To date this has been a prudent and commercially attractive way of operating for the parties involved; but with global thermal coal trade forecast to grow only incrementally or even stagnate from about 2022\textsuperscript{viii}, there is even stronger focus on fully leveraging the current dedicated assets.

This level of coordination at an industry level is not easy to achieve, and there is considerable interest in the HVCC as an example of a successful shared supply chain, with HVCCC receiving frequent requests from Australia and overseas for briefings on the model.

ARTC plays a key role in this supply chain and has been an important part of its development. But, as with the other major asset owners, particularly the coal terminals, the implication of the coordinated model is the need to consider if the decisions made at the strategic, tactical and operational levels with regard to coal chain capacity make sense at the ‘system’ level. For ARTC this means that while planned maintenance tasks are built up from maintenance standards and are primarily driven by safety, and corrective maintenance must have a quick response, where possible they also need to be delivered in a way that minimises the impact on overall system capacity.
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Endnotes


ii Tonnes measured as inbound to terminals in Calendar Years (Source: HVCCC data). Price is average $US. (Source: Office of the Chief Economist. www.industry.gov.au/OCE)

iii A total of 816 track kms


v Constitution of the Hunter Valley Coal Chain Coordinator, Schedule 1, Object of the Company.

vi Average tonnes 2014-2017

vii Source: GA chart, data from HVCCC. Refers to tonnes inbound to Newcastle Port, Calendar Year 2014-2018

viii Gattorna Alignment research for Port Waratah Coal Services, 2008-9


x Port Waratah terminals averaged 3.4 load points per vessel in 2015

xi Gattorna Alignment analysis, from HVCCC data


xiii Office of the Chief Economist (June 2018)


and
