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Dick Lees

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The Alice-Darwin railway: a feat of project management*

Dick Lees
General Manager, Special Projects, Kellogg Brown & Root Pty Ltd
Honorary Fellow, Institution of Engineers, Australia
Fellow, Australasian Institute of Mining and Metallurgy

SUMMARY: *This paper describes the project management of the 1420 kilometre Alice Springs to Darwin railway. The sponsor group included the Commonwealth, South Australian and Northern Territory Governments. The Asia Pacific Transport Consortium delivered the new line under a BOOT contract with the AustralAsia Railway Corporation. KBR invited the John Holland Group, Barclay Mowlem, Macmahon Holdings and Australian Railroad Group – all industry leaders – to join it in forming the Asia Pacific Transport Consortium. Funding was provided by both sponsor and deliverer under a BOOT structure.*

Project managing the design and construction is outlined, including the whole of life approach, quality, procurement, cost control and industrial relations.

1 BACKGROUND

The 1420-kilometre Alice Springs – Darwin rail line completes the Adelaide to Darwin Railway, thereby connecting all mainland states with the north of Australia and creating a 'landbridge' to Asia. It is a visionary project that will open up trade opportunities within Australia and overseas, and foster the development of regional industries.

Asia Pacific Transport, a consortium led by Kellogg Brown & Root Pty Ltd (KBR), succeeded in delivering the line ahead of schedule, within budget, and with excellent safety, industrial relations and local industry participation records. This success can be attributed to the consortium's management approach, which was characterised by excellent planning, commitment to innovation, and building good relations with stakeholders.

The Asia Pacific Transport Consortium delivered the new rail line under a BOOT (build, own, operate, transfer) contract with the AustralAsia Railway Corporation, which represents the interests of the Commonwealth, South Australian and Northern Territory governments. Design and construction of the railway was contracted by Asia Pacific Transport to a design and construction joint venture (ADrail), and was completed in October 2003. Operations commenced in January 2004. FreightLink, the consortium's operating company, will manage rail services for the first 50 years of the railway's life. This includes maintaining and operating the Tarcoola – Alice Springs line and overseeing port terminal operations at Darwin's East Arm Port.

The rail link will enable more efficient transport of goods between northern and southern Australia, and by reducing the time it takes for freight to reach Darwin, shipping to vital Asian markets will also be more cost-effective. The completed railway is opening up new opportunities for industries like mining, agriculture, aquaculture and tourism.

Constructed at a total cost of more than A$1.4 billion, this is one of the largest infrastructure developments ever undertaken in Australia. The construction project required 2 million sleepers (Fig 1), 8 million sleeper clips, 2.5 million tonnes of ballast (Fig 2), 2800

* Invited special focus paper accepted after review (April 2005)

km of rail, 15 million cubic metres of earthworks (Fig 3), 100,000 m of corrugated steel pipe for culverts, and material for 93 bridges, including crossings of the Katherine and Elizabeth rivers.

The consortium members did not just have their reputations at stake, but hundreds of millions of dollars of their own and their investors' money. How the project was managed was all-important.

Planning began well before the start of the project. The first step was to assemble the right team, so KBR invited the John Holland Group, Barclay Mowlem, Macmahon Holdings and Australian Railroad Group – all industry leaders – to join it in forming the Asia Pacific Transport Consortium.

Figure 1: Sleeper handling

Figure 2: Ballast transport

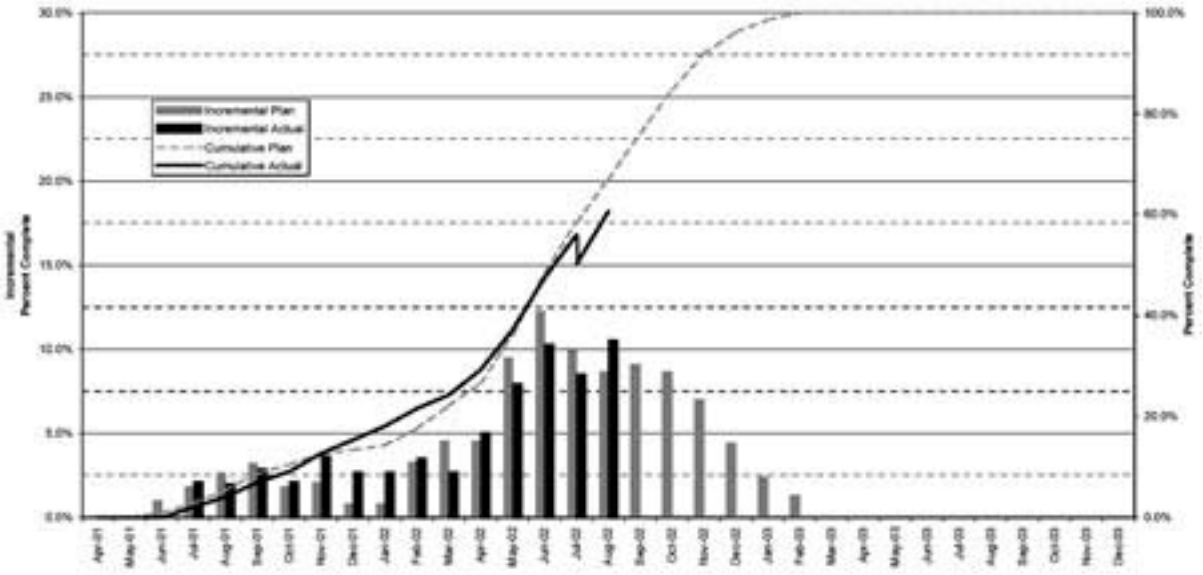

Figure 3: Bulk earthworks

2 PROJECT STRUCTURE AND FINANCING

Successfully completing a project like this took more than technical expertise, more than the wealth of experience on large-scale projects that all Asia Pacific Transport sponsors had. It demanded their total belief in the future of the railway, as is evidenced by their willingness to underwrite well over half the railway's total cost.

