

**AUSTRALIAN CONSTRUCTION ACHIEVEMENT AWARD 2015
TECHNICAL PAPER**

GOLD COAST LIGHT RAIL

ABSTRACT

The \$1.3 billion Gold Coast light rail is an ambitious, city-changing infrastructure project that has integrated new and existing transport systems, stimulated urban regeneration and facilitated sustainable transit-oriented development. With the aim of providing the world's best public transport infrastructure, this transformational project has fulfilled a vision of a vibrant, bold future for Australia's sixth largest city.

Challenging latent conditions, ambitious sustainability goals and a constrained urban corridor required innovative design and delivery methodologies and collaboration between all stakeholders to balance program milestones with keeping traders open for business. The complexity of the project demanded outstanding design solutions, engineering excellence and pioneering construction methods, driven by an integrated culture of collaboration with an emphasis on safety. The project was ultimately delivered on time in mid-2014, with the success of the system demonstrated at its opening on Sunday 20 July 2014, which approximately 80,000 commuters attended.

The Gold Coast light rail is leading a new wave of light rail infrastructure projects across the country and McConnell Dowell's experience will ready the construction industry and government to meet the future complexities of delivering contemporary light rail in Australia. In this paper McConnell Dowell share their learnings from constructing Queensland's first contemporary light rail in a constrained urban environment which had never before experienced a project of this scale.

KEY WORDS

McConnell Dowell, GoldLinQ, Gold Coast, light rail, trams, Public-Private Partnership, legacy, sustainability, innovation, transit-oriented development, integrated public transport, safety, traffic, stakeholders.

1.0 INTRODUCTION

PLANNING

In the late 1990s both the Queensland Government and Gold Coast City Council recognised the need for a long-term solution to growing population demands and increased traffic congestion on the beachside Gold Coast. The City needed an integrated, high quality, safe and efficient transport system to serve the Gold Coast in a sustainable manner throughout the 21st century. Light rail was measured against a number of criteria including capacity, passenger comfort, reliability, safety, sustainability and value-for-money, and was selected as the system the City needed to lift public transport patronage from an all-time low of 3.5% in 1992.

The key aims of the project were to:

- **Encourage an increase in public transport use** – significantly increase the use of public transport due to the ability to move large numbers of people quickly between activity centres, encouraging residents and visitors to use public transport and reduce the use of private vehicles.
- **Transform the city** – development of a world class transit service that attracts development and positions the city for sustainable growth.
- **Renew and revitalise** – the long life of light rail infrastructure encourages investment and increases land values around the system.
- **Enhance the liveability of the Gold Coast** - transit oriented developments that promote a great whole-of-journey experience emphasising pedestrian accessibility to attractive, safe and interesting light rail stations.

FUNDING

A series of feasibility studies, assessments, concept design impact management schemes and hundreds of hours of community consultation were undertaken over a ten year period from the late 1990s. Government funding was announced in 2009 with the preferred contract delivery method of a Public Private Partnership (PPP) chosen. When Stage One of the Gold Coast light rail (GCLR) was issued for tender at the start of 2010, it was the first public transport infrastructure project in Australia to be jointly funded by all three levels of government.

The tender was awarded to the GoldLinQ Consortium in May 2011, with construction commencing in January 2012 and practical completion achieved in June 2014. The first PPP undertaken following the height of the Global Financial Crisis (GFC) in Australia, the GCLR lifted the Gold Coast out of the GFC, spurring local industry opportunities and supplying jobs to the region.

INTERFACES

Stage One of the GCLR is a 13-kilometre, 16 station corridor connecting planned and existing high-density business, education, medical, residential, tourism and entertainment precincts. The project aims to reduce traffic congestion between key activities centres including the future 2018 Commonwealth Games Village, Griffith University and University Hospital, renowned Surfers Paradise, the heart of the city, and modern Broadbeach, featuring Jupiters Casino, Pacific Fair Shopping Centre and the Gold Coast Convention and Exhibition Centre.

Delivering a major infrastructure project traversing high-density precincts, with differing identities and needs, which had never experienced civil construction of this scale before, required new thinking and innovative delivery methodologies to balance tight program milestones and minimise impacts.

McConnell Dowell's experience on the GCLR project will ready the industry and government to meet the future complexities of delivering light rail under the PPP framework in a heavily-congested urban environment.

An integrated approach to the many design and program risks ensured effective project controls and leadership on interface requirements. A high performing project culture of proactive relationships and accountability facilitated innovative solutions to secure the project's successful completion in mid-2014.

This paper examines the delivery of the \$1.3 billion dollar Gold Coast light rail, measuring the outcomes achieved, detailing the technical complexities and risks that were overcome through design and engineering excellence and strong project management from the D&C Contractors perspective.

1.1 SCOPE

Stage One of the GCLR is a 13-kilometre, 16 station urban transport corridor connecting planned and existing high-density precincts using 14 world-class bi-directional light rail vehicles (trams). This complex and technically demanding project is the first of its kind in Queensland and is leading the way for light rail nationally.

