AUSTRALIAN CONSTRUCTION ACHIEVEMENT AWARD 2009

FINALIST SUBMISSION

PacificLink Alliance - Creating Tugun Bypass

Technical Report

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Abstract: The following document outlines some of the key issues contended with in the creation of the Tugun Bypass – one of the most long-awaited road infrastructure projects in South East Queensland.

INTRODUCTION

The $543 million Tugun Bypass was delivered by PacificLink Alliance in 27 months, despite five government stakeholder layers across two states, 20 approval authorities, a highly interested media and active community. The bypass' relatively short route does not adequately express the number and complexity of issues surrounding its design, approval and construction.

The alliance solved complex approvals, significant environmental constraints and difficult geology to deliver seven kilometres of high quality dual carriageway motorway linked to two state traffic systems, six bridges and a tunnel under the Gold Coast Airport future runway expansion.

The alliance project team has redefined through innovation and professionalism what is possible in an Australian construction context. The team overcame extraordinary challenges and delivered one of Australia's highest quality roads.

ACHIEVEMENTS INCLUDE:

- Built a tunnel top down in a swamp, under an airport flight path, adjacent to an environmentally sensitive area, on Federal Government land, which connected a road between New South Wales and Queensland;
- Met 'impossible' early deadline – Essential Tunnel Works delivered by 10 November 2006, a period of only 8 1/2 months, 3 1/2 of which were consumed in developing and gaining approval of complex, detailed environmental management plans;
- Project completion six months early, delivering the project in 27 months and 3% under the target outturn cost;
- Crossed five government jurisdictions – two state, two local and federal – and had 20 approving bodies;
- Constructed a tunnel 12 metres below the water table and met all leakage criteria;
- Installed life and fire safety systems which permit Australia's only 100 kilometre per hour speed environment tunnel, with all but two classes of dangerous goods allowed;
- Worked adjacent to SEPP14 wetlands, including extensive dewatering without impacting the sensitive environmental area;
- Took extraordinary steps to address environmental challenges and meet community expectations, including testing and installation of a frog-specific fence;
- Worked below an operating airport flight path with maximum headroom of only six metres;
- Excellent health and safety record, including 500,000 hours worked lost time injury free;
- Proactive and open communication with 120 community groups and the local community, and delivered major legacy project walking trail through Hidden Valley;

- Delivered an outstanding urban design solution through urban and rural landscapes, flat and undulating land, and in two states, within a distance of only seven kilometres;
- Constructed Hidden Valley bridges using an innovative bridge launching system to minimise the impact on the sensitive environmental valley below;
- Top down construction of Tugun Hill bridge to maintain access for residents, then excavated 25 metre hill in two weeks; and
- Minimised traffic disruption while tying into live interchanges carrying 40,000 vehicles per day.

The construction of Tugun Bypass is truly testament to what can be achieved when the constructor works with the designer and client to develop and deliver innovative solutions and, ultimately, a remarkable project. PacificLink Alliance was an alliance between Abigroup Contractors (contractor), SMEC Australia (designer) and the Queensland Government Department of Main Roads (client).

SCOPE OF WORK

Completed in mid-2008, the Tugun Bypass has provided a new, motorway standard link between Queensland and New South Wales (Figure 1), easing congestion and reducing travel times for tourist, heavy vehicle and local traffic. The bypass is four lanes wide, with provision for upgrading to six lanes and a rail line in the corridor.

Final approval of the project was received from the Federal Government in February 2006. Construction works for the Tugun Bypass began in June 2006. Design, construction and commissioning of the project was completed in 27 months, six months early, and 3% under the target outturn cost.

The project team demonstrated innovation and creativity to skilfully navigate a complex maze of planning, environmental, jurisdictional and cultural heritage issues, any one of which could have derailed the project.

PROJECT ELEMENTS

The Tugun Bypass project included design and construction of:

- seven kilometre dual carriageway (provision for upgrade to six lanes);
- 334 metre tunnel underneath the Gold Coast Airport runway extension;
- six bridges, including four overbridges and twin bridges across a valley;
- 800,000 cubic metres of earthworks;
- 160,000 cubic metres of concrete; and
- 100,000 tonnes of asphalt.

Installation of complex mechanical and electrical systems, including:

- microwave and wireless connections to two traffic management centres using different traffic control systems in two states;
- automated tunnel fire control system;

- detection systems including over height vehicles; traffic speed, volume, type and weight; air quality; and water level; and
- remotely monitored impressed current cathodic protection system.