KBR managed the bidding process, led negotiations and ensured the financial support was in place. KBR also led the design and construct joint venture, called ADrail.

Following complex negotiations, the AustralAsia Railway Corporation and Asia Pacific Transport entered into a Concession Deed providing the framework for the design, construction and operation of the railway. This deed came into force at Financial Close, which involved 112 different signatories checking and signing 333 project documents.

The AustralAsia Railway Corporation provided $480 million of funding. The remainder (about $900 million) was raised by the consortium.

As a PPP project, the Alice–Darwin Railway is important on several levels. It has:

- allowed government to provide major civil infrastructure with limited financial commitment and risk;
- enabled taxpayers' funds to be deployed elsewhere;
- maximised industry participation;
- generated private-sector revenue;
- introduced commercial best practices.

It has also shown the Australian financial community that deals of this magnitude can be done, and done extremely well: the Alice–Darwin Railway Project was named *Global Finance*'s Asia Pacific Infrastructure Deal of the Year in 2001 and *Euromoney*'s PPP Deal of the Year in 2002.

To help ensure the project's viability, the consortium:

- assembled a team with expertise in operations, rail, logistics, design, construction, maintenance and project management, with the ability to self-perform these tasks, thus reducing the need to use more expensive methods of subcontracting the works;
- developed strategies for efficient and speedy construction of the new railway, incorporating innovative engineering and construction solutions and logistics planning that significantly increased the rate and reliability of trackworks construction;
- drew on the sponsors' collective experience in the construction of railways in remote locations, and experience in working with indigenous communities and maximising local content and labour – this in turn enabled a reduced cost structure;
- negotiated to include the existing railway from Tarcoola to Alice Springs in the project from commencement of construction of the new line, giving the benefit of the operational revenue to the project finances;
- structured the rail access code to provide a commercial framework to the consortium and its financiers for other competitive access seekers;
- gained support from the transport industry;
- negotiated a Concession Deed with the AustralAsia Railway Corporation that placed project and operational risk with the party best able to manage risk; in this respect the AustralAsia Railway Corporation accepted risks associated with land title, legislative requirements, indigenous matters and other matters outside the control of the consortium;
- maximised the opportunities provided by the recently completed Port of Darwin, which has a dedicated freight terminal giving direct access to the railway. This combination of infrastructure enabled the consortium to develop a business plan that combines domestic business with international trade.

Construction risk was supported by joint and several completion guarantees from the consortium members' parent companies for fixed-time, fixed-price project delivery.

Having regard to the linear construction risk of the project, liquidated damages were provided for 6% of the construction contract value. Additionally, the project sponsors used insurance bonding to provide additional security support for the government funding program, particularly over the first 24 months of construction.

2.1 Scheduling

As shown in Table 1, the time from project initiation to project delivery was a little over six years. This is a real achievement, considering the challenges of this greenfield project. The construction schedule was especially tight – just 30 months. Financial close was achieved later than expected, which put further pressure on the schedule.

Table 1: Project milestones

November 1997	Submission of expression of interest to tender for the BOOT project. Approximately 26 EOIs were received by the AustralAsia Railway Corporation
February 1998	Shortlisting of 3 tenderers
March 1998 to March 1999	Tender submission was prepared in this period including design and construction; maintenance plans; business plans; financial packaging, equity, debt and government contribution to the project; traffic forecasts for domestic and international freight; financial models; company details in support of consortium make-up, structure and ability to deliver; concession deed compliance
June 1999	Asia Pacific Transport achieved preferred tenderer status to enable further negotiations to take place with the AustralAsia Railway Corporation on key contracts and financial matters
November 1999	The consortium received the mandate from governments to deliver the project and to go forward to complete the project and financial documentation, finalise equity and debt provisions and achieve contractual completion and financial close
April 2001	Financial close was achieved, enabling the design and construction joint venture to commence construction of the Alice Springs – Darwin line (and the consortium to take over operation of the existing Tarcoola – Alice Springs line)
October 2003	Design and construction of the railway and the Darwin port was completed and handed over to the consortium
January 2004	Accreditation was obtained, commissioning testing of the railway completed, rolling stock procured, access agreement prescribed to enable operations to commence

The contractual date for completion of the design and construction works was 30 March 2004 to enable operations to commence on 1 April 2004. However, there were obvious advantages in commencing operations early, so the start-up date was moved forward to 15 January 2004. Construction was formally completed on 31 October 2003 with the issue of the Design and Construction Completion Certificate by the Independent Certifier. Progress and controls are shown in Figures 4, 5, and 6.