At the peak of construction in mid-2013, the GCLR had 35 open excavations, more than 50 subcontract companies and 1,000 workers on site, completing four million man hours of work in under three years.

Working on and adjacent to live roadways with up to 32,000 vehicles per day, the project implemented more than 57 traffic management plans, and hundreds of temporary traffic control plans, for short and long-term works, including contra-flow, detours, road closures, block closures and intersection closures requiring more than 100 traffic controllers to facilitate construction.

Undertaking the largest simultaneous public utility upgrade in Queensland's history, almost 60% of the GCLR project's total scope took place underground, with more than 30,000-kilometres of new or existing public utilities requiring simultaneous construction, upgrade or relocation.

Due to the constrained and congested nature of the corridor, vacuum excavators were used almost exclusively, with up to 28 on site per day during peak construction, averaging a cost of \$2 million per month.

The engineering scope included 27-kilometres of single rail, crossing 52 intersections, connecting 16 stations, over five new bridges, including a viaduct over the Smith Street Motorway, two bridges over the Nerang River and two over secondary waterways, installing 5 turnout track switch systems and a 30,000 square metre maintenance depot and stabling facility on an old landfill site.

More than 60,000 tonnes of landfill was excavated from the City's historical dump site to accommodate the sustainable and sustainably built *4-star Green Star Industrial Design & As-built* rated depot and tram stabling yard, including a recycled water wash plant. More than 660 piles, each up to 30 metres in length, were installed into the depot landfill site for the depot building and viaduct.

Other major technical features of the project include state-of-the-art signaling control systems and emergency call-up protocols, real-time operational tracking and journey planner integration, 36-kilometres of overhead line and six traction power sub-stations to supply 750VDC for the traction power network.

1.2 PPP CONTRACT

The GCLR is the first public transport infrastructure project in Australia to be jointly funded by all three levels of government and was the first PPP undertaken following the height of the GFC in Australia.

This performance based PPP was structured, timed and delivered to lift the Gold Coast out of the GFC through:

- Increased government funding to reduce the amount of private debt.
- Allocation of patronage and revenue risk to the State to reduce long-term private sector risk.

- A service payment implemented over the concession period for the delivery of KPIs under a performance and abatement regime to increase the attractiveness of the project.

Whilst complex, the PPP model aims to enable whole-of-life outcomes and drives program performance. Partnership is the key word and this commercial framework requires the maturity of the government and private sector to inspire cooperation and enable the flexibility to facilitate best-for-project outcomes.

The GoldLinQ Consortium entered into an 18 year PPP contract with the Queensland Government to design, build, finance, operate and maintain the light rail public transportation system. McConnell Dowell and Bombardier formed a non-integrated design and construct joint venture to deliver the system over three years. The operations and maintenance is delivered by Keolis Downer under a 15 year contract now underway.

In addition to government funding, the project’s private financiers were a combination of existing members of the consortium and external parties with experience in financing social and transportation infrastructure projects, including three full-term senior debt investors and five financial equity investors.

The extended PPP contract model for the GCLR is demonstrated in Figure One.



Figure One

The contract was administered by the Queensland Government and GoldLinQ, with an Independent Verifier (IV) reviewing and certifying the project complied with the Project Deed requirements. APP-Hyder formed a joint venture as the IV to certify the design, procurement, construction and commissioning of the light rail system. Additionally, and for the first time in Australia, the Communications and Stakeholder management of the project works by the D&C JV and GoldLinQ were also verified. The Independent Verifier was employed directly by the Queensland Government, with no input or influence from the contractor.

2.0 OUTCOMES ACHIEVED AGAINST PLANNED TARGETS

McConnell Dowell made a commitment to achieve excellence in construction by developing KPIs to track the success of the project. Delivered on time in mid-2014, this unique PPP contract arrangement requires details of the project cost model remain confidential.

2.1 KPI #1 – SAFETY

*Adhere to the Project Charter and Safety Policy.
LTIFR Target of <.55 PH/AI Target of >50*

McConnell Dowell maintained an excellent safety record, working 3,700,000 man hours as at 31 July 2014 and recording a total LTIFR of .49 against a target of <.55 and a total PH/AI of 68 against a target of >50.

AWARENESS

Key to this success was the development of an exemplary safety culture and a high level of risk awareness amongst project personnel at all levels. This was evidenced in two safety culture reviews conducted by external consultants where the project was awarded a 4 (good) and a 5 (excellent) out of 5. These high safety culture scores were achieved through:

- Hazard identification and management – coaching and guiding the workforce in the effective use of START cards, issues discussed at toolbox and pre-start meetings.
- Visible leadership – active messaging and demonstrating safe behaviours, management team on site presenting safety awards and linking personal experiences to safety.
- Attitudes and behaviours – commitment to investing in safety improvements and training.