The advanced life and fire safety systems have resulted in the only tunnel in Australia with a 100 kilometre per hour speed environment, and with all but two classes of dangerous goods allowed.

The preliminary EIS identified areas of high environmental value, including protected wetlands, significant vegetation, culturally significant areas and areas containing threatened flora species and fauna habitat.

The project took extraordinary measures to:

- protect endangered fauna including Wallum Sedge frogs, planigales, potaroos, and sugar gliders;
- relocate or revegetate threatened flora;
- manage acid sulphate soils and sites contaminated with heavy metals; and
- provide compensatory habitat.

The alliance was also responsible for:

- consultation with 120 active community groups with a vocal minority opposing the project;
- managing five layers of government stakeholders and a highly interested media; and
- approvals from more than 20 bodies, including Gold Coast Airport Corporation.

ESSENTIAL TUNNEL WORKS

The Essential Tunnel Works (ETW) were a critical part of the project delivery. They had to be completed by 10 November to avoid harsh penalties by the Gold Coast Airport Corporation.

The ETW scope included:

- construction of 17,200sqm metres of tunnel diaphragm walls and barrettes using 16,500 cubic metres of concrete and 4,260 tonnes of reinforcement steel;
- excavation and construction of tunnel roof slab, including 9,000 cubic metres of concrete, 2,960 tonnes of reinforcement steel and an average concrete pour of 630 cubic metres and maximum of 2250 cubic metres per day;
- installation and commissioning 21 extraction wells and 44 re-injection wells for groundwater management, an average 20 metres deep;
- installation of 58 deep-well cathodic protection anodes of 30 metres depth;
- installation of 9,000 square metres of primer and waterproofing membrane and 9,000 square metres of concrete protection slab to roof structure;
- installation of a groundwater cross drainage system;

- construction of the rail slab, including 18,500 cubic metres of concrete, 1,550 tonnes of reinforcement steel and an average concrete pour of 1,500 cubic metres; and
- placement and compaction of 12,000 cubic metres of cement treated backfill and sand fill over the completed works.

TYPE OF CONTRACT

The $543 million Tugun Bypass was delivered by an alliance between Abigroup Contractors (contractor), SMEC Australia (designer) and the Queensland Department of Main Roads (client). The project was jointly funded by the Queensland and Federal Governments, with the federal contribution capped at $120 million.

In July 2005, Main Roads sought proposals from consortia interested in entering into an alliance to design, construct and maintain the bypass. Initiating a competitive alliance (dual target outturn cost) selection process in parallel with the final stages of the approvals process helped enable a timely start to construction, once the necessary approvals were obtained.

A number of key points made this alliance contract innovative, including using a competitive alliance process, a dependent long term maintenance contract and significant non-owner participant incentivisation.

The alliance method of project delivery adopted for Tugun Bypass produced a number of project management 'firsts' for Main Roads and has significantly influenced the method of future project delivery, as well as adding to the body of 'alliance knowledge' in Australia.

DUAL TOC ALLIANCE

Due to concerns about the ability to achieve value for money without some time flexibility to negotiate an appropriate target outturn cost (TOC), a competitive or dual TOC process was chosen whereby two parallel interim alliances were appointed to develop a complete design and construct proposal, including a fixed TOC.

The interim alliances were very compressed, with a period of fourteen weeks for this work. The process ensured innovation, value for money and a competitive TOC, as well as providing some certainty in the buoyant market that a suitable proponent team was available and that at least one project team would meet all the project approvals required.

The competitive interim alliance process resulted in Main Roads paying for each of the two proposal developments, only one of which was ultimately used. However, benefits exceeding the cost for the unsuccessful proponent were achieved by transfer of intellectual property from the unsuccessful proposal and as a result of the competitive environment in which the TCE was developed.

DEPENDENT LONG TERM MAINTENANCE CONTRACT

The Tugun Bypass project was the first project in Queensland to use an alliance design and construct form of delivery in conjunction with a dependent long term maintenance contract. This contract was set in place in conjunction with the design and construct alliance contract. It was designed to encourage the constructor to

focus on quality workmanship to minimise their future maintenance costs. The scope of works and technical criteria (SWTC) was developed around the minimisation of whole of life (WOL) costs. These were reflected in the durability requirements (design life) for each element.