2.2 Project management

Asia Pacific Transport let the design and construction contract to ADrail, an unincorporated joint venture comprising KBR, John Holland, Barclay Mowlem and Macmahon.

All personnel who worked on the design and construction project were either seconded by the ADrail partners, or directly employed by ADrail. The selection criterion for project personnel was best candidate for the job, regardless of which company he or she came from. The Project Management Team, however, was structured to include a senior representative of each the partners:

- Project Director: KBR
- Commercial Manager: Barclay Mowlem
- Design and Construction Manager: John Holland
- Design Manager: KBR
- Construction Manager: Macmahon.

The Joint Venture Management Committee comprised the CEOs of John Holland, Barclay Mowlem and Macmahon, and KBR's General Manager, Special Projects. This structure helped ensure fast and effective decision making.

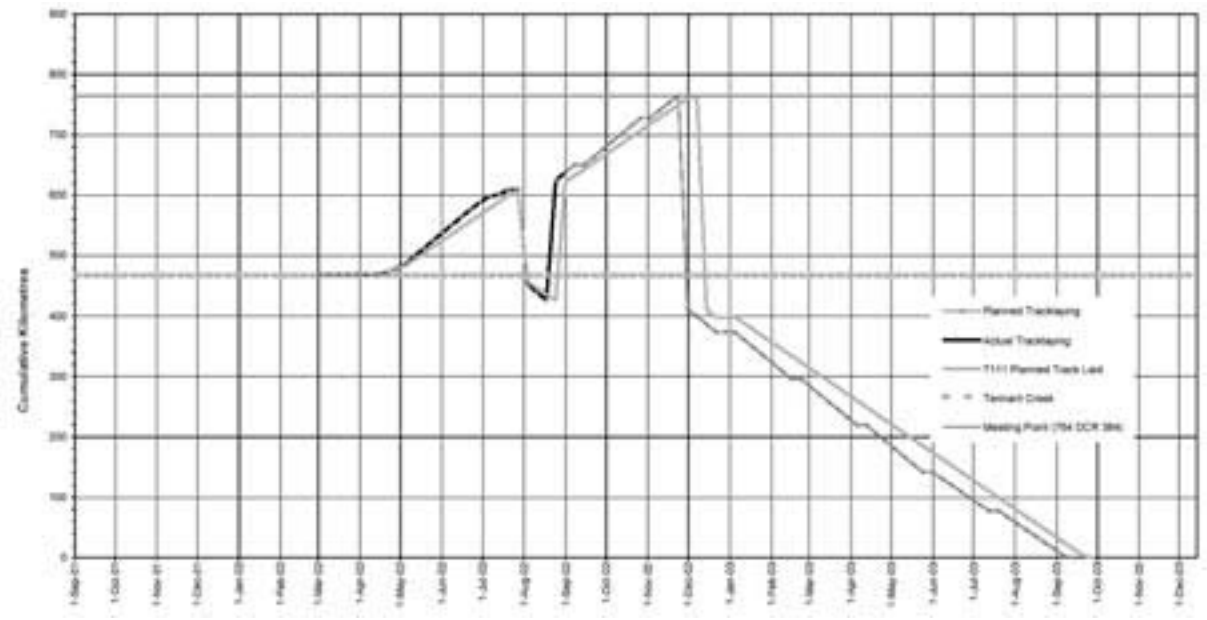

Figure 4: Track laying progress compared to baseline

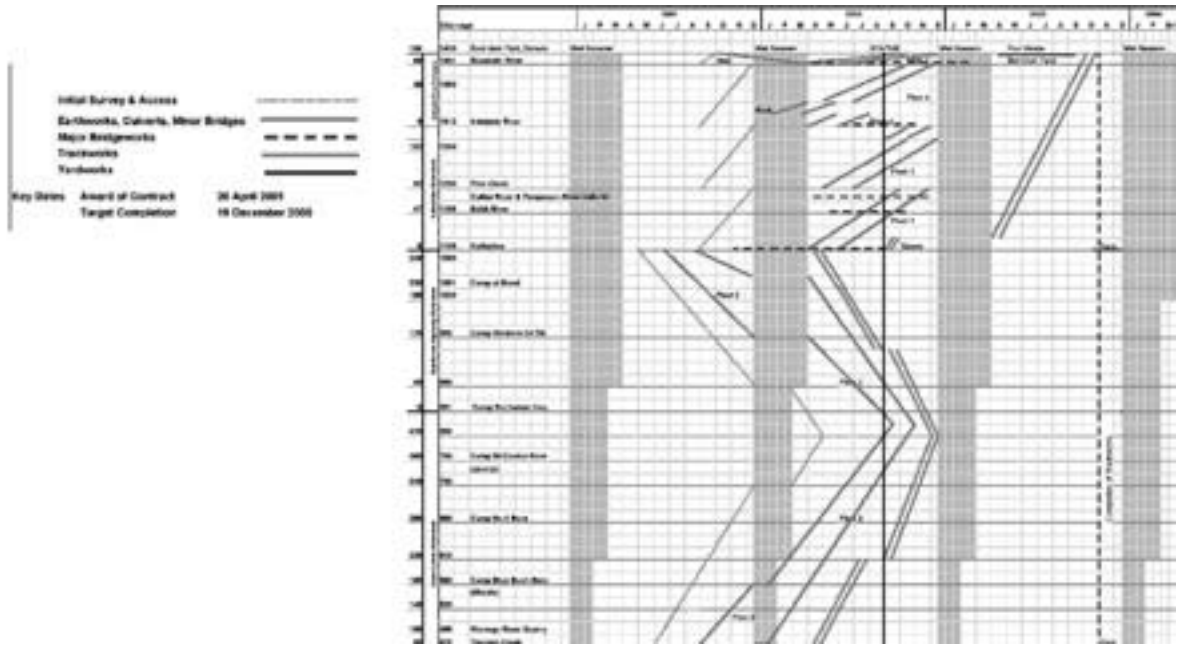

Figure 5: Line of Balance construction schedule

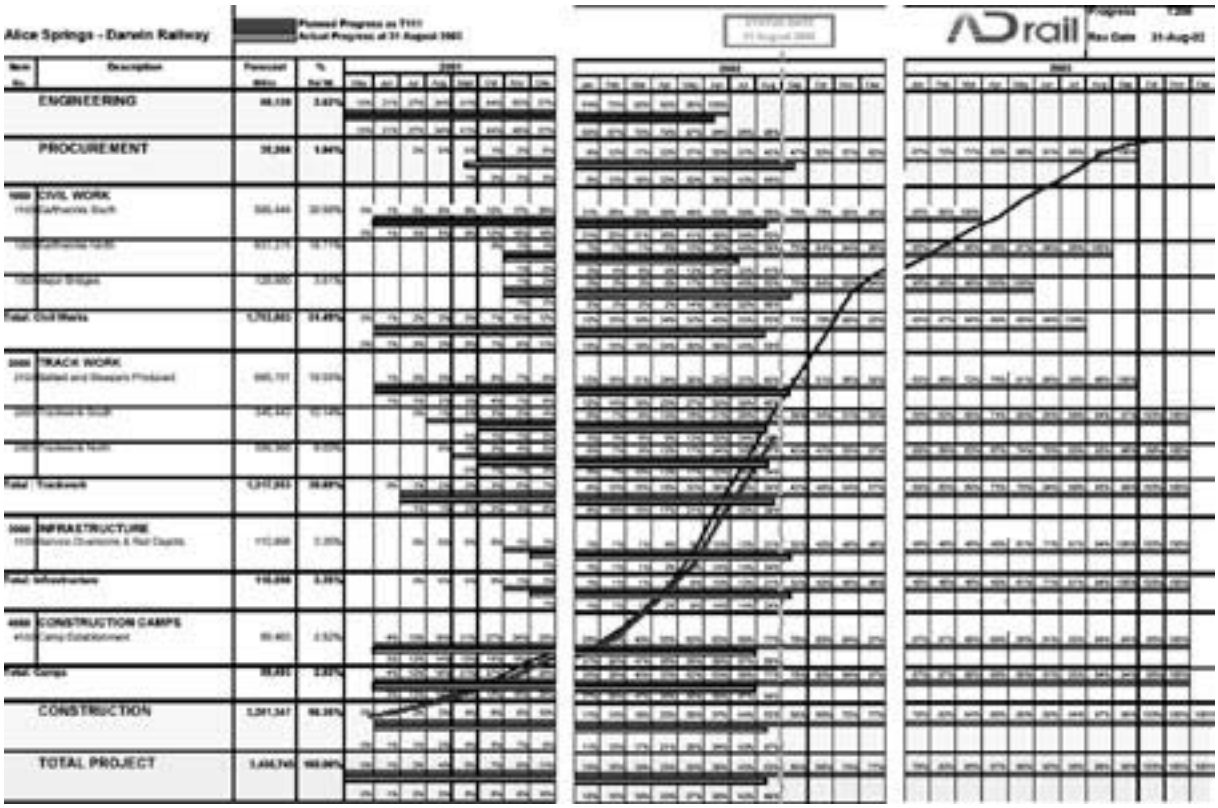

Figure 6: Example of progress chart

Additionally, each partner was called on to sponsor aspects of the project for which it had special expertise. This included:

- KBR: project management, cost control, procurement, design, environmental management
- Barclay Mowlem: trackworks (north), major bridges
- Macmahon: earthworks, culverts, minor bridges
- John Holland: trackworks (south).

One of the keys to the project's success was the consortium members' ability to work effectively with each other, putting aside their competitive instincts and focusing on the same goal. Management was open and transparent.

Initially there were difficulties in distilling the wishes of individual Management Committee members. This was overcome by appointing an independent executive chairman, who was successfully able to bridge the gap between the Management Committee and the Project Management Team.

3 DESIGN AND CONSTRUCTION

As well as good project management, the keys to meeting the challenges of distance, climate, scale and budget were simplicity of design and speed of construction.

3.1 Design achievement

The KBR-led design team had a lead-time of just eight weeks between financial close and the start of field construction, including time for approvals.

The original scheduling placed various bridges on the critical path, particularly those at the Katherine River and the Elizabeth River estuary. The simplicity of the design so speeded their construction that not only was this criticality removed, but the program was shortened. Once the designs were agreed, no changes to detail of bridges or culverts were requested by field staff and there were no errors requiring reworking of documentation.