COMMUNICATION

McConnell Dowell also implemented a wide-range of communication and involvement initiatives to foster a positive safety culture and promote awareness of changing project risks throughout the delivery of the project including:

- Implementing a Safe Spine injury prevention program to improve back-care.
- Introducing gloves as mandatory PPE to minimise hand and finger injuries.
- Setting safety KPIs for all sub-contractors, including attendance at pre-starts, SafeTalks and monthly sub-contractor safety meetings, where sub-contractors active involvement was fostered and feedback was sought by the project team.
- Developing procedural awareness training modules tailored to address unique or emerging health and safety issues.
- Distributing a fortnightly 'Crib Chat' newsletter containing safety statistics, stories, safety slogan competitions and quizzes.
- Displaying monthly safety update posters at all site offices, highlighting injury trends and linking safety and production in a simple and graphic format.
- Distributing regular safety flashes via email, pre-starts and toolboxes to address unique or emerging risks.
- Establishing and instilling a public safety focus first and foremost in all forums.

INNOVATION

The project's primary focus was to protect people and due to the size, scope and complexity of the engineering challenge, new and innovative ways to ensure the safety of the workforce, subcontractors and the public were developed.

Robust risk and safety management procedures, including a unique two-step Permit to Excavate procedure (PTE) ensured that the appropriate checks and balances were in place prior to works commencing. PTE work activity packs contained detailed Job Safety and Environment Analysis (JSEA) drawings for engineered shoring and service supports. The procedure required a senior project team members to approve service identification and personally verify the investigation was undertaken in the field in accordance with the PTE before approving excavation to commence. A total of just over 10,000 permits were issued between August 2013 and May 2014.

TESTING AND COMMISSIONING

Facing the unique challenge of working on and around a live light rail system during the testing and commissioning (T&C) phase required the development of best-practice safety control measures, setting new industry and regulator standards. The live electrical network required the implementation of possession and occupation based permit systems to provide separation between trams and workers. McConnell Dowell delivered upon their commitment to safety excellence by developing and implementing detailed safety procedures around the Lock Out Tag Out (LOTO), Permit to Work (PTW) and Permit Recipient (PR) procedures, which ensured that all activities within the light rail vehicle operating hazard zone were controlled and accounted for. The project also ensured safety during T&C by restructuring the project induction to include new training information on working safely around the operating system as well as a specially developed T&C safety induction video. No lost time injuries were reported during the T&C phase.

INTEGRATED TEAM

The GCLR team regularly went beyond the call of duty to ensure public safety including undertaking weekly site safety walks and implementing duplicate traffic control measures to achieve complete separation of construction works from traffic along the Gold Coast Highway.

2.2 KPI #2 – QUALITY

Implement quality management in accordance with ISO9001 standards.

Forging the way in contemporary light rail in Australia meant quality was critical. At the forefront of project quality controls was Project Centre, a central web-based information platform for the live management of D&C information. The innovative use of this system achieved a free flow of technical information and transparency between consortium partners, design consultants, asset owners and the IV, integrating stakeholders and meeting whole-of-life contractual and project requirements.

INTEGRATED DOCUMENTATION

Methods were developed for documenting the quality of all aspects of construction and regular inspections and testing were undertaken. Quality records were attached to the relevant Work Lots in Project Centre and suppliers could directly upload test results, schedules and compliance certificates for immediate internal and external review and approval. Some 4000 Work Lots were created for the project.

The use of Project Centre to compile quality records also enabled the monitoring and management of the status of completed work and closed lots. Project Centre was also fundamental for completion and complex returned works handovers, as it was designed using completions requirements and operational parameters to facilitate both ease of use and ease of handover at completion.

EFFICIENT CONTROLS

Substantial design controls were also established to monitor and control the delivery of the works. Complex contractual requirements such as the design review process, including Stage One, Stage Two and IFC design approval and certification mechanisms were embedded within the system to enable all parties access to monitor the design process live. The inclusion of complex Request for Information (RFI) systems were developed and linked to the project's Design Site Instruction (DSI), solutions provided directly from the multiple design consultants, and linked to the complex design review and change process. Innovations, including the live control of Inspection and Test Plans and Hold/Witness Point Management, facilitated a new way of process control for the project which enabled faster more efficient solutions to design and construction issues.

The ability to produce immediate, accurate and complete Project Centre reports on all aspects of the project assisted in design reviews, design approvals, material orders, quality management reports, construction progress reports, traffic management reports and the measurement of project KPIs. McConnell Dowell's approach ensured efficient management of a complex array of activities and facilitated early monitoring of risks and opportunities that may have not otherwise been achieved.

AUDITS

The GCLR project was internally and independently audited more than 30 times, this open, two-way interface enabled integration and improved controls to facilitate approvals efficiency that was applauded by GoldLinQ, the Rail Safety Regulator, Work Place Health and Safety and the Electrical Safety Office. An independent Quality Auditor employed to undertake a full project audit on behalf of GoldLinQ stated the GCLR was the *"best project audited in 20 years of working within construction on major projects"*.

2.3 KPI #3 – ENVIRONMENT AND SUSTAINABILITY

Achieve ISCA certification.

The project achieved the highest standards of sustainability, constructing the light rail depot on an historical landfill site to a 4-star Green Star rating and achieving the finest Infrastructure Sustainability rating of any project to date, winning the *Infrastructure Sustainability Council's 2014 Infrastructure Sustainability Project/Asset Award*.

The project delivered a number of positive sustainable outcomes, including:

- Directing 156,000 tonnes of material away from landfill.
- Saving more than 44,000 tonnes in materials compared to the reference design.
- Saving 5,000 tonnes of CO2 emissions.
- Implementing more than \$14.2 million in savings from more than 190 implemented sustainability initiatives.

A significant reduction in materials lifecycle was also achieved through design development and modified construction practices, including:

- A reduction in the thickness of the track slab along the length of the alignment.
- The use of exchangeable switch blades at turnout track switch systems to limit the amount of excavation and concrete replacement traditionally required for turnout replacements during the operations and maintenance period.
- Significant design changes shifting the depot and stabling yard footprint away from the main landfill cell avoiding the need to excavate and relocate 68,000 tonnes of waste material, resulting in a 40% reduction in the quantity of concrete and steel required and avoidance of 3,200 tonnes of CO2 emissions.

BEST PRACTICE

McConnell Dowell consistently strived to achieve the highest levels of environmental practice across the project. The success of the team was recognised by winning the *Award for Achievement in Environment* at the *2013 National Association of Women in Construction QLD/NT Awards*. McConnell Dowell implemented a variety of water saving strategies including the use of water efficient devices in permanent and temporary facilities, Xeriscape landscaping, rainwater and stormwater harvesting, recycled water usage for dust-suppression and compaction activities and the use of recycled water in the tram wash-plant. McConnell Dowell also undertook 2500 square metres of vegetation offset 15-kilometres south of the project.

SPECIALISTS

The control and management of all site environmental issues was based around the Construction Environmental Management Plan. To assist in the execution and monitoring of this plan, the project employed a number of specialists including marine scientists, soil conservationists, avian ecologists and air quality, noise and vibration consultants and fauna spotter catchers.

SPECIES

Despite traversing built-up areas, McConnell Dowell encountered a number of protected and endangered species along the corridor. Working closely with the Department of Environment and Heritage Protection (DEHP), McConnell Dowell successfully relocated an Osprey nest 50 metres north of its original position without impacting the breeding pair. A thriving population of Tusked Frogs was also found in a man-made pond and successfully relocated. A recovery and relocation plan was developed to re-home the frogs at the Currumbin Wildlife Sanctuary in collaboration with DEHP a specialist frog expert and ecologist. In both instances of the fauna relocations latent conditions and site constraints prevented design alternatives to avoid disruption.

During construction of the depot, two frog species listed on the *Nature Conservation Act*, the Wallum Froglet and the Green Thighed Frog, were found living in a creek catchment on the landfill site. In association with DEHP and a local environmental association, McConnell Dowell constructed a bio-retention basin behind the depot to collect sediment and maintain water quality before flowing into the catchment. Through these works McConnell Dowell was able to improve the habitat of the frogs.

2.4 KPI #4 – COMMUNITY AND LOCAL INDUSTRY PARTICIPATION

Minimise disruption to the business community by implementing a no-surprises approach to construction.

Meet or exceed a stretch target of 78.9% of goods and services procured locally.

Meet or exceed a stretch target of 82.5% of employees from the wider Gold Coast region.

Early, continuous and collaborative face-to-face coordination with local councils, community groups and impacted individuals effected positive results, including fast-track construction strategies to minimise disruption to businesses.

UNCOVER OPPORTUNITIES

Feedback from key stakeholders in the Surfers Paradise precinct indicated that traders made up to 80% of their annual income during the Christmas holiday period. In collaboration with local businesses, State and local government representations, McConnell Dowell developed the Surfers Paradise Accelerated Construction Scheme (SPACS).

The SPACS committed the project to reinstating central Surfers Paradise and ceasing work in that area in December and January each year as part of the campaign to save Christmas. In return, block closures of up to 300-metres in length were implemented, temporarily closing the ultimate southbound traffic movement on Surfers Paradise Boulevard to facilitate kerb-to-kerb construction. The SPACS reduced nine months of construction to just four.

BUSINESS SUPPORT

A unique business support campaign was implemented to encourage residents and tourists to continue to support local businesses during construction. The “Love Our City” campaign was launched in collaboration with the local newspaper and received strong support from the community. Public awareness of the campaign was high, with an independent community sentiment survey finding 90% retention and take-up of the campaign against a 70% awareness target.

VARIED TOOLS

McConnell Dowell found early and consistent communication was the key to successful stakeholder management engendering a ‘no surprises approach’. Giving people time to comprehend the project and ask questions helped manage a wide range of potentially damaging issues. McConnell Dowell’s approach used traditional methods, including letterbox drops and doorknocks, a 24-hour community contact line, a quarterly newsletter, community forums, one-on-one consultation, information days, website updates, a YouTube channel, media updates, presentations, site visits and a project Open Day. These were combined with non-traditional methods including Google maps updates, coordination with airport services and travel agencies to notify tourists, a business support program, school’s curriculum program and volunteer way-finding services in collaboration with third party organisations.

DIRECT APPROACH

Other measures to mitigate stakeholder concerns included:

- Changing the landscaping solutions to provide better visual amenity and noise protection based on a specific set of criteria, at certain locations.
- SMS alerts to advise residents of changed traffic conditions.
- Active involvement in construction meetings to influence strategies that minimise disruption to road users and residents.
- Liaison with property owners, City waste management, commercial waste management companies and commercial delivery companies to maintain access to properties at all times or provide alternate options.

JOBS AND SPENDING

GCLR spurred local industry opportunities, supplying jobs to the Gold Coast and region. The project set a target of 82.5% local employment for the wider Gold Coast area, achieving 96% recruitment of project employees from within that area, with over 80% living within the City of Gold Coast electorate. The project also set a stretch target of 78.9% local goods and services procured, at completion the project had significantly exceeded this target achieving 94.50% of goods, services and employment from the local economy generating approximately 6,500 direct and indirect jobs and spending more than \$600 million with local businesses.

3.0 COMPLEXITY, DIFFICULTY AND OPTIMISATION

Integrating a new light rail system into a constrained and congested urban corridor required a proactive approach to managing safety, traffic and community risks. Cutting straight through the heart of the Gold Coast, the GCLR project faced an inherently high level of challenges and constraints in both the design and construction phase of the works, including:

- Working on or adjacent to five major State roads, highways and motorways, plus local roads, whilst ensuring no disruption to traffic flow of up to 32,000 vehicles per day.
- Working within metres of more than 5,000 of residential and business properties, including through the Gold Coast's key tourism precincts.
- Interfacing with almost 80 individual property owners to undertake extensive reinstatement works following State led property resumptions.
- Interfacing with and facilitating a calendar of major events in and around the project area including the Gold Coast 600, Gold Coast Marathon, Anzac Day Parade, Big Day Out and Schoolies.
- Completing Queensland's largest simultaneous public utility upgrade on more than 30,000-kilometres of services in suburbs with a legacy of fast, uncontrolled development.
- Management of a recreational boating community around continually changing marine worksites over the Gold Coast's main commercial and recreational waterway, the Nerang River.
- Design and delivery of 40,000 individual Issued for Construction (IFC) drawings across almost 300 design packages to ensure compliance with stringent long-term performance objectives and design life criteria.
- Management of six baseline programs incorporating more than 15,000 individual line items where every sequential construction activity along the lineal corridor was effectively on the critical path.

Each of these potential issues was effectively managed by the project team through the implementation of innovative design and construction solutions and through strong leadership, planning and delivery of the works.

3.1 TRAFFIC SIGNALS

The signalling software and programming logic used on GCLR is unlike anything else in Australia.

As a requirement of the project contract, trams are guaranteed full priority at all 52 intersections to ensure a 37 minute end-to-end journey - a significant change from the traditional level crossing or user demand scenarios.

To address this requirement, McConnell Dowell recruited an internationally renowned traffic coder to develop and implement a traffic control system which would integrate the new tram system, with the State Governments higher order signalling control system into the existing traffic network.

Standard signalling systems operate in cyclical and sequential phases, generally made up of primary and secondary phases and requiring up to two pages of detailed coding to function. Incorporating a full priority tram into a cyclical system would result in the traffic signals resetting to the first phase after every tram had passed, theoretically eliminating the system's ability to cycle through every phase and causing significant traffic congestion for secondary phases.

By incorporating a stand-alone Remote Terminal Unit (RTU) to interact with the Traffic Signal Controller (TSC) and relay information about approaching trams, McConnell Dowell was able to increase the signal coding of the TSC by up to 1500%.

This additional coding allowed the TSC to temporarily store 64-bit traffic phase data in its memory, run the tram phase and then revert to the stored traffic phase, completing its cyclical and sequential operation for every phase.

This innovative solution:

- Set new standards in real-time tracking, creating a signalling system which interfaced with the trams' operational network to contribute to journey planning software, operations and maintenance systems
- Linked the traffic network, signal software, tram software, Transport and Main Roads, City of Gold Coast and operator software
- Brought about industry change, with other states now looking to adopt this technology which exceeds Australian industry standards and sets the benchmark for transport network integration.

The project also implemented and trialed emergency services call-up software, currently set to be rolled out across Queensland.

3.2 UNDERGROUND SERVICES

Undertaking one of Queensland's largest simultaneous public utility upgrades was an enormous task and the most congested traffic, community and event areas seemed to feature the most complex project delivery requirements.

Managing independent, and independently motivated, PUP authorities to influence timely design solutions and obtain approval for all public utility design documentation within the complex contractual framework of a PPP posed significant design challenges. This difficulty was compounded by the historically uncontrolled development of the PUP scope due to ambiguous agreements not being enforceable under the project contract and a legacy of fast and uncontrolled development on the Gold Coast resulting in a largely unmapped, poorly performing and unknown service corridor.

In order to negate this risk, McConnell Dowell adopted a resourcing model to match the complex design interface and technical requirements of the project, mobilising dedicated and specialist resources to manage the design consultants, implement the appropriate project controls and systems and interface with more than 10 PUP authorities.

The project used 12D modelling to space-proof design solutions and develop a clear underground envelope through which new and relocated services could be installed without clashes. Vacuum excavators were used almost exclusively to reduce the risk of damaging assets, to minimise the impact of the plant on traffic and the community and facilitate safe working conditions for project employees.

3.3 FERNY AVENUE CASE STUDY

The primary challenge faced on the GCLR was the coordination of a large, linear, complex project against the background of a very tight timeframe, with strict contractual requirements to accommodate third parties, the unknown legacy of underground services, major arterial roads and highways in a constrained urban environment and a large number of immediately affected stakeholders with a variety of attitudes and opinions towards the project.

These issues were compounded at the Ferny Avenue intersection, a major traffic interchange in Surfers Paradise connecting the Gold Coast Highway, Ferny Avenue and Surfers Paradise Boulevard and the main thoroughfare into and out of the heart of the Gold Coast.

UTILITY COMPLEXITIES

The Ferny Avenue intersection featured the most complex project delivery requirements for utility relocations, including major water mains, gas mains, sewer mains, stormwater, power and telecommunications.

Pipe-jacked Water main

Cutting through the middle of the intersection, up to 5-metres deep in some places, was a 600 diameter asbestos concrete water main, the primary water supply trunk for Surfers Paradise. Due to the age and material of the water main, it was extremely sensitive to vibration and was a significant impediment to undertaking major re-construction of the roadway and construction of a track slab in the intersection. Prior to major construction commencing, McConnell Dowell had to install a new water main in parallel with the existing main to make the existing AC main redundant.

To minimise open cut excavation and potential traffic impacts to the Gold Coast Highway, the new water main was pipe-jacked under the live highway for up to 80 metres. An 11 metre long by 5 metre wide 4 metre deep pit was opened in the middle of the intersection to undertake the pipe-jacking and facilitate the cut-over. The water main was installed and tested successfully without any issues.

Interstate Fibre

Also running along the Gold Coast Highway and Surfers Paradise Boulevard is the main interstate fibre Telstra trunk connecting Queensland and New South Wales. Containing up to 10,000 individual copper fibres, the Telstra trunk was extremely delicate and required significant protection during project activities. A potential service hit or outage at this location had significant consequences for McConnell Dowell, with the contract imposing substantial hourly delay costs for service impacts to Telstra customers.

Running directly under the final track slab alignment on Surfers Paradise Boulevard and adjacent to 78 driven and CFA piles, the interstate fibre required a permanent solution which protected the fibres whilst also maintaining access for Telstra. In collaboration with Telstra, McConnell Dowell developed a unique protection slab to encase and maintain the trunk in its existing position and accommodate Telstra access pits within the track slab. No service strikes on the interstate fibre occurred during the construction of the project.

HERITAGE

The Ferny Avenue intersection was also home to the only Indigenous Heritage site along the corridor. A small cove adjacent to a Nerang River tributary, Jarra Parilla Cove needed to be protected from erosion, disturbance and contamination. McConnell Dowell also had an obligation to minimise excavation at this location and undertake sub-surface testing to ensure no heritage items were lost. Close control over construction activities was necessary to protect the cove, including diverting hundreds of truck and plant movements away from the cove via the installation of barriers. To minimise disturbance, earthworks were carefully completed on either side of the cove using sediment and erosion control measures, construction crews were relocated to other areas and site office and shelters were relocated further north. No environmental impacts were recorded at Jarra Parilla Cove throughout the construction of GCLR.

ENVIRONMENT

The Ferny Avenue intersection was also home to an unexpected family of Tusked Frogs, found in an adjoining property's man-made pond. The McConnell Dowell team engaged a frog specialist and ecologist and funded the relocation of the frogs to Currumbin Wildlife Sanctuary. Other animals relocated from the Ferny Avenue intersection included various birds, bearded dragons, green tree frogs and a surprise juvenile crocodile dumped in the work area.

STAKEHOLDER MANAGEMENT

A number of State led property resumptions also took place around the Ferny Avenue intersection to accommodate the land required to install the light rail track, Traction Power Sub-station, and new and existing traffic movements.

Extensive stakeholder management was required to negotiate complex reinstatement agreements that included impacts on private underground car parks, pools, driveways, gardens and landscaped areas of major residential and accommodation properties.

Strong daily relationships were built with body corporates and property managers to facilitate project works on resumed land, as well as significant project activities, including driven and CFA piling, within metres of properties.

Through active negotiation and a real understanding of the true aspirations and drivers of stakeholders up to \$500,000 worth of savings were made in reinstatement works on a multi-million dollar reinstatement commitment.

As part of these complex agreements more than 30 access changes and closures were managed with the luxury accommodation towers housing more than 300 residents and guests. To enable access for residents and guests during access changes, the project delivered parking and other offset arrangements.

Further, construction works were planned and extensive safety measures were put in place to enable the stakeholder's request for full use of their pool and outdoor area during the accommodation and reinstatement works, even when works passed within less than a metre from the pool area.

GOLD COAST 600

The Ferny Avenue intersection was also home to the Gold Coast 600, a major annual event for the City. McConnell Dowell had contractual obligations to vacate the Ferny Avenue intersection in stages to accommodate the set-up and running of the event.

However, providing staged handovers up to eight weeks before the Gold Coast 600 put additional strain on the construction program. McConnell Dowell worked closely with event organisers to negotiate improved handover timeframes, gaining much needed time to complete project activities within the Ferny Avenue intersection.

McConnell Dowell also worked closely with the Gold Coast 600 team to facilitate safe set-up of the event around the live light rail during T&C. As a result of this positive relationship, McConnell Dowell was able to understand and overcome an operational issue caused by a late change to the reference design in 2010.

A re-alignment of the track from the Gold Coast Highway to Surfers Paradise Boulevard, on the Gold Coast 600 circuit, raised a number of issues regarding the proximity of the tram to the event and the potential safety ramifications for passengers and drivers. The reference design stipulated single-track running during Gold Coast 600 events.

McConnell Dowell delivered a design solution which enabled safe dual-track running during the Gold Coast 600, improving operational viability, revenue confidence and public transport options for the more than 185,000 race-goers that descend on the City each year.

PROGRAM

Deviating from the traditional approach, the project was programmed to focus on areas, not disciplines, which enabled better coordination, allowed for the continuity of rail construction and improved approvals efficiency.

Critical to the success of the Ferny Avenue intersection was the ability to monitor the construction of all works in real time via P6 Primavera and generate updates on progress quickly and easily.

To keep the project on track at all times a number of programming initiatives, workshops and forums were implemented to track critical path and ensure resources were available to meet project milestones.

Due to the linear nature of the project, any one activity could affect all activities after it, effectively meaning every item was on the critical path.

Early on, Ferny Avenue intersection was identified as the 'Achilles Heel' of the project, with approximately six to eight critical paths activities occurring there during peak construction.

Program initiatives to drive the Ferny Avenue intersection included regular meetings to quantify any delay or gain in time, provide productivity contingency available, float available and explaining both the reasons for changes to the program and the actions being undertaken to re-gain any lost time.

4.0 PROJECT LEADERSHIP AND MANAGEMENT

4.1 ONE TEAM, ONE DREAM

The top-down establishment of a strong project culture, focussed on safety and shared targets, was key to the success of the GCLR project. Management attended and provided an in person introduction to the project at more than 7,200 inductions to instil a one team focus from day one. Daily and weekly site meetings led by the management team imparted information on construction progress and set new targets to maintain a shared vision. Cross-discipline strategy sessions were established to coordinate and expedite works. Management would attend these forums to facilitate shared solutions.

The construction management team also established and delivered a "Boots on Ballast" program which saw all senior managers spend a day on site, working shoulder-to-shoulder with the project workforce. For example, the Quality Manager spent a day in the shoes of the PUP Superintendent and the Project Director tied steel for a rail turnout at the depot. This program made leaders accessible and enabled the management team to directly hear the challenges faced by the workforce on a daily basis. It developed a shoulder-to-shoulder, in-the-trenches together behaviour breaking down silos and identifying process and cost reduction improvements.

4.2 CULTURE OF COLLABORATION

Integral to the success of the GCLR was project governance, which required a keen focus on relationship management to develop a structure that could manage the risks associated with delivering a \$1.3 billion light rail system in the heart of the Gold Coast.

Building a culture of collaboration on the GCLR required the commitment and effort of all project proponents in a complex commercial structure incorporating three levels of government, a multi-faceted consortium, private debt and equity partners, Independent Verifier and Certifier, regulators, asset owners and sub-contractors.

The interface and integration of all PPP parties and project teams was at the centre of a best-for-project leadership culture. This was supported by proactive and direct relationship management through agreed and timely interfaces at all levels. To develop a truly collaborative and genuine partnership, clear and continuous improvement management systems were established for risk, environment and sustainability, community, stakeholder management, Occupational Health and Safety and Human Resources & Industrial Relations.

4.3 LIGHT RAIL LEGACY

As the first contemporary light rail in Queensland, the GCLR project has led the way for light rail projects across Australia. Light rail design, procedures, skills and construction innovations including signalling, traction power, T&C, stray current geometry, track alignment and vehicle interfaces, are already contributing to the success of similar projects in Australia.

Genuine partnership with the State Government saw the GCLR set new industry standards in light rail design and quality. The Rail Safety team, made up of government and consortium representatives, worked closely with the State Rail Safety Regulator to adapt various codes, standards and best-practice principles to fit the unique construction requirements of the project. Together the Rail Safety Team delivered innovative solutions to build a new regulatory framework for light rail projects in Queensland, setting national industry precedents for future major infrastructure projects including:

- Updating the Queensland Transport Infrastructure Act 1994 to specify light rail, enabling the Queensland Government to establish a legal framework to allow the construction, maintenance and operations of light rail transport infrastructure and initiating the development of new requirements to ensure safe delivery and operations.
- The seven-module trams, specifically designed for the Gold Coast, feature the latest technology, including the Bombardier Mitrac propulsion system, which reduces CO2 emissions, the most powerful air-conditioning system for this class of tram, 100% low floor technology for optimal ride comfort and specially designed surfboard racks.

4.4 HUMAN RESOURCES

To achieve the project target of providing 188,000 hours of deemed training to green labour and upskilling the local workforce, McConnell Dowell implemented a training budget in excess of \$2 million including State and Federal incentives. McConnell Dowell employed more than 900 people at peak construction, with 92% of the workforce new to the light rail industry. The training and upskilling of the staff on the project significantly contributed to the skills and experience of the light rail industry in Queensland and left a lasting legacy of employable skills for the community.

More than 260,000 hours were invested in civil construction competency-based training, with 49% of the workforce engaged in civil traineeships and an average of 170 hours spent on training per month. McConnell Dowell's commitment to training excellence saw 16 undergraduate and graduate employment placements translate to 3 fulltime positions. In recognition for the exceptional training program the GCLR project was awarded *Employer of the Year* at the *2013 Queensland Training Awards*.

McConnell Dowell also facilitated a series of leadership development courses to shape the high performing construction management team. Leadership workshops were designed to assist the participants to deal with the challenges and complexity of the project by focussing on team building, self-awareness, resilience and strategic planning.

Training and upskilling also a key priority around safety, in particular around the change of environment once the project transitioned into the T&C phase. The challenge was to ensure more than 1,000 employees were aware of the changed conditions and risks associated now the site environment had changed to include powered overhead lines and moving trams.

McConnell Dowell implemented a range of training sessions and activities to ensure the project team transitioned safely including specialised T&C inductions and training, a project wide Energisation Awareness event and Safety Stop events which required workers to down tools and consider T&C safety issues.

4.5 INDUSTRIAL RELATIONS

The GCLR project was a model of industrial harmony, with no major industrial action occurring during the project delivery. This was achieved through a robust and well-received Enterprise Bargaining Agreement, which developed a culture of strong performance, reward and recognition with the workforce. Strong working relationships and positive dialogue with unions flowed down to workforce and subcontractors.

4.6 RISK MANAGEMENT

The projects extensive use of Early Works Risks Assessments (EWRA) and the @RISK tool allowed early identification of risks and opportunities and encouraged a transition from the forecasting of risk to a constant awareness and automatic factoring of risk into everyday construction activities.

Through monthly risk and opportunity workshops with delivery and leadership streams, on-the-ground issues became more visible to management via the correct escalation process providing for the appropriate energy and resources to be expended on finding cost effective solutions. This process immersed consortium partners in addressing the challenges consistently and in partnership with McConnell Dowell through information and awareness.

One of the key risks identified was the challenge around the design interface with delivery. To address this a daily “war room” was created to escalate and resolve issues impacting on construction delivery. This open session was available to all project stakeholders and staff and provided a proactive forum to communicate issues and allocate actions, progress solutions and assign accountability.

5.0 CONCLUSION

The GCLR is one of the most significant pieces of public transport infrastructure completed in south-east Queensland. Now the spine of TransLink's Gold Coast network, the GCLR integrates with new bus routes and provides improved connectivity between trams, buses and trains.

SYSTEM SUCCESS

The success of the system can be measured in the community's ownership and advocacy for GCLR:

- Stakeholder satisfaction continues to be realised as passenger forecasts are exceeded by 5,000 passengers per day.
- Within two months of opening, the GCLR had hit the one million paid passenger's milestone.
- To date the GCLR has had more than 3.2 million trips.
- TransLink figures from July 2014 to January 2015 show that public transport usage on the Gold Coast has risen by 18% against the same period last year.
- The system is exceeding 99.8% availability.

In delivering the first contemporary light rail in Queensland and the associated future proofing of public utility upgrades, the GCLR entailed long-ranging impacts on motorists, pedestrians, cyclists, transport companies and commercial road users, developers, tourism companies and hotels, residents, visitors and local businesses. The GCLR has consistently drawn from best-practice principles and lessons learnt from various internationally successful light rail systems to deliver a project which brought superior outcomes for the public.

SUPERIOR OUTCOMES

The project provided important enhancements to the local community and environment, as well as major economic benefits to the wider community. In addition to setting a number of benchmarks for future light rail infrastructure projects, the project will continue to provide substantial tangible benefits for future generations to come.

Without compare, the GCLR achieved client and stakeholder objectives and formed strong, beneficial relationships through proactive and direct relationship management at all levels. At completion the project had:

- Achieved 94.50% of goods, services and employment from the local economy.
- Generated approximately 6,500 direct and indirect jobs.
- Spent more than \$600 million with local businesses.

The construction legacy means Gold Coast private development is up 159% for the quarter ending December 2014 and retail tenancy occupations have increased by up to 30% along the corridor.

LEADING THE WAY

Many firsts were developed for the contemporary light rail industry, providing whole-of-life, operations and maintenance cost savings and benefits. Innovations influencing future light rail construction include innovative exchangeable track switching systems, integrated traffic signalling systems incorporating real-time tracking, higher order systems and emergency services call-up. Most importantly, the GCLR has initiated Australia's light rail revival. The legacy of the Gold Coast light rail has set a new benchmark for construction project delivery in Australia.