The costs of the maintenance contract tender, which had to be submitted by each of the proponents concurrently with their design, and TCE were taken into consideration in the selection of the preferred proponent.

TIME AND KRA INCENTIVISATION

The project alliance agreement (PAA) and the SWTC stipulated fitness for purpose of the design and construction. In addition, the non-owner participants of the alliance were incentivised under the PAA for achieving results in terms of early completion (and hence availability of the bypass to the travelling public) and performance in key result areas (KRAs) including quality, environmental performance, key stakeholder relationships, community relations and urban design. The KRAs were regularly measured and reviewed throughout the life of the project, to ensure that the project was tracking towards a successful outcome.

OUTCOMES ACHIEVED AGAINST PLANNED TARGETS FOR KEY PROJECT PARAMETERS

PacificLink Alliance was an extremely successful alliance by any measure. The alliance easily exceeded the key result area (KRA) targets and other project parameters.

KEY RESULT AREAS

In addition to cost and time performance, the stipulated key result areas (KRAs) were in areas of importance to the owner, the Queensland Department of Main Roads: quality, environmental performance, key stakeholder relationships, community relations and urban design. Both time and KRA performance were incentivised under the terms of the PAA. Both the KRAs and the key performance indicators (KPIs) used to evaluate achievement were regularly reviewed and actioned to ensure a successful project outcome.

The first performance review conducted in June 2006 recorded an overall performance score (OPS) less than 60% (ratings: 0% fail; 50% business as usual; 100% outstanding).

At completion, the score was 76% (Figure 2). This outstanding improvement was led by community (increased from 60% to 79%) and quality (45% to 80%) KRAs (Table 1).

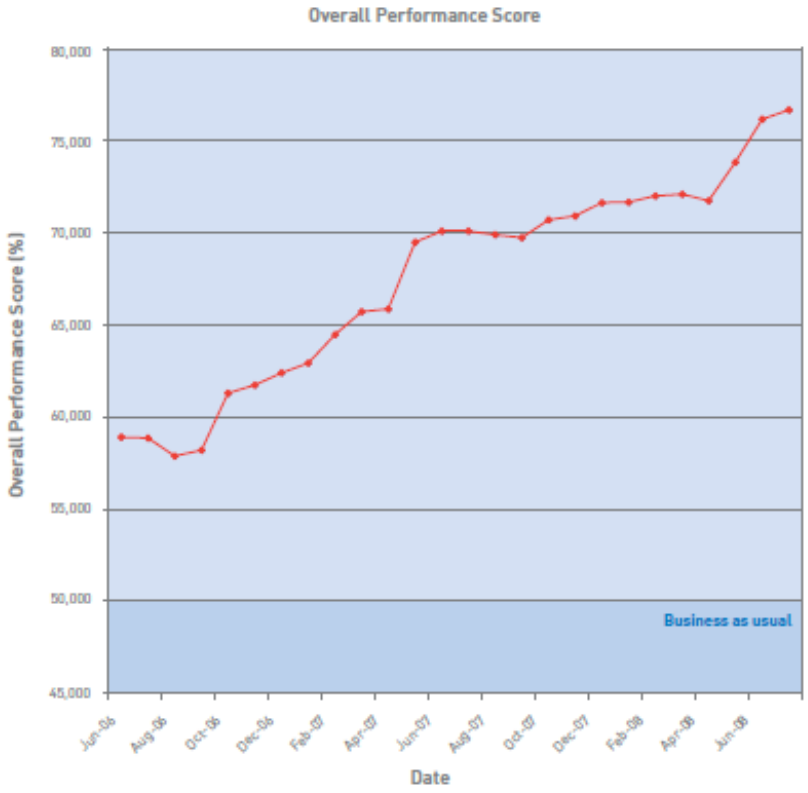

Figure 2 Overall performance score Achievement

PROJECT PARAMETERS

The Tugun Bypass was also highly successful as rated by other project parameters:

- **Safety** – outstanding safety outcome of 2.26 lost time injuries (LTIs) per 2.39 million hours (industry average 8-9 LTIs per 2.39 million hours); achieved more than 500,000 hours LTI free.
- **Time** – delivered in 27 months and six months ahead of schedule, including Essential Tunnel Works (ETW) in five month construction period
- **Cost** – completed 3% under the target outturn cost (TOC), which was developed under a competitive dual TOC alliance
- **Sustainability** – reduced travel times by up to 15 minutes; design allowed for future transport requirements; re-used and recycled materials; used energy efficient plant and equipment; and carbon dioxide emissions from traffic reduced by 11,000 tonnes per year initially, increasing over time.

Table 1 Key Result Area achievement Score

KRA	KPI	Weight	Score
Quality	Quality of tunnel design and construction, final ride roughness and quality assurance system.	20%	80%
Environment	Environmental incidents and management, awareness and participation, legacy and innovation.	20%	79%
Relationships	Health of relationships with key stakeholders, including RTA, EMR, Main Roads, Gold Coast Airport and the project verifier.	25%	69%
Community	Responsiveness to issues, community engagement, team commitment.	20%	79%
Urban design	Quality of urban and landscape design, as designed and constructed.	15%	78%
Total			76%

COMPLEXITY, DIFFICULTY AND OPTIMISATION OF THE CONSTRUCTION TASK

Despite the relatively short seven kilometre length of the Tugun Bypass, it was an extremely complex project. Construction challenges included:

- integration with two traffic management systems in Queensland and New South Wales;
- tying in to live interchanges carrying 40,000 vehicles per day;
- top down tunnel construction 12 metres below the water table;
- diaphragm wall tunnel construction;
- essential tunnel works completed in five months;
- maximum headroom six metres under operating airport flight path;
- complex geology including contaminated land and acid sulphate material; and
- bridge beams launched over environmentally sensitive valley.

STAKEHOLDERS

The program began in a highly emotive environment with the bypass having been under consideration for more than 10 years. This was compounded by the highly complex political environment of the project.

The project crossed five government jurisdictions – New South Wales, Queensland and Federal Governments; Gold Coast City Council; and Tweed Heads Shire Council. The project also involved more than 20 approving bodies, including the Gold Coast Airport Corporation.

CONSTRUCTION OPTIMISATION

The construction team faced many challenges delivering Tugun Bypass on time and to budget. Innovation and commitment to best for project outcomes led to breakthrough results.

AIRPORT RESTRICTIONS

Constructing the tunnel on airport land in close proximity to an operating flight path posed unique project risks.

A close working relationship was established with the Gold Coast Airport to access land. Regular meetings with key players ensured this relationship was maintained and all issues were addressed.

All staff engaged on the project had to be specially trained to safely access the airside of the airport. NOTAMs (Notices to Airmen) needed to be issued for all works on the airside to ensure pilots were aware of issues of direct operational significance and changes that may affect aircraft operations. Security also had to be provided for the airport land.

The tunnel was constructed on airport land with maximum headroom six metres under an operating airport flight path. Special low headroom equipment was sourced for construction. In many cases, equipment simply was not available and existing plant had to be modified. Examples included cutters for the diaphragm walls, concrete conveyor systems, telescopic booms and concrete pumps.

Once the Essential Tunnel Works were complete, the airport contractor built the runway extension over the top of the tunnel, while the alliance conducted excavations underneath. This required innovation in design to allow for construction loads on top of the incomplete tunnel, rather than the uplift loads that it would endure in its final state.

URBAN DESIGN

The Tugun Bypass, within its length of seven kilometres, passes through urban and rural landscapes, flat and undulating land, and crosses the border between Queensland and New South Wales. This posed a unique challenge to develop an urban design progression in a short length, while also complying with standards and expectations of two state road authorities.

Peer review assessment of the landscape and urban form considered the mix of road users and adjacent uses; best practice in construction at a national level; endorsement by stakeholders; cultural expression; and the border crossing. The urban design received excellent scores approaching outstanding.

Comments from peer reviewers included:

- unique, unusual and most striking of any border marker in Australia;
- used a mixture of indigenous and contemporary artwork in the noise barriers, retaining wall and tunnel walls;
- strength of integration between design and construction detail to achieve high quality result;
- large majority of stakeholders impressed with urban and landscape design; and
- contemporary inclusion of subtle indigenous references sensitive to the Gold Coast area.

HIDDEN VALLEY BRIDGES

Hidden Valley is an environmentally sensitive area. Construction needed to pass over the top of the valley, with minimal disturbance below.

The project team adopted an innovative bridge launching system that had minimal impact on the valley below. The Hidden Valley bridges were constructed with a specifically designed launching truss and crane to allow trusses to be placed without requiring cranes in the valley below.

Existing vegetation below the bridges was retained with minimal impact. To ensure vegetation continued to thrive below the finished bridges, the design was modified so that rain water runoff was directed beneath the bridges, rather than away from them as is typical. The innovation and attention to environmental aspects were appreciated by the community and environmental groups. The vegetation around the bridges is still healthy and flourishing.

TUGUN HILL BRIDGE

Construction of Tugun Hill bridge posed unique challenges. The 25 metre deep excavation of Tugun Hill was essential to connect the southern part of the site to the northern section. However, an access road across where the site was to be excavated was essential to allow property access for Tugun Hill residents. There was no alternative route available, or possible.

The alliance team therefore redefined the situation and constructed the bridge top down, with the top of the bridge constructed on the original ground level. The bridge was constructed as a monolithic structure – all in one piece with integrated headstock, girders and piers. Once the bridge had been constructed, the ground was then excavated beneath it in only two weeks. Spoil was used as fill on other parts of the site.

The top-down approach to the Tugun Hill bridge construction maintained access to residents' properties, but also allowed construction in a safe manner, eliminating the risk of working at heights of 25 metres. The finished bridge is a slimline, unobtrusive bridge.

To complete the task, the batters had to be revegetated. Geotechnical investigations had indicated that the cutting would be weathered rock. However, after excavation the batters were found to be extremely weathered material that was dispersive and

had a very low pH. After a trial, a compost Ecoblanket was chosen to be applied to the batters. The treatment was an erosion resistant mix that would grow grass, which would die and become compost for trees, providing effective revegetation of the site. After 12 months, there are more than 30 native species growing profusely on the batters.

LIVE INTERCHANGES

Traffic disruption had to be minimised while tying in to live interchanges carrying 40,000 vehicles per day. The design phase of the alliance reviewed traffic sequencing arrangements for constructability and operation.

This was implemented with no serious disruption to traffic flows and no significant complaints from the public.

SYSTEMS

The mechanical and electrical systems of this project were highly complex. A whole of project approach was taken, despite different systems being required north and south of the state border. Key features included:

- job-specific hardware and software, developed for the job and to allow connection and controls to two different traffic management systems in two different states;
- microwave and optical fibre connections to two traffic management centres using different systems in two states;
- VMS and VSLS signs wirelessly linked at project boundaries;
- tunnel monitoring 24/7 via connection between fixed CCTV and the Nerang TMC;
- completely automated fire control system in tunnel – requires manual intervention to stop it;
- motorway emergency phones and full length ptz (pan-titt-zoom) CCTV coverage;
- minimum 50% redundancy in M&E systems with 99.995% reliability required;
- two new sub-stations and on-site two megalitre backup supply of water for the fire deluge system;
- detection systems including over height vehicles; traffic speed, volume, type and weight; air quality; and water level; and
- remotely monitored cathodic protection system.

ENVIRONMENT

The environmental impact statement (EIS) identified areas of high environmental value along the alignment, including protected wetlands, significant vegetation, culturally significant areas and areas containing threatened flora species and fauna habitat.

The project took extraordinary measures to:

- protect endangered fauna including Wallum Sedge frogs, planigales, potaroos, and sugar gliders;
- relocate or revegetate threatened flora;
- manage acid sulphate soils and sites contaminated with heavy metals; and
- provide compensatory habitat.

COMMUNITY

This politically sensitive project faced more than 120 active community groups with a vocal minority of opposing stakeholders, five government bodies (two local, two state and federal), stakeholders, and highly interested media.

A “no surprises” approach was adopted to minimise anxiety and disruption, and foster confidence among community members during project works. Personal and targeted consultation with local residents, businesses and stakeholders fostered positive relationships, thus providing the foundation for good relationships and resolution of issues.

Outcomes included:

- community input through the community liaison group;
- construction vehicles kept off local roads to accommodate community concerns;
- successful implementation of off-road noise treatment program for 100 residences – a first for Main Roads; and
- community legacy project to provide pedestrian access between Currumbin and Tugun.

LOGISTICS

Tugun Bypass had a long, narrow footprint dictated by environmentally sensitive surrounding areas, adjacent housing and the Gold Coast Airport. Programming had to ensure there was continuous access along the project length. Airport airside access to allow access along the project after the ETW and before the tunnel was trafficable was granted after special CASA training and as a result of trust built up over several months.

PROGRAM

The program was initially dictated by the need to complete the ETW so that Gold Coast Airport could complete their runway extension. The ETW was completed in five months, with the entire project completed in 27 months, six months early.

COST

The innovations register was central to delivering the project 3% under TOC. Approximately 67% of the 216 innovations recorded were implemented and completed – 23 had significant cost savings ($50,000 - $100,000) or KRA performance improvement (20%).

HERITAGE

The draft EIS included a cultural heritage study. Following formal submissions, Main Roads funded additional studies in consultation with local indigenous bodies. Cultural heritage management plans were prepared in accordance with legislation in two states. Extensive consultation was undertaken with all endorsed, traditional owners.

Whilst a cultural heritage study of the proposed route had been included in the draft EIS, following formal submissions, Main Roads funded additional studies in consultation with local indigenous bodies.

Cultural Heritage Management Plans (CHMPs) were recommended and were prepared in accordance with the National Parks and Wildlife Act 1974 (NSW) and Aboriginal Cultural Heritage Act 2003 (Qld). Extensive consultation was undertaken with all endorsed, traditional owners. The management strategy within the CHMPs included a literature review and database searches of the area, geomorphological assessment, archaeological assessment and monitoring.

After Main Roads could not reach agreement with one party, they referred the Queensland CHMP to the Land and Resources Tribunal (LRT) for adjudication. The LRT upheld the validity of the CHMP.

LEADERSHIP AND MANAGEMENT OF THE PROJECT DELIVERY

The success of PacificLink Alliance is grounded in the development of an innovative and emotive project philosophy that encapsulated the quest for construction excellence but at the same time set the parameters for alliance behaviour. The project philosophy was to create, “A journey to remember”.

The alliance charter defined “A journey to remember” as being the process of creating highly valued infrastructure which exceeded expectations for quality, delivery and safety and was delivered below budget and ahead of schedule.

OCCUPATIONAL HEALTH AND SAFETY

The outstanding health and safety outcome was achieved through extensive training, inducting all people who entered the high profile project site, and a continual focus on safety. Safety outcomes were measured, but importantly safety lead indicators were also tracked, such as inspections and observations, weekly tool box safety talks and monthly safety committee meetings involving project staff from all disciplines. Inspections and observations in the field included management staff.

SAFETY RECORD

Tugun Bypass was a high profile project under intense scrutiny from government, media and the community. This project was also a very labour intensive project, requiring complex tasks to be completed on site. However, the safety outcomes were outstanding. Safety was driven at the top level by project management. All managers took responsibility for staff and the workforce being safety conscious. Safety began at the design stage, with all designs undergoing a safety review. Safe work methods were developed with field personnel and engineers.

Table 2 Safety statistics

Learning and Safing safety statistics	
Toolbox talks & daily pre-start talks	5,300
Site inductions	3,498
Training hours	108,968
JHA's	2,700
Safety inspections	945
Total manhours	2,390,200
Random breath tests	407
Random drug tests	11
Lagging safety statistics	
LTIFR (LTI per 1 million man hours)	3.34
Hours LTI free	>500,000
Major road accidents by project vehicles	0

PLANNING AND CONTROL

A project management plan was prepared and implemented covering approvals, design and construction, through to commissioning and handover. Key aspects were:

- regular D&C meetings involving key people critical at that stage;
- design program aligned with construction program;
- multi-criteria analysis for design options;
- weekly status update meetings;
- construction operations managed through proprietary QESE (quality, engineering, safety, environment) database system;
- proprietary Qtrak & QDMS document control systems;
- integrated work method statements covering safety, quality, environment, and construction process developed with the workforce; and
- design approvals and verification system to manage two road authorities and the project verifier.

PLANNING AND APPROVALS

A major task for the project team was to ensure the proposal met all the legislative, environmental and technical standards set by the 20 approval agencies.

The challenge was to identify, engage and inform these disparate agency stakeholders in order to produce and obtain concurrence for a single set of project approval documents. These documents had to comply with a range of state and federal legislative requirements.

Representatives from the relevant approval agencies agreed to a joint assessment and approvals process, whereby the RTA would be a proponent for the two kilometre

section of the bypass on New South Wales land and the two kilometre section on Commonwealth (Gold Coast Airport) land. Main Roads would be the proponent for the three kilometre section on Queensland land.

The agencies agreed that a set of complementary assessment documents would be prepared and released for a display and consultation period. The three month common consultation period was greater than the legislative requirement set by most agencies, and was chosen to provide stakeholders with sufficient time to review and comment on the entire proposal.

Additional geotechnical, environmental and cultural heritage studies were conducted following the EIA consultation period. Findings assisted the project team refine the proposed environmental mitigation measures.

Following the public consultation period, the RTA (with Main Roads input) prepared a Submissions Report, which responded to the issues raised in the formal submissions on the EIA, detailed the findings of the additional environmental and geotechnical studies undertaken and outlined the statement of commitments. The EIA documents, including the Submissions Report, were lodged as the basis for the New South Wales and Commonwealth agencies' assessment of the bypass proposal.

ENVIRONMENT

Extensive environmental conditions and controls were imposed as part of the Conditions of Approval from the Department of Environment and Heritage (now a part of the Department of Environment, Water, Heritage and the Arts - DEWHA), NSW Department of Planning and Department of Infrastructure, Transport, Regional Development and Local Government (DoTARS) and operational work authorities (licenses, permits or approvals) under Commonwealth, New South Wales and Queensland laws.

The following environmental management systems and plans were developed to address these conditions and ensure construction and ongoing operation of the Tugun Bypass project had and will continue to have a minimal environmental impact:

- Pacific Link Alliance Environmental Management System (PLAEMS) - developed from EETWCEMP, CEMP, integrated work method statements and sub management plans;
- Early Essential Tunnel Works Construction Environmental Management Plan (EETWCEMP) permitted the commencement of non-substantial works;
- Construction Environmental Management Plan (CEMP) – defined the environmental conditions and controls for major construction works; and
- Operational Environmental Management Plan (OEMP) – required under the NSW Department of Planning (DOP) CoA No 13 and addresses environmental issues associated with the maintenance/ operational phase of the bypass project and is part of the maintenance manual.

ENDANGERED SPECIES

PacificLink alliance took extraordinary steps to address environmental challenges and meet community expectations.

In the first instance, the project minimised its environmental footprint. Secondly, compensatory habitat provided was above and beyond the EIS requirements. Compensatory habitat was only required in New South Wales under the EIS. However, the project also provided compensatory habitat in Queensland and in relation to the federal-controlled airport land.

The project also made provision for endangered species, including:

- fauna underpasses in low lying areas for planigales and potaroos were designed so that they were still navigable during rain events;
- highly endangered flora was protected or relocated, with the new location kept secret; and
- team event (with appropriate official supervision) conducted to catch frogs and fish for relocation.

Of particular note is the work done to protect the local frogs. The Wallum Sedge Frog is especially endangered. The project undertook frog fence trials to keep frogs from hopping onto the road. Detailed studies were undertaken on the Wallum Sedge frog to determine the likely height that it can hop and/or climb over objects. The resulting design and site trials eventually found a successful solution with a 20-year design life. Recycled plastic planks with a galvanised metal flashing – which was the key to preventing climb-over – were installed to protect this endangered frog.

INNOVATIONS AND LEGACY

The ideas and innovation committee encouraged and recorded ideas on an innovations register that tracked the initiative to completion. More than 216 ideas and innovations were recorded, with the best ideas recognised and rewarded. Innovations resulted in estimated savings of $26 million. Innovations recorded on the register included:

- Recycling of the surplus bridge piles to be used for the Border Statement. Savings on purchase and transport costs approximately 50%;
- Steel screw piles on tunnel ramps. Cost savings and noise reduction benefits estimated $3m;
- Establish an onsite pug mill and use sand from the tunnel excavation to create the cement stabilised fill layer needed on the tunnel roof. Neutralise possible acid and also provide stabilisation;
- Incorporate banana jet fans into tunnel ventilation system power supply with reduced need for cabling, reduced running costs and still meeting SWTC requirements;
- Use a web-based system to present information to community regarding Clancy Court. Integrated issues management database for all aspects of noise management;
- Walking trail to link Hidden Valley with Tugun Conservation Park to the north adjacent to the road reserve became the signature community legacy project;
- Utilise one way service road to avoid impact on Kennedy Drive Roundabouts and tie-in north of Kennedy Drive. Estimated saving $2m;

- Accelerate lighting design to avoid need for temporary lighting. Saving $100,000;
- Adopt guard fence in lieu of wire rope. RTA requires wider, flatter clear zone than required in Queensland. This would have required more fill and a wider footprint (more clearing). Reduced significant earthworks with estimated saving $500k plus reduced greenhouse effect;
- Delete noise canopy from project and use off road reserve “architectural treatments”. Saving $13m; and
- Friction welded couplers. Significant saving over normal mechanical couplers estimated $1m. Lessons and innovations have been incorporated into subsequent alliances such as Northern Busway and Ipswich Motorway Upgrade.

NEW TECHNOLOGIES

PacificLink Alliance continually challenged staff and the workforce to exceed business as usual practices through information sharing, innovation and implementing new technologies. An innovation award program was implemented to encourage and recognise innovative and new ways of doing things.

New technologies included methods for:

- diaphragm wall construction, concrete properties management, ground settlement management and waterproofing;
- dewatering and recharge of ground water;
- friction welding for couplers;
- cathodic protection of tunnel structure;
- top-down construction of slim-profile bridge;
- steel screw piles, and tunnel stress and settlement monitoring during construction; and
- frog species-specific exclusion fence and alternative pond habitat.

TUNNEL WATER PROOFING

Effective waterproofing of the tunnel was essential given the high expected groundwater level after dewatering was complete. The tunnel was built in a swamp adjacent to an environmentally sensitive wetland SEPP14 area. There was a high water table and the site was flood prone. In addition, the ground water flow path ran across the tunnel alignment. The joints between the concrete panels needed to be waterproofed. However, the nature and extent of waterproofing required could not be determined until excavation of the tunnel and the joints, previously underground, could be inspected. International research was conducted to identify effective water tight joint systems. Importantly, there had to be redundancy in the system to prevent major leakages. The three chosen systems allowed for initial differential settlement and future uplift:

- bituminous membranes underneath floor slab;
- hydrophilic strips between concrete panels, which expand with water; and

- grout re-injectable Fuco tubes allowing grout to be pumped into joints p periodically during the tunnel's 100-year design life.

There have been no significant leaks in the completed tunnel and it has met its design leakage criteria. The solution has attracted intense industry interest, with many groups coming onsite to inspect.

STEEL SCREW PILES

The tunnel was constructed in a water table near surface level. The ramps would therefore experience uplift forces and needed to be kept firmly anchored.

To ensure the ramps remained in the correct position, 2,200 screw piles between six and 30 metres in length were driven, then connected both structurally and electrically to the ramp slab reinforcement, before being cast in with each ramp slab segment. Investigations were conducted to justify the sacrificial thickness of steel screw pile required. Cost savings and noise reduction benefits of this innovation were estimated at $3 million.

TRAINING AND DEVELOPMENT

PacificLink Alliance recognised the value of training in the current resource constrained Queensland market place. Training allowed people to be developed into roles, but also was a major factor in keeping existing staff.

The alliance easily surpassed the Queensland Government 10% Training Policy requirement. 60,000 hours was originally agreed, with a stretch target of 85,000 hours. The project ultimately delivered 110,000 hours of workforce training onsite. Recognising the special needs of the project, all the workforce was trained in confined spaces in a purpose-built facility onsite.

A staff development program provided for staff mentoring and 360 degree reviews. The graduate program allowed junior engineers to experience many different aspects of construction. Administration staff were also provided training opportunities.

INDUSTRIAL RELATIONS

The project spanned two states, meaning that there were double the AWU, CFMEU and WorkCover representatives. During the interim alliance phase, Main Roads led the development and agreement of a model project agreement between construction parties and the Unions. This model agreement was subsequently lodged and certified. During the alliance period, proactive engagement built positive relationships. The project achieved no work stoppages and was incident free.

Table 3 Traineeships and apprenticeships

Qualification	No.
Certificate III in Civil Construction (Road Construction & Maintenance)	3
Certificate III in Civil Construction (Plant Operations)	8
Certificate III in Civil Construction (Pipelaying)	27
Certificate III in Transport & Distribution	1
Certificate III in Business Administration	2
Up-skilled qualification	
Certificate IV in Training and Workplace Assessment	2
Overall number of trainees/apprentices	41

CONCLUSION

Tugun Bypass faced challenges that many projects face, but few projects face as many challenges as did Tugun.

Whilst there are many “stand-out” challenges, the issues around working in the States of both Queensland and New South Wales, as well as on Commonwealth land that is leased out to a significant corporation (Gold Coast Airport Limited) would have to rate as one of the most significant.

REFERENCES

Nil.