All design documentation was reviewed by the Design Working Group, which represented the South Australian and Northern Territory governments,

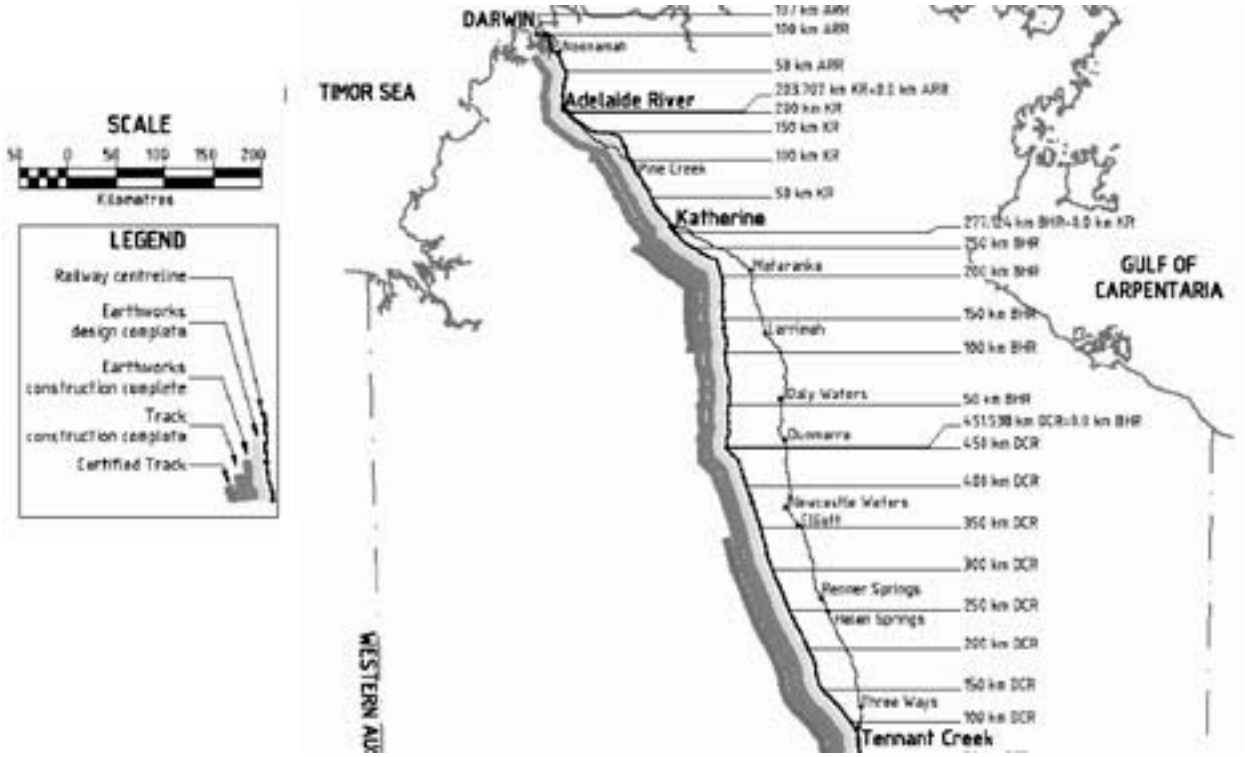

Figure 7: Design and construction progress north from Tennant Creek

AustralAsia Railway Corporation, the banks and Asia Pacific Transport. Construction was never held up by lack of design documentation. Design and construction progress north of Tennant Creek is shown in Fig 7.

3.2 Whole-of-life approach

From the beginning, the railway was designed with operations and maintenance as key considerations in assessing whole-of-life solutions and ensuring value for money.

- Track design: KBR carried out computer simulations of train operations in either direction to confirm optimum operating speeds related to gradient, locomotive power and hence fuel economy for all sections of the track; these were then used to calculate optimum rail cant (cross slope) to minimise wear and maintenance. The rail selection was based on wear considerations; the rail clips were designed to be removable (with special tools) for ease of sleeper replacement as necessary. Soft rail pads were not used because of life and replacement issues.
- Flood management: by investing in hydrological analysis, the consortium has minimised a major risk – flooding and track wash-aways – thereby substantially reducing operating and maintenance costs.
- Access: the consortium negotiated with AustralAsia Railway Corporation to secure a nominal 100-metre-wide operating corridor; this provided access and provisioning during operation and maintenance.

As part of the process for the design and construction of the railway, the maintenance and operations parties were required to sign off on the documentation. Accordingly, these parties were actively involved in the review of the construction to ensure that operational and maintenance parameters were included in the final product. Again this enabled the operator and the maintainer to accurately determine their commitments and ensure that a 'whole-of-life' approach to delivery was considered in the design and construction phase of the project.

3.3 Quality assurance

The consortium's strategy was to achieve full certification for the track as it was progressively built, so that construction traffic could travel at design speeds in order to support the very tight schedule and to ensure appropriate rail working safety.

The project quality management system was established as an intranet-based system, giving access to all documentation via servers located at

all sites. A comprehensive system of planned and documented internal quality audits was established. These included 55 internal audits, and a further 26 external audits conducted on subcontractors. Lloyd's Register Quality Assurance conducted a total of five audits during the contract.

At the commencement of the project the consortium set a nonconformance frequency rate (NFR) of 400 and a defect rate (DR) of 100, based on industry standards. The project achieved an average monthly NFR rate of 82.86 and a monthly DR of 2.05.

3.4 Logistical planning

The consortium's logistical strategy was a major factor in the early completion and overall success of the project. Using a 'fast-tracking' approach, the consortium divided the planning, engineering design and construction stages of the project into sub-projects that could proceed simultaneously, each with an area manager who reported to the Construction Manager.

3.4.1 Climate

Without doubt, the biggest logistical challenge was climate – the 1420-km rail route stretches from the monsoonal and tropical climate of Darwin to the relative aridity of Alice Springs. The potential for disruption to the tight construction schedule was high.

Rather than the more obvious solution of working from each end, using the larger centres of Alice Springs and Darwin as bases, the consortium established the major construction depots at Katherine and Tennant Creek. These towns are almost at the quarter points of the whole project, which made them ideal locations strategically.

This approach provided the opportunity for four work fronts (working north and south from each depot). In principle, three earthworks teams worked simultaneously, which meant the northern section was worked in the dry season, then that team moved south during the wet season, which stretches from December through March, sometimes later. Two track-laying crews were deployed, each laying 1.8 km a day.

At the northern end of the rail corridor, effective construction was halted during the wet season. The rains penetrate inland but their duration is progressively shorter, historically interrupting construction for approximately a month at the southern end of the line. However, nature makes its own decisions, and in 2001–02, the rains arrived early in the south and there was more rain than anticipated, requiring swift rescheduling and the redeployment of materials, camps and labour, together with daily reassessments of the situation. By contrast, in 2002, the rains didn't start until February.

3.4.2 Distance

Remoteness was also a major logistical challenge. Temporary construction camps were located approximately 100 km apart and had to be self-sufficient for water (reverse osmosis), power (generators) and sewage treatment. The camps were moved along the four sectors, and accommodated construction teams for earthworks, culverts and minor bridges.

It was recognised early that sleepers would be on the critical path, no matter how fast earthworks went, and that tracklaying required a steady material flow. One of the earliest moves, therefore, was to establish sleeper factories at Katherine and Tennant Creek to begin fabricating the more than 2 million prestressed concrete sleepers required, as shown in Fig 8.

The rail was rolled at Whyalla, South Australia, in 27.5-metre lengths and transported by train to a siding just south of Alice Springs. From there it was trucked to Tennant Creek or Katherine, then welded into 375-metre lengths, which were carried by train to the work fronts, together with a day's supply of sleepers. After laying, the rail was made fully continuous by site welding, and then the clips were fixed to complete the track laying prior to ballasting. Likewise, the rolling stock for the make-up of the construction trains was railed to Alice Springs then transported to Katherine and Tennant Creek for rail laying and ballasting.

The earth embankment was constructed from locally available materials, and KBR designed the track bed to take these differing materials into account. Ballast was sourced locally near Katherine and Tennant Creek.

KBR also considered the logistical challenges when designing the track and other infrastructure. For example, pre-cast concrete bridge beams, which were made in Darwin, had to conform to road freight limitations on weight and size. Major bridge progress is shown in Fig 9. Culvert design allowed the metal pipes to be spiral wound virtually on site.

The consortium subcontracted services wherever it would be more efficient (in cost or time) to do so. These subcontracts included ballast transport, fuel, work trains, air travel and camp operations.

4 PROCUREMENT AND COST CONTROL

The task the procurement team faced was daunting: sourcing the materials and services required for 1420 km of rail line. These goods and services all had to be sourced, purchased and supplied

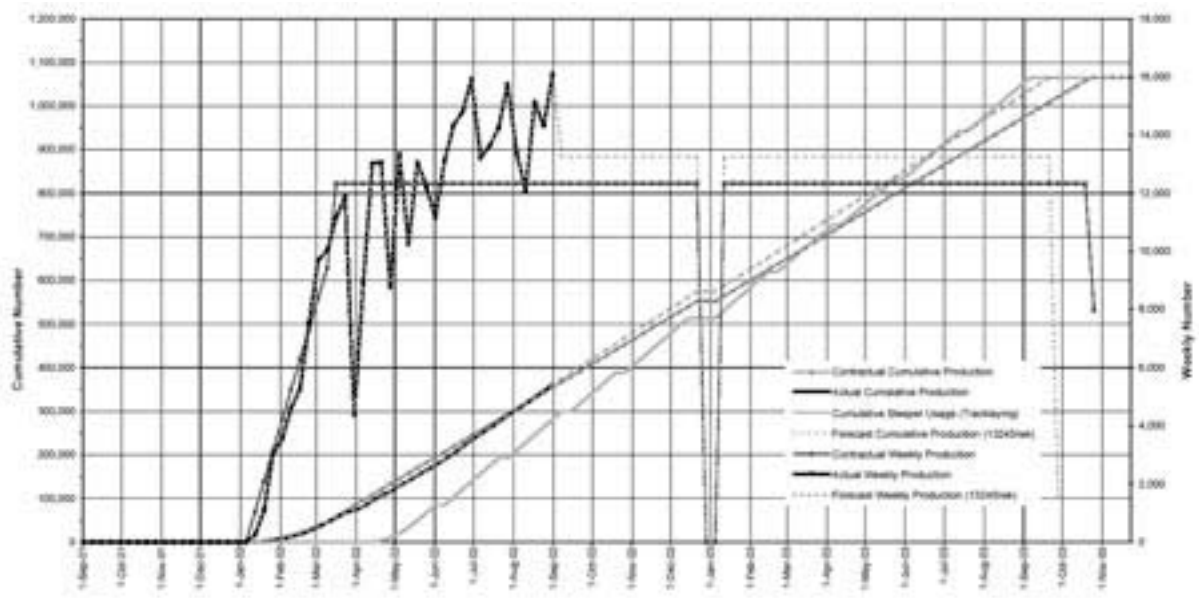

Figure 8: Sleeper production

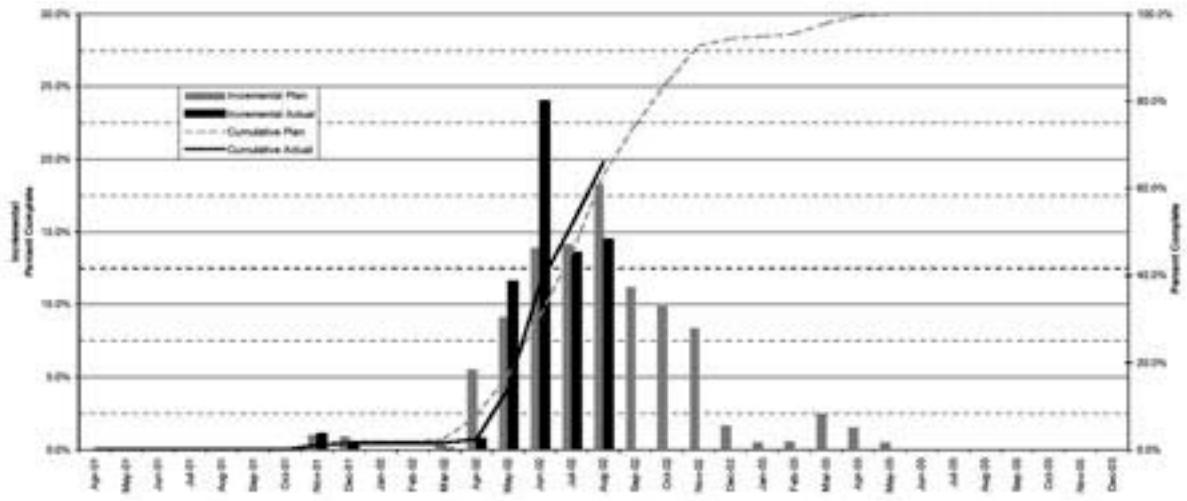

Figure 9: Major bridge process

within a very short period. Accordingly, effective procurement management played a key role in the overall efficiency of the project and was vital to keeping construction ahead of schedule.

The goods and services needed can be broken down into the following main groups:

- High-cost items: this was the main procurement task, involving around 700 packages totalling approximately $600 million; the packages in this group included some very large single items, for example, the steel rails, and the sleepers and sleeper clips for the trackworks.
- Goods and services required for temporary facilities; this category included the drilling and equipping of bores for supplying the water needed for construction, and all the day-to-day living facilities such as construction workers' camps, sewage treatment and water supply. Where possible the consortium used existing facilities (for example hotel accommodation) in line with its commitment to maximise local involvement.
- Consumables: as well as purchasing the main goods and services required for permanent and temporary facilities, the Procurement Team set up a field procurement group for the purchase of consumables/expendable items; these included spare parts for mobile and fixed plant, fuel, fencing, flagging and signage; more than 25,000 orders were placed for over 100,000 individual line items, valued at around $70 million.

- Rolling stock: the consortium contracted EDI Rail to design, manufacture and deliver the rolling stock, including four 4000-horsepower Q-Class diesel electric locomotives and fifty-five 48-foot 5-pack articulated container flat cars; the consortium also has a 10-year maintenance agreement with EDI to maintain the rolling stock it supplies; Bluebird Rail Operations is supplying and maintaining five crew cars, and other rolling stock are leased from Australian Railroad Group.

At the peak of the project, 2000 requisitions a month were processed. The Procurement Team had up to 12 staff dedicated to purchasing, and a further five who took care of subcontracts. A key measure of the success of the procurement task was the cost of processing the field orders: this was achieved at an average of $50 an order.

Apart from the sheer amount of goods and services required, there were a number of other procurement challenges; the main ones are outlined below.

4.1 Time

It was critical to the project's success that there be no delay in securing the high-cost, long-lead items. However, as noted above, financial close took longer than anticipated. Purchase arrangements were finalised prior to financial close, but obviously no commitments could be made until financial close had been achieved. The team had to keep these suppliers interested without making any commitment that it would possibly not be able to keep.

The Procurement Team was established in KBR's Adelaide office in early June 2000, nearly a year before financial close was achieved. It commissioned the survey and site investigations needed for the design work, and procured minor materials and services to support early works at the sleeper factories under construction in Katherine and Tennant Creek. It tendered as many subcontracts as it could, and negotiated with subcontractors and suppliers for major cost centres to the 'letter of intent' stage. The Procurement Team established an office in Darwin in late March 2001. All of this preparation meant that just six days after financial close on 20 April 2001, the team was ready to issue several key formal commitments, valued at approximately $300 million.

By the end of July 2001, just three months after financial close, the team had awarded a further 21 packages worth more than $1 million each and 41 packages in excess of $50,000 each. In addition, 20 new packages had been put out to tender.

4.2 Cost

Since the new line was constructed under a BOOT contract, for the project to be viable, construction cost had to be strictly limited. Given the stringent target cost per kilometre, the Procurement Team was under considerable pressure. It made sure it stayed attuned to local and non-local pricing by constantly studying trends and monitoring feedback from people in the field.

Cost engineers were located in each work area. Using a data-gathering and reporting network, they continuously updated actual cost and trended final forecast cost. This enabled the project management team to take the action required to ensure that the project was delivered for the least outturn cost.

4.3 Local content

The project's Local Industry and Aboriginal Participation Plan (LIAPP) provided the formal contractual basis for the consortium's commitment that the Northern Territory and South Australia would derive maximum economic benefit from the construction and operation of the line, and from the future development of the rail corridor between Adelaide and Darwin. The target was to spend 75% of the project construction cost in South Australia and the Northern Territory; this was exceeded, with the final figure in excess of 95%. The consortium achieved this largely because it retained control of procurement rather than subcontracting it out.

The consortium welcomed the involvement of the ISOs – the South Australian Industrial Supplies Office and the Northern Territory Industry Search and Opportunities Office – and representatives from each were resident in the project's Darwin Procurement Office, especially in the critical first 12 months of the project. The ISOs utilised their own systems to source potential suppliers, and the Procurement Team then invited the suitable ones to prequalify. The team reported back to the ISOs on a monthly basis, and its register of suppliers was audited regularly.

4.4 Communications

At any one time there were up to six remote construction sites continually being relocated. Accordingly, the project's procurement system combined paper-based and electronic systems. Early on the Procurement Team had investigated using a totally electronic system, but concluded that that would not have been suitable as most requisitions came from the field – which for this

project, often meant remote locations without access to reliable communications to support computers. (One of the very first procurement jobs was to set up temporary satellite dishes and phone and fax communications).

4.5 Quality

While the consortium had a requirement to maximise local content, this was not at the expense of quality – the Procurement Team constantly monitored the quality of the goods and services supplied. Additionally, it monitored key construction contracts for compliance with the National Code of Practice for the Construction Industry. A total of 29 packages were reviewed; all were found to fully comply with the Code.

5 PARTNERSHIPS AND INDUSTRIAL RELATIONS

The project used a mixture of union and non-union labour. The workforce was motivated, and no time was lost due to industrial relations. The project was praised by the Cole Royal Commission into the construction industry. It also had an exceptionally good safety record.

Relations with industry and local businesses were also important. The project's designers worked with local contractors to solve problems such as how to transport the long segments of rail from the depot to the construction site.

The project offered good training and employment opportunities. More than 1100 jobs were directly created during the construction phase, and Access Economics estimated that 7000 additional jobs were created nationally. There were about 1200 individual enrolments in project-related courses, and about 25% of trainees were indigenous people (the project set a new benchmark for Aboriginal participation on an Australian construction project). The Northern and Central Land Councils received a share in the project equity.

The project shows how engineering and construction companies can take a leading role in instigating major infrastructure developments as well as bringing them to fruition. It is a testament to the consortium's 'partnership' approach – the positive working relationships developed with governments, communities and industry. The completed railway is now operating, linking southern Australia with Darwin and beyond and opening up new trade opportunities to a range of Australian businesses.

The author would like to acknowledge the contribution of Franco Moretti, Tony Dawson and Gary Egan in preparing this article.

RICHARD (DICK) LEES

Dick Lees has over forty years' experience in project and construction management associated with major infrastructure and mineral resource development projects in Australia, the South Pacific, and South-East Asia. These projects have included some of the most remote locations in the region. As General Manager Special Projects he was the KBR representative on the $1,200 million Alice Springs to Darwin design and construct contract and prior to that as Deputy Project Director for the engineering and construction of the $1,200 million Lihir Gold project in Papua New Guinea.

Project experience includes feasibility study and audit assignments, through to engineering, procurement and construction management responsibility and lump sum turnkey design and construction work. The scope of work encompassed in these assignments has included mine development, mine services, mine facilities, materials handling, process plant and services, power generation, townships and camp sites, and general infrastructure requirements for resource projects.

He also held corporate responsibility to the former Kinhill Board for the performance and quality of the work undertaken by the group's then Mining and Minerals Processing Division and as Deputy Chairman of the Bateman Kinhill partnership during its start-up phase.

Qualifications

- Associate Diploma of Civil Engineering, Bendigo Institute of Technology, Victoria
- Construction Management Course, University of New South Wales

Current position

- General Manager – Special Projects, Brisbane
- Joined the company 1978

Professional affliations and appointments

- Honorary Fellow, Engineers Australia
- Fellow, Australasian Institute of Mining and Metallurgy