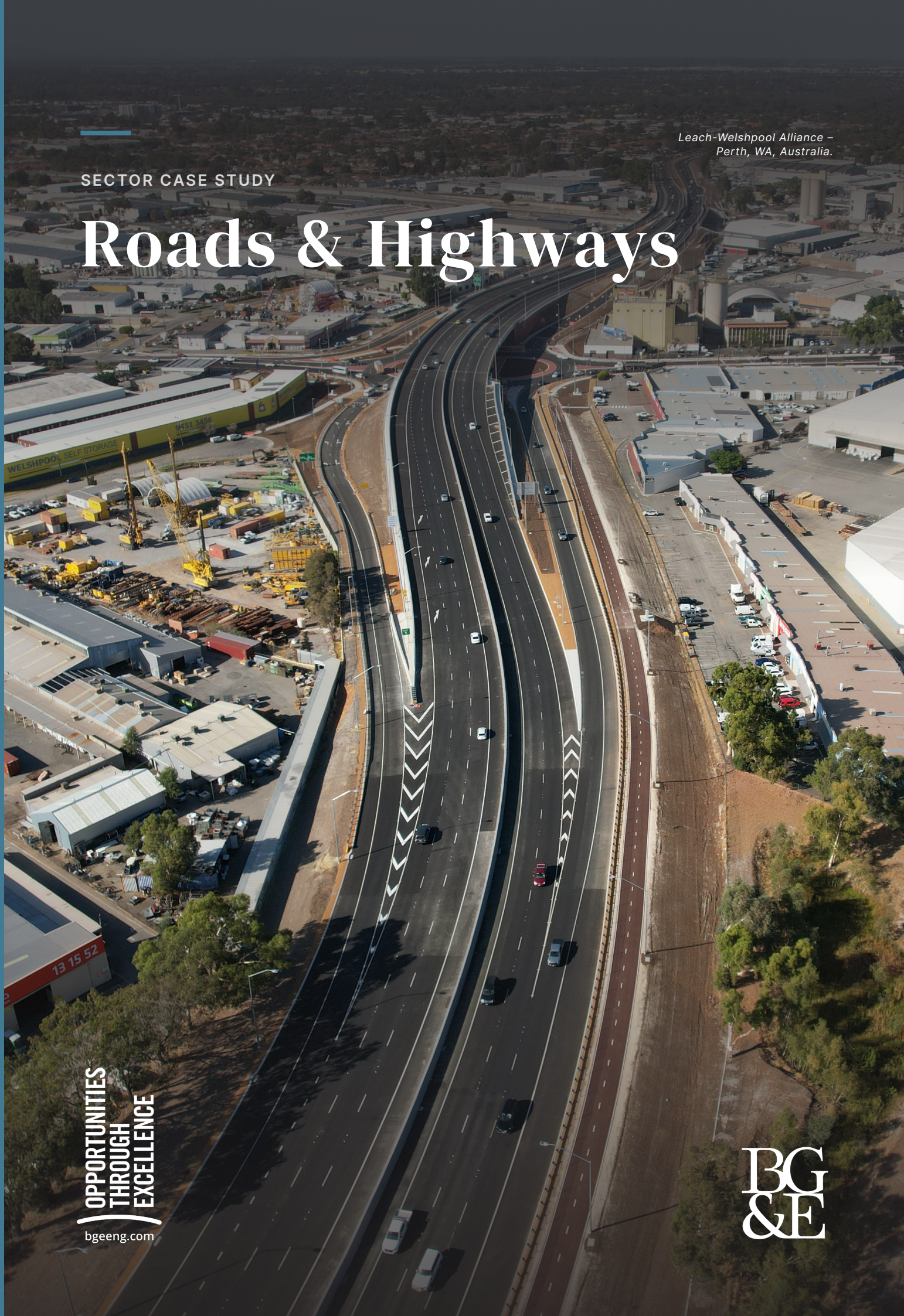
SECTOR CASE STUDY

Roads & Highways



Leach-Welshpool Alliance – Perth, WA, Australia.

OPPORTUNITIES THROUGH EXCELLENCE

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BG&E

M1 Pacific Motorway Extension to Raymond Terrace: Southern Package

NEWCASTLE, NSW, AUSTRALIA
CLIENT: JOHN HOLLAND & GAMUDA JV

BG&E, alongside JV partner, Jacobs, provided the detailed design for the Southern Package - which achieved multiple 10/10 review scores from Transport for NSW (TfNSW), met an ambitious eight month delivery design schedule, and optimised key design elements - significantly reducing quantities in the detailed design phase.

The M1 Pacific Motorway extension to Raymond Terrace project includes a 15 kilometre extension of the existing M1 Pacific Motorway (M1) at Black Hill to the existing Pacific Highway at Raymond Terrace. This extension will provide a critical link between Sydney and Brisbane along one of the busiest transport corridors in Australia.

The project is being delivered across two contracts. The BG&E and Jacobs JV was engaged by the John Holland and Gamuda JV to provide detailed design for the Southern Package - Black Hill to Tomago.

Key features of the project included:

- 10 kilometres of new dual carriageway motorway with two lanes in each direction.
- Motorway access from the existing road network via new interchanges at Black Hill, Tarro, and Tomago.
- 1% Annual Exceedance Probability (AEP) flood immunity.
- Eight new bridges, including a 2.6 kilometre viaduct over the Hunter River flood plain.
- Multiple local road connections.
- Roadside furniture, including safety barriers, signage, fauna fencing and crossings, and street lighting.
- New structures, including bridges and noise walls.
- Walking and cycling facilities.
- Utilities and services adjustments, including water mains and high voltage transmission lines.
- Modifications to or new signalised intersections at Black Hill, Tomago, and Heatherbrae.

Key innovations and outcomes included:

- The design received multiple 10/10 review scores from TfNSW.
- Achieved an aggressive and ambitious target design delivery programme with key packages at FDD or IFC completed in under eight months.
- Significant design optimisation through all involved design phases, including alignment, drainage, and bridge.
- Reduction in all key quantities throughout the detailed design phase.

Major works started in 2023 and are slated for completion by 2028.

Once complete, the M1 Pacific Motorway will save motorists seven to nine minutes in travel time during peak periods and bypass five sets of traffic lights.

M1 Pacific Motorway extension to Raymond Terrace: Southern Package - Newcastle,, NSW, Australia.

M12 Motorway: Central Package

WESTERN SYDNEY, NSW, AUSTRALIA
CLIENT: JOHN HOLLAND GROUP

As a part of the $4.4 billion Western Sydney Infrastructure Plan (WSIP), the Australian and NSW governments are building the 16 kilometre M12 Motorway (M12).

The $2.1 billion east-to-west M12 is designed to connect the Western Sydney International Airport with Sydney's wider motorway network, increasing capacity, easing congestion, and reducing travel time.

In collaboration with GHD, BG&E helped to deliver the Central Package, which encompassed a 7.5 kilometre section between Badgerys Creek and Duff Road, Cecil Hills. The project features seven new bridges, new dual carriageway motorway, active transport links, and complex flooding, drainage and water quality considerations.

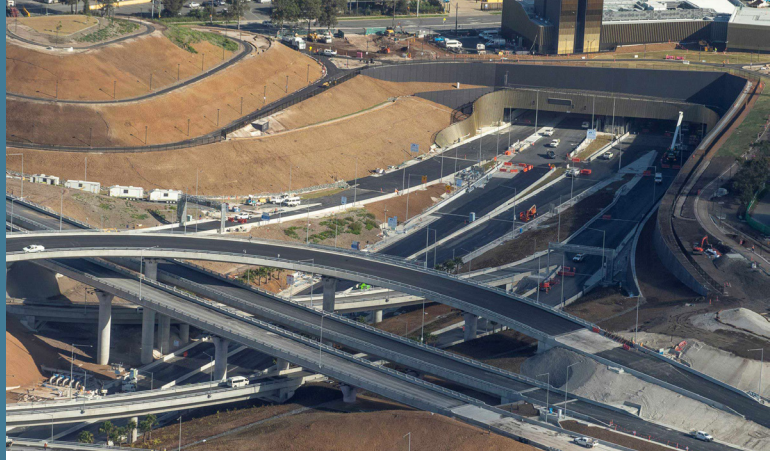
M12 Motorway: Central Package –
Western Sydney, NSW, Australia.

BG&E were instrumental in the following aspects of the project:

- Structures design lead for the complex voided slab bridge at Elizabeth Drive and the Super-T bridge for the university access.
- Internal reviewer for four other Super-T and plank bridges - two of them are classified as Class C – complex bridges.
- Value engineered to improve bridge constructability and aesthetics.
- Lead flood modeller, responsible for significantly reducing the spans of the bridge crossing across Kemps Creek and South Creek.
- Lead pavement drainage engineer, responsible for the design and modelling of the pavement drainage network and the water quality treatment strategy.

The project is targeting an 'Excellent' Infrastructure Sustainability Rating with the Infrastructure Sustainability Council – by reusing and recycling 95% of the excavated materials, using 40% of recycled aggregates for the sub-base layers, and minimising water use on the site.

The M12 is slated for completion by 2025.



WestConnex: Stage 3B - Rozelle Interchange

ROZELLE, NSW, AUSTRALIA
CLIENT: JOHN HOLLAND & CPB JV

WestConnex: Stage 3B - Rozelle Interchange is the final stage of WestConnex. This project delivers an underground motorway linking the M4-M5 Link Tunnels to the City West Link and Victoria Road. It removes cars from Victoria Road by providing a bypass between Iron Cove Bridge and Anzac Bridge. It connects to the future Western Harbour Tunnel and includes 10 hectares of new public open space.

BG&E provided structural, civil, and construction engineering services. Specifically, our team designed the temporary civil and structural components to allow site access, establishment, and tunnelling.

Some of the key elements in our scope of work included:

- Three site compounds at Rozelle, City West Link, and Iron Cove Link.
- All temporary drainage and water quality requirements.
- Two new intersections and staging requirements from City West Link into the Rozelle site compound.
- Temporary flood modelling for the Rozelle site compound.
- Three declines to tunnel portals, including structural design of:
  - the retaining elements and the geometry for the 60 metre ramp into the decline portal to a depth of eight metres,
  - a 154 metre ramp into the decline portal to a depth 14.5 metres, and
  - a 100 metre ramp into the decline portal to a depth of 13 metres.
- Foundations for three acoustic sheds for noise attenuation of construction activities.
- City West Link temporary staging structures.
- Two span plank road bridge with a high skew and horizontal curves used to support traffic on the temporary ramps to divert traffic for the staged demolition and construction of the Victoria Road bridge.
- An eight span steel pedestrian bridge to provide temporary pedestrian access around the demolition and construction works at City West Link.

Achieving practical completion in late 2023, a key highlight of the project was the delivery of beneficial urban design outcomes - including returning 10 hectares of parkland to the local community, new and upgraded pedestrian and cyclist infrastructure, and connectivity between Annandale, Lilyfield, and the Bays Precinct.

Pacific Highway Upgrade, Woolgoolga to Ballina: Portion A

NORTH COAST, NSW, AUSTRALIA
CLIENT: ROADS & MARITIME SERVICES (RMS)

The Pacific Highway upgrade is Australia's largest road infrastructure project, connecting Sydney and Brisbane, significantly contributing to the country's economic activity.

Coffs Harbour to Ballina is one of the four main project sections and encompasses the $4.9 billion Woolgoolga to Ballina upgrade.

Opened to traffic in 2020, the Woolgoolga to Ballina upgrade transformed 155 kilometres of road into a safer dual carriageway.

It included over 100 bridges, 10 grade separated interchanges, five town bypasses, underpasses and overpasses for local traffic, fauna crossings, and driver rest areas.

Woolgoolga to Ballina: Portion A, the largest of the four design packages, included 49 kilometres of dual carriageway and 73 bridges - stretching from MacLean to Glenugle. This project was awarded to GHD, with BG&E as the subconsultant.

BG&E's highly skilled team provided bridge, structural, civil, flooding and drainage engineering, and materials testing and durability services.

The key features of Woolgoolga to Ballina: Portion A included:

- 116 design lots with four stages for each lot, with most packages delivered up to two weeks before schedule, to an aggressive program.
- 35 kilometres of early works road design within four months.
- Optimised road alignment, compared to the reference design.
- Optimised bridge deck designs, reducing the number of 1,500 Super T bridge girders by 88 compared with reference designs (which provided a saving of $2.8 million).
- Optimised bridge span configurations and substructure design (which also reduced construction costs by $4.8 million).
- Refined the design of standard RMS prestressed planks and Super T beams.

The improvements to this vital transport corridor support regional development and enhance the local communities' amenity - while providing safer, more efficient, and more reliable travel for all road users.

Pacific Highway Upgrade, Woolgoolga to Ballina: Portion A - North Coast, NSW, Australia.

Princes Highway & Waratah Street Intersection Upgrade

SUTHERLAND SHIRE, NSW, AUSTRALIA
CLIENT: TRANSPORT FOR NSW

As part of the MRB Technical Services (a JV between Mott MacDonald, RPS, and BG&E), BG&E was involved in the concept and detailed design for the Princes Highway and Waratah Street Intersection project, and the detailed design of King Georges Road (KGR) - Stage Two. Both of these projects seek to improve the significant journey time delays currently experienced.

The Princes Highway and Waratah Street Intersection upgrade includes the following elements:

- Reconfiguration and widening of the Waratah Street approach to Princes Highway to provide dual signalised right turn and left turn lanes.
- Widening of the Princes Highway western kerb (northbound) to provide a dedicated left turn lane from Princes Highway to Waratah Street (reduced length to avoid impacts to council heritage trees).
- Pedestrian crossing amendments, including a signalised pedestrian crossing for Waratah Street.
- Extension of the Waratah Street median to restrict right turn movements into and out of the service road, and amendments to driveways through the intersection.

The KGR2A improvement includes the following elements:

- Widening of KGR from two to three lanes in each direction from Connells Point Road to the William Street and Culwulla Street intersection.
- Introducing a median along KGR and relocating footpaths and utilities to suit the new layout.
- Extending the southbound right turn bay on KGR at the Connells Point Road intersection, including removing the left slip lane, zebra crossing and pedestrian island on the northeast corner for improved safety. maintaining signalised pedestrian crossing.
- Optimising drainage design to minimise physical work and adjustments to the existing network.

Both projects require the work to be undertaken within constrained environments while accommodating a wide range of utilities. Particularly, the project team had to contend with inadequate drainage in the existing condition, with the project potentially increasing the issues downstream in the Council owned system.

The project team worked collaboratively with the TfNSW project team to understand and deal with the complex issues around utilities, including a water main and 132kV for Princes Highway and on KGR2A where existing assets are within an already congested footway which is being further reduced due to the road widening.

MRB delivered the detailed design, federated model, and project plans on time, meeting TfNSW's quality expectations and promptly addressing any issues. These items were completed in parallel with progressing various optioneering items and investigation plans.

The project team has delivered the detailed design and IFT documentation to TfNSW, who as of mid-2024 are in the process of tendering for the construction of the works. MRB will continue to have input through the construction phase.

Princes Highway & Waratah Street Intersection Upgrade - Sutherland Shire, NSW, Australia.

New Richmond Bridge: Stage One - The Driftway

RICHMOND, NSW, AUSTRALIA
CLIENT: TRANSPORT FOR NSW

The Driftway is a Hawkesbury City Council Road located on the Hawkesbury City Council and Penrith City Council LGA boundary. BG&E, in partnership with Mott Macdonald and RPS, operating as MRB JV, carried out the detailed design services for Transport for NSW (TfNSW).

The key design features of the proposed upgrade to The Driftway include:

- Upgrade of the Londonderry Road and The Driftway intersection to a roundabout, including two southbound lanes through the roundabout for emergency flood evacuation requirements.
- Realignment of 230 metres of The Driftway at its eastern extent to create a four-leg roundabout with Blacktown Road and Racecourse Road.
- Upgrade of intersections with Luxford Road and Reynolds Road to painted channelised right turn T-junctions.
- A new bridge over a tributary of Rickabys Creek (separate TfNSW detailed design).
- A new retaining wall along the northwestern corner of Racecourse Road and Blacktown Road.
- Pavement improvements to 3.6 kilometres of The Driftway, including widening both shoulders from one to 1.5 metres.

To minimise cost, the proposed pavement solution was in-situ stabilisation of 200 millimetres of the existing pavement with a 200 millimetre overlay.

Due to the highly variable existing pavement crossfalls, the road design was carefully prepared to ensure that the use of existing pavement was maximised without adversely impacting the geometric road design solution. This also minimised the extent of full depth pavement widening.

Construction staging featured heavily in the design development and full depth asphalt was proposed to allow temporary traffic loading and temporary ramps to be used.

BG&E was also engaged to undertake site durability investigations of existing culverts with the aim of retaining the existing infrastructure and thereby reducing cost. It was determined that culverts were suitable for retention which enabled further savings to the project and the pavement designs were adapted to suit the low cover of existing culverts.

To enhance safety and eliminate several design concessions, the team lowered the design and posted speeds to align with existing conditions.

Budget and programme were key drivers. To ensure that the road safety outcomes are maximised, a preferred concept was preferred for TfNSW. In order to meet program commitments, the 80% and 100% detailed design phases were shortened.

New Richmond Bridge: Stage One - The Driftway - Richmond, NSW, Australia.

Ipswich Motorway Upgrade: Stage One - Rocklea to Darra

BRISBANE, QLD, AUSTRALIA
CLIENT: BOSTON GLOBAL

The Ipswich Motorway Upgrade: Stage One - Rocklea to Darra is a three kilometre upgrade of the Ipswich Motorway and surrounding service roads. It is located approximately 15 kilometres west of Brisbane's city centre.

BG&E and Cardno produced the tender design for this project, which was successful, and our client – Bielby Hull Albem JV, undertook the design and construction of the project. The detailed design was completed in approximately nine months thereafter.

Due to savings that were achieved as part of the design and construction process, a vital $40 million service road upgrade was added to the scope of works and was delivered within the overall project budget.

Some of the key features of this project included:

- Raising the existing motorway by 2.5 metres and widening by a carriageway in each direction, without interrupting the 85,000 vehicles that travelled daily.
- Significantly improving flood immunity for a section of the motorway prone to frequent flooding, without creating impacts for adjacent landowners.
- Implementing geotechnical design solutions that addressed settlement issues through a floodplain with very soft ground.
- Utilising innovative deck unit and pile design solutions.

This project received an excellence rating from Australia's Infrastructure Sustainability Council, a highly commended award from Consult Australia for Project Collaboration and 12D's Innovation Award for the use of 12d Synergy as a CDE for the Project.

Ipswich Motorway Upgrade Project - Stage One: Rocklea to Darra - Brisbane, QLD, Australia.

Coomera Connector: Stage One

GOLD COAST, QLD, AUSTRALIA
CLIENT: QLD DEPARTMENT OF TRANSPORT & MAIN ROADS

The Coomera Connector is a 45 kilometre north-south transport corridor connecting the Logan Motorway and Pacific Motorway interchange at Loganholme and Nerang-Broadbeach Road in Nerang.

The Department of Transport and Main Roads (DTMR) identified the 16 kilometre section between Coomera and Nerang (referred to as Stage One: Coomera to Nerang) as having the highest demand for providing additional capacity between Loganholme and Nerang.

The preferred arrangement has been identified as a new urban high-speed motorway having grade-separated interchanges which will provide an alternate route to the M1 for both the Coomera and Nerang River crossings.

Stage One will be delivered in three construction packages, of which BG&E are providing services for two.

STAGE ONE NORTH – SHIPPER DRIVE TO HELENSVALE ROAD

Stage One North includes a four kilometre section from Shipper Drive to Helensvale Road. Construction commenced in early 2023 and is slated for completion by 2025.

BG&E and WSP (WBJV) was engaged by Acciona and Georgiou (AGJV) to carry out the successful tender design and subsequent detailed design.

BG&E's QLD Transport team were the design lead for the alignment and geometry of the motorway, the interchanges, as well as the adjacent active transport facility. The Coomera Connector Stage One North is designed as a four lane motorway with a provision for future six lanes by widening into the median. A key feature of the project is the 900 metre long dual carriageway bridge across the Coomera River designed by BG&E's Bridge team.

Traffic connecting to and from the northern end will travel along Shipper Drive to surrounding suburbs and the M1 Motorway via Foxwell Road. To meet the increased traffic demand, Shipper Drive is being upgraded to a four lane median divided arterial road from the interchange to Foxwell Road roundabout which is being converted to a signalised intersection.

STAGE ONE SOUTH – SMITH STREET MOTORWAY TO NERANG-

Stage One South includes a four kilometre section from Smith Street Motorway to Nerang-Broadbeach Road. Construction commenced in early 2024 and is slated for completion between 2025 and 2030.

In 2022, the contract was awarded to the BG&E and HDR JV to undertake detailed design for the Stage One South package, to be delivered as a Transport Infrastructure Contract – Construct Only.

BG&E, working with our design partner HDR and a specialist group of subconsultants, developed a four kilometre long greenfield design that included the following key features:

- A new grade separated interchange with the Southport to Nerang Road.
- Cutting through extremely hard rock up to 18 metres deep, including consideration of blasting techniques
- Design of two kilometres of motorway immediately adjacent to the Gold Coast rail line.
- Design of large embankments up to 10 metres.
- Design of the new Nerang River Bridge.
- Design of soft ground treatments through the Nerang Floodplain.
- Design of a new at-grade intersection of the Coomera Connectors southern termination point and Nerang to Broadbeach Road.

Coomera Connector: Stage One - Gold Coast, QLD, Australia.

Smithfield Bypass

CAIRNS, QLD, AUSTRALIA
CLIENT: HIGHWAY & ALBEM JV

The $164 million Smithfield Bypass is a vital piece of infrastructure for the northern beaches of Cairns, in Far North Queensland. The new bypass aimed to remove regional traffic from the local road network, resulting in benefits for the townsite, as well as safety and congestion improvements for all road users.

The project included:

- A new bypass which has reduced congestion on the existing Captain Cook Highway.
- The upgrade of the Cairns Western Arterial Road to four lanes from the southern connection of the bypass.
- The installation of traffic signals at the nearby Caravonica State School.

In partnership with HDR, BG&E provided design management, bridge and staging design, and civil and traffic engineering services for the bypass.

We were involved in Smithfield Bypass from the tender design stage through to completion of the detailed design.

When comparing the original project design and the long term ‘ultimate’ design, our team identified, during the tender, an opportunity for an alternative road layout that avoided the need to construct one of the interchanges. Not constructing this redundant interchange eliminated the need for millions of dollars in additional infrastructure that would be obsolete within 10 years, delivering significant whole-of-life savings.

The new structurally and sustainably efficient layout achieved an Excellent Design rating under the Infrastructure Sustainability Council’s Infrastructure Sustainability Rating Scheme.

The change to the scope resulted in challenges to the design development process and keeping to the original required timeframe for construction. To manage this, the team adopted an open, transparent and collaborative approach with the client.

Design works were provided in a rapid and prioritised order, enabling some aspects of construction to proceed while the design was still underway, which reduced project timeframes. Our successful identification and implementation of a better solution within the same timeframe underscores BG&E’s commitment to achieving whole of project benefits through design.

The project received the QLD CCF award for ‘Best Project - >$100M’ in 2022.

Smithfield Bypass – Cairns, QLD, Australia.

Townsville Ring Road

TOWNSVILLE, QLD, AUSTRALIA
CLIENT: GEORGIOU

The Townsville Ring Road: Stage Five (TRR5) is a section of the Bruce Highway route through Townsville, that forms part of the National Highway - Queensland's primary freight, passenger and tourism corridor, and connects Townsville's suburbs to key employment nodes and essential services.

BG&E was engaged by Georgiou to design the long-term temporary traffic management (TTM) staging works associated with the TRR5 project.

BG&E produced five long-term traffic stages and five sub-stages. For each TTM stage, this included TMD approved and RPEQ certified design documentation for road geometry, drainage, barrier design, delineation and signage, and temporary lighting design.

We worked closely with Georgiou to develop TTM works that ensure the safety of the workers and community, normal traffic operation, and efficient construction works.

The key features of this project are:

- Duplication of a six kilometre, two lane section of the Townsville Ring Road between Vickers Bridge and Shaw Road to four lanes.
- Duplication of bridges over Bohle and Little Bohle rivers.
- Duplication of overpass bridges at Beck Drive and Hervey Range Developmental Road.
- A new interchange at Beck Drive, catering for all directions of travel and providing a better connection between the Townsville Ring Road and the Upper Ross area.
- Changes to the existing Riverway Drive interchange to ensure its safe operation with the new Beck Drive interchange, including removal of the southbound off-ramp and northbound on-ramp.
- Installation of drainage for flood mitigation.
- Installation of intelligent transport systems.
- Noise mitigation measures.
- Environmental considerations.
- Upgrades to the surrounding local road network, including signalisation of the Beck Drive and Gouldian Avenue intersection.
- Active transport facilities including new and upgraded shared pathways for pedestrians and bike riders.

Construction started in June 2021 and was completed in early October 2023.

Townsville Ring Road: Stage Five - Townsville, QLD, Australia.

John Street Flood Immunity Study

IPSWICH, QLD, AUSTRALIA
CLIENT: QLD DEPARTMENT OF TRANSPORT & MAIN ROADS

During heavy rain events within the Rosewood township, significant flooding occurred along John Street through the main commercial centre of Rosewood. This has resulted in considerable community concern and vocal appeals to local and state authorities to improve flood immunity through the town centre.

BG&E was engaged by the QLD Department of Transport and Main Roads to conduct a flood study, options analysis and business case, which encompasses:

- Options development and analysis, as well as shortlisting options.
- Business case development.
- Flooding and drainage design.
- Design of roads, drainage and a benefit cost ratio.
- Civil, pavement, geotechnical and environmental engineering services.
- Cost estimates.
- Risk and multi-criteria analysis workshops.

Key objectives of this project included:

- Improving the road network resilience and reducing the time of road closures caused by flooding.
- Improving flood resilience of the Rosewood township.
- Improving the existing road profile of John Street to be compliant with the required design standard.
- Increasing the drainage capacity of John Street to contain flows between kerbs and reduce the occurrence of flooding into adjacent properties.
- Increasing the asset life by rehabilitating the road pavement while minimising the depth of excavation, cost and disruption to local business during construction.
- Increasing safety for all road users.
- Providing a value-for-money solution.
- Ensuring no net worsening for flooding on private properties.

The benefits which will flow from achieving these objectives are:

- Increased flood immunity to minimise road closures during and after rain events.
- Alleviation of concerns raised by local community, businesses and members of parliament.
- Increased asset performance and life.
- Increased road network, safety reliability and accessibility.

John Street Flood Immunity Study - Ipswich, QLD, Australia.

Pakenham Roads Upgrade

PAKENHAM, VIC, AUSTRALIA
CLIENT: SYMAL GROUP & MAJOR ROAD PROJECTS VICTORIA

BG&E was engaged for two of the three stages of the Packenham Roads Upgrade: Stage One - Princes Freeway Interchanges Upgrade and Stage Three - Racecourse Road Upgrade.

BG&E was engaged as the principal consultant to undertake the detailed design for Stage One and Stage Three of the Major Road Projects Victoria (MRPV)'s Pakenham Roads Upgrade Program (PRU) which will create a more efficient transport network for Pakenham, reducing bottlenecks and improving connectivity and safety for all road users.

Stage One involves the upgrade of a critical two kilometre section of the Princes Freeway, including upgrade to two existing interchange ramps and bridges.

Stage Three involves the upgrade of Racecourse Road to the north of the Healesville Koo Wee Rup Road (HKWR) interchange.

The BG&E design team undertook geometric road design, bridge design, freeway gantry and protection barrier design, earthworks design, traffic barrier design, signage and line marking design, bus and active transport facilities design, drainage design, hydrology and flood modelling, geotechnical and pavement design, intelligent transport systems, lighting and traffic signal design, and landscape and urban design.

The bridge over the Princes Freeway was the first major road bridge detailed design undertaken by BG&E's Melbourne team and hence represents a significant milestone in BG&E's expansion in Australia.

The new bridge provides for an additional two lanes of traffic and a shared user path for pedestrians and cyclists to the existing bridge.

The bridge is a two span Super T structure of a total length of 62 metres. The bridge is fully integral with no deck joints between abutments. The abutments consist of driven precast concrete piles which were sleeved prior to the construction of spill-through embankments to provide flexibility for the integral abutments. The central median pier is a blade-type structure, protected from collision by 75 metre pier protection 'battleships'.

The BG&E team worked collaboratively with the contractor, Symal, and the road authority to assess various structural forms before settling on the integral structure - which will provide significant long term benefits to the asset owner by reducing and eliminating inspection and maintenance activities. Furthermore, the integral abutment design – which includes an industry-leading approach to pavement interface – will ensure a safe, smooth ride for motorists.

Pakenham Roads Upgrade - Pakenham, VIC, Australia.

Narre Warren North Road Upgrade

NARRE WARREN, VIC, AUSTRALIA
CLIENT: MAJOR ROAD PROJECTS VICTORIA & SYMAL GROUP

The Victorian and Federal governments jointly funded the Narre Warren North Road Upgrade, between Fox Road and Belgrave-Hallam Road, in Melbourne's south eastern suburbs to improve safety and travel times for the more than 14,000 vehicles that use the road each day.

The project included:

- Duplication of lanes in each direction between Fox Road and Belgrave-Hallam Road.
- The upgrade of the Heatherton Road and Ernst Wanke Road intersections.
- Improved safety by adding new traffic lights to the Memorial Drive intersection and installing safety barriers.
- Modification and simplification of the Brundrett Road and Crawley Road intersections to improve safety by removing conflicting right turn movements.
- Upgrade of the existing and building new walking and cycling paths to improve connectivity.
- New U-turn facilities.
- Improved access and egress for the fire station.
- Reconstruction of the existing culvert.

BG&E provided civil engineering, road design, traffic modelling, flood modelling, drainage and pavement design, and geotechnical services for the project.

Design ran from 2020 to 2021, and works commenced from late 2021 to mid 2023.

Hallam North & Heatherton Road Upgrade

HALLAM, VIC, AUSTRALIA
CLIENT: SYMAL GROUP & MAJOR ROAD PROJECTS VICTORIA

As a part of Victoria's Big Build, Hallam North and Heatherton Road were upgraded, with works beginning in September 2020 and completed in late 2022. The upgrade included the duplication of Hallam North Road, upgraded intersections, and new walking and cycling paths.

The works consisted of:

- The duplication of Hallam North Road from two lanes to four lanes (two lanes in each direction) with central median.
- Intersection upgrade and signalisation of the Hallam North and Heatherton Road intersection to replace the existing roundabout.
- Upgraded signalised intersection with Thomas Mitchell Drive to improve access and safety.
- Provision of new signalised intersection with Heatherton Village Shopping Centre and Heatherton Road.
- Dedicated turn lanes and U-turn facilities.
- New and upgraded SUPs along both sides of Hallam North Road and Heatherton Road for project length.
- Stormwater and sub-surface drainage design and flood modelling.
- Road works, earthworks, retaining wall design, street lighting, safety barriers, new shared paths, traffic signals and associated works.
- Relocation and protection of utility services.
- Landscaping, urban design and associated works.

BG&E identified and proposed several road improvements - including the signalisation of a shopping centre access.

The upgrade has improved traffic flow and eased congestion at the Heatherton Road intersection, improved accessibility to the freeway network, made it easier for the local community to walk or cycle in the local area, and lowered the risk and severity of crashes by adding safety barriers.

Bulmans Road Urbanisation

MELTON WEST, VIC, AUSTRALIA
CLIENT: THE CITY OF MELTON

The Bulmans Road Corridor is an important link for the region, connecting the suburbs of Harkness and Melton West to the township of Melton, Woodgrove Shopping Centre and the Western Freeway. Two schools and the Westlake Reserve along Bulmans Road generate significant traffic volumes, resulting in safety and congestion concerns during peak hours.

The upgrade of the corridor from the Western Freeway to Centenary Avenue will help address these concerns for all users - including pedestrians, cyclists, motorists and bus companies.

The project scope of work included:

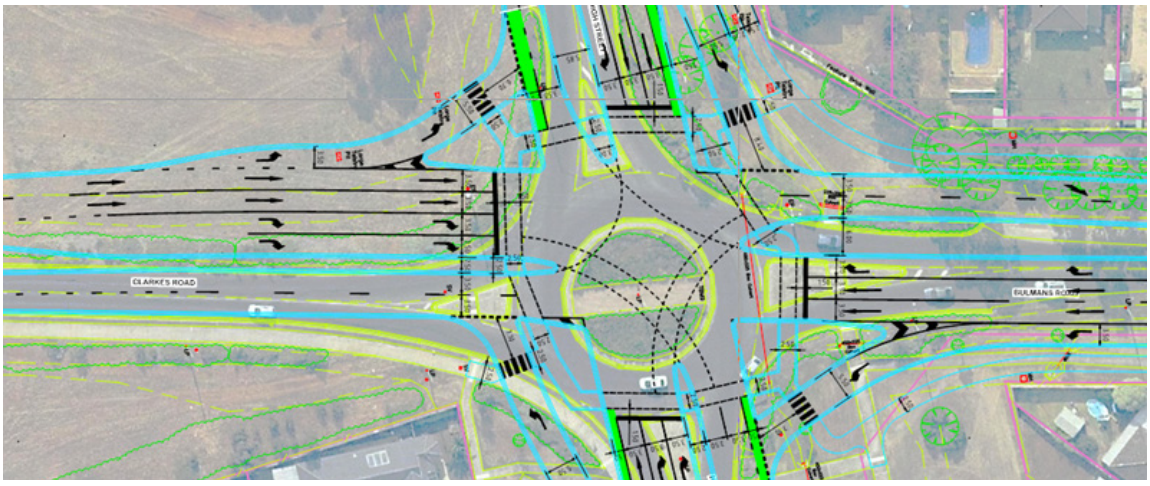
- Urbanisation of three kilometres of Bulmans Road and High Street (kerbs, underground drainage and centre median islands).
- Road widening and realignment.
- Signalisation of High Street and Bulmans Road with allowance for future duplication of Bulmans Road to cross over and connect to the Western Freeway.
- Additional services roads.
- Centralised school bus interchange for five buses and upgrade of bus stops along current bus routes.
- Formalised on-street parking and school crossings.
- Shared paths, footpaths, cyclist lanes and associated links.
- Relocation of underground services and overhead high voltage cables and associated third-party infrastructure.

BG&E undertook the following services:

- Multiple concept designs based on the client's brief, with the preferred concept selected after comprehensive stakeholder engagement with the schools, local residents and bus companies.
- Detailed design and issued for construction drawings for the road and drainage upgrade, including the upgrade of bus stops and provision of shared use pathways.
- SIDRA analysis and signalised intersection design for the High Street and Bulmans Road Intersection.
- Scoped and procured site investigations, including:
  - Authority services location surveys.
  - Geotechnical testing to enable pavement design and contamination classification.
  - Arborist assessment of all impacted trees.
  - Cultural heritage management plan.
  - Flora and fauna assessment.
  - Traffic surveys.
  - Road safety audits.
- Identification of service impacts and coordination of relocation and protection designs, including procurement of authority works offers.
- Management and coordination of subconsultants for the design of traffic signals, public lighting and landscape design works.
- Cost estimation and staging for the works including provision of tender schedules and quantities.
- Construction phase services for Stage One.

BG&E was engaged by The Shire of Melton for detailed design services in 2020. The complexity of the project was greater than originally anticipated and to suit Council funding, BG&E proposed a two stage construction approach:

- Stage One works commenced in July 2023 for the section of Bulmans Road between Westlake Drive and Centenary Avenue and is expected to be completed in December 2024.
- Stage Two works are programmed for construction in 2025 and include the Signalisation of High Street and Bulmans Road along with approaches.



Bulmans Road Urbanisation Project – Melton West, VIC, Australia.

Officer South Road Interchange Upgrade

OFFICER, VIC, AUSTRALIA
CLIENT: CARDINIA SHIRE COUNCIL

Officer Road South is an existing unsealed two lane, two way undivided road with no access ramps to Princes Freeway at the intersection.

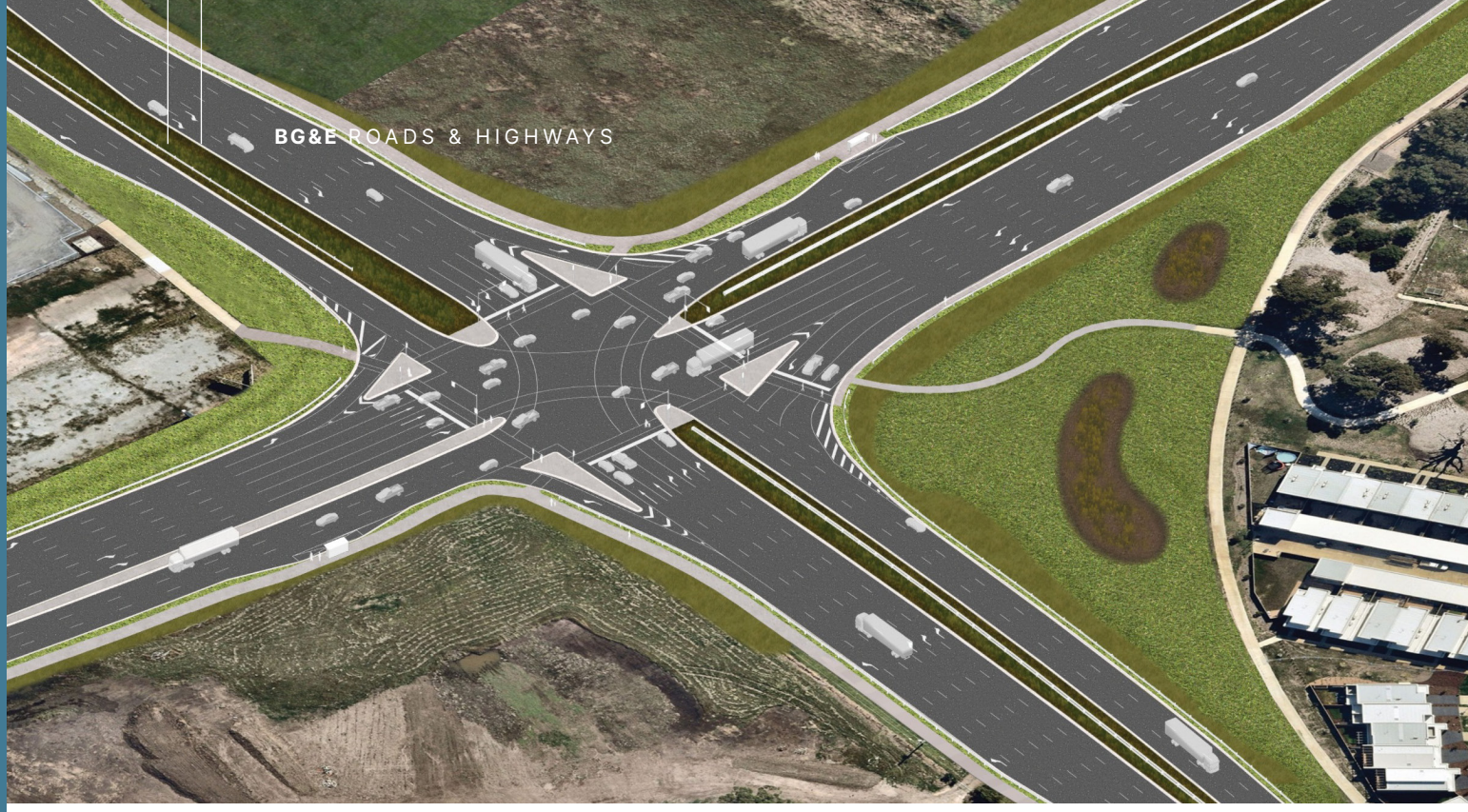
BG&E was engaged by Satterley Property Group to upgrade the existing Officer South Road into a divided urban arterial road (north of Princes Freeway) with access to the Freeway in the form of a half-diamond interchange.

The works involve roadworks, earthworks, street lighting, safety barriers, drainage improvements, new shared paths, traffic signals, civil structures, signage and line marking, and associated works.

Working collaboratively with Cardinia Shire Council, the Department of Transport, and Melbourne Water - BG&E developed an innovative road geometry and drainage solution that enabled the different catchment areas to be captured and discharged to different drainage strategies, depending on the requirements of different stakeholders.

The coordination of geometric and drainage designs was particularly challenging due to a number of site constraints:

- The geometric design was constrained by very flat existing terrain, the need to achieve 5.4 metres of overhead clearance under the Princes Freeway overbridge, and geometric tie-in points both on Officer South Road and at the freeway ramps.
- The drainage design, on the other hand, was constrained by the presence of large Melbourne Water retention basins next to Officer South Road, very high flood levels within the basins, the need to keep the road and drainage outlets above these flood levels, and limited space for drainage structures.



Western Port Highway Upgrade

MELBOURNE, VIC, AUSTRALIA
CLIENT: DOWNER & MAJOR ROAD PROJECTS VICTORIA

The Western Port Highway upgrade project has eased congestion at the intersections of Ballarto Road and Cranbourne-Frankston Road in outer south east Melbourne by replacing two roundabouts with signalised intersections.

BG&E and design and construction contractor, Downer EDI, developed the project scope and budget in collaboration with Major Road Project Victoria, as the delivery authority.

BG&E was the lead consultant - responsible for traffic, civil, and structural engineering, along with specialist subconsultants for the provision of lighting, landscape, environmental design, cultural heritage review, and road safety audits.

The works consisted of:

- Additional through lanes for Western Port Highway at the upgrade intersection.
- Duplication of Ballarto Road from two lanes to four lanes (two lanes in each direction) with central median at the upgrade intersection.
- Additional through lanes for Cranbourne-Frankston Road, including bus priority lanes at the upgrade intersection.
- Dedicated turn lanes.
- New shared user pathways along Ballarto Road and Cranbourne Frankston Road intersection legs.
- Road works, earthworks, retaining wall design, street lighting, safety barriers, new shared paths, traffic signals, and associated works.
- Major culvert extension for the eastern contour drain.
- Stormwater and sub-surface drainage design and flood modelling.
- Traffic engineering.
- Relocation and protection of utility services.
- Landscaping, urban design and associated works.

The Western Port Highway project has enabled all four sets of traffic lights within a six kilometre stretch to be sequenced - so the road network now has increased capacity and efficiency, supporting communities with faster connection for people and freight.

Westen Port Highway Upgrade – Melbourne, VIC, Australia.

Tonkin Gap Project

PERTH, WA, AUSTRALIA
CLIENT: MAIN ROADS WA

BG&E undertook the detailed development and design for this critical piece of infrastructure that has transformed the Tonkin Highway into a safe and efficient north-south transport link - relieving the bottleneck where the Great Eastern Highway reduced from three lanes to two in Bayswater and Redcliffe.

The $500 million Tonkin Gap and Associated Works Project was delivered by the Tonkin Gap Alliance, which includes Main Roads WA, Public Transport Authority (PTA), Georgiou, BMD, WA Limestone, GHD, and BG&E.

The associated works include the design and construction of rail-enabling works, including rail bridges and significant dive structures for the METRONET Morley-Ellenbrook Line on behalf of the PTA, to enable trains to enter the median strip of Tonkin Highway at Bayswater, exiting in Malaga.

The project had complex bridge structures (Tee-Roff concrete, launch bridges, steel footbridge, and arch footbridge), two dive structures, the principal shared path underpasses, noise walls, and mechanically stabilised earth walls.

The delivery of the Morley Station Bus Interchange Bridge over Tonkin Highway involved coordination with Transperth to divert bus routes and provide temporary bus stops to service patrons. In addition, the project had to plan to minimise disruption to the Midland Line during the design and construction of the two new Tonkin Highway bridges spanning the line.

The project spanned two LGAs and required delivery of multiple PTA, Main Roads and local government assets. Given the constrained environment, there was a considerable focus on engagement throughout the design and construction.

The project was highly constrained by existing infrastructure. Due to a narrow corridor, high water table, presence of live traffic, and critical services - the project was highly complex.

To minimise the risk associated with future space-proofing and constructability, design development and conflict identification were undertaken through digital systems such as 12D and Revit. This approach also aided real-time visualisation of the design as it developed and improved collaboration with the client and construction team.

During the project design stage, several development challenges were identified due to design development, groundwater modelling impacts, changes to rail alignment, and operational efficiency audits.

The project team worked closely with the Main Roads WA project director and client to work through these challenges.

Two BG&E employees were members of the Alliance Management Team and presented to the Board, Steering Committee, external reference groups, ONRSR, community reference groups, and community members.

The success of this project can be attributed to the effective communication of management and governance to the wider project team so that all parties were aware of decisions and outcomes to prevent abortive work.

WESTERN AUSTRALIAN CIVIL CONSTRUCTION INDUSTRY & TRAINING AWARDS, 2024: ***Winner*** - Sustainability Achievement Award.

MASTER BUILDERS COMMONWEALTH BANK EXCELLENCE IN CONSTRUCTION AWARDS, 2024: ***Winner*** - Best Civil Engineering Works >$1M Award.

Tonkin Gap Project -
Perth, WA, Australia.

Armadale Road & North Lake Road

PERTH, WA, AUSTRALIA
CLIENT: ARMADALE ACCESS ALLIANCE

The Armadale Road to North Lake Road Bridge was built over the Kwinana Freeway to ease congestion, improve access for Cockburn visitors and residents, and complement other road improvements in the surrounding area. Since the bridge opened in 2022, North Lake Road now connects to Armadale Road and is used by over 50,000 vehicles daily.

This world class project was recognised at the annual Master Builders-Bankwest Excellence in Construction Awards, winning the 'Best Civil Engineering Works Over $100,000,000' and 'Construction on a Challenging Site' categories.

The project was delivered in an alliance contract by the Armadale Access Alliance - comprising Main Roads WA, Laing O'Rourke, and BG&E.

Works for this project included:

- Construction of a new bridge over Kwinana Freeway, connecting Armadale Road and North Lake Road.
- Armadale Road was upgraded from Tapper Road to Kwinana Freeway, passing over the intersection of Tapper Road with a new bridge, and under the intersection of Solomon Road, via a trench structure.
- New north facing on and off ramps at Kwinana Freeway.
- Local roads were reconfigured with two new roundabouts to maintain connectivity.
- Collector distributor roads on both sides of the Kwinana Freeway from Berrigan Drive to Armadale Road.
- Modifications to the existing North Lake Road and Midgegooroo Avenue signalised the intersection.
- Additional lanes and turning capacity were added to the intersection of Armadale Road and Ghostgum Avenue to support ongoing residential growth in the suburbs of Calleya and Treeby.

Armadale Road & North Lake Road – Perth, WA, Australia.

Leach Highway & Welshpool Road Interchange

PERTH, WA, AUSTRALIA
CLIENT: MAIN ROADS WA

Leach Highway is a critical strategic freight and regional link in WA connecting Fremantle and the Inner Harbour with the industrial areas including the Kewdale Intermodal Rail Freight Terminal and Perth Airport.

Transport inefficiencies have a direct impact on economic activity in WA through loss of productivity and increased freight costs. The at-grade intersection of Leach Highway and Welshpool Road was one of Perth's most congested and dangerous intersections with at least 50,000 vehicles travelling through daily and high percentage of heavy vehicles travel on this route.

BG&E was the sole civil and structural designer for the project, which included:

- Upgrade of approximately 2.2 kilometres of Leach Highway between Orrong Road and Albany Highway and the upgrade of approximately 500 metres of Welshpool Road between John Street and Ewing Street.
- Modifications to maintain existing standards of affected local roads.
- A new grade separated interchange which consists of a roundabout with road bridge carrying Leach Highway over Welshpool Road.
- A new duplicate road bridge on Leach Highway adjacent to the existing bridge spanning over Armadale-Perth railway line, Sevenoaks Street and Railway Parade.
- Upgrade of barriers and installation of anti-throw/electrification screens on the existing bridge.
- Strengthening of the existing bridge to accommodate a higher performance level barrier.
- Installation of deflection walls and pier protection walls to bridge piers in the rail reserve.
- A Principal Shared Path (PSP) along the western side of Leach Highway from Sevenoaks Street to Orrong Road.
- Shared paths connecting the PSP to local roads, and replacement or realignment of affected existing paths.
- Traffic noise mitigation measures adjacent to noise sensitive developments.
- Resurfacing of existing roads.
- Boundary fencing and pedestrian and cyclist safety fencing.
- Accommodation works within properties affected by the project.
- Roadside and median safety barriers.
- Drainage including underground drainage, swales and basins.
- Installation and modification of roadway lighting.
- Installation and modification of public space lighting to shared paths, footpaths and stairs.
- Provision of new and modified signage, gantries and pavement markings.
- Installation and modification of Intelligent Transport Systems along Leach Highway and on key connecting roads.

Leach Highway & Welshpool Road Interchange – Perth, WA, Australia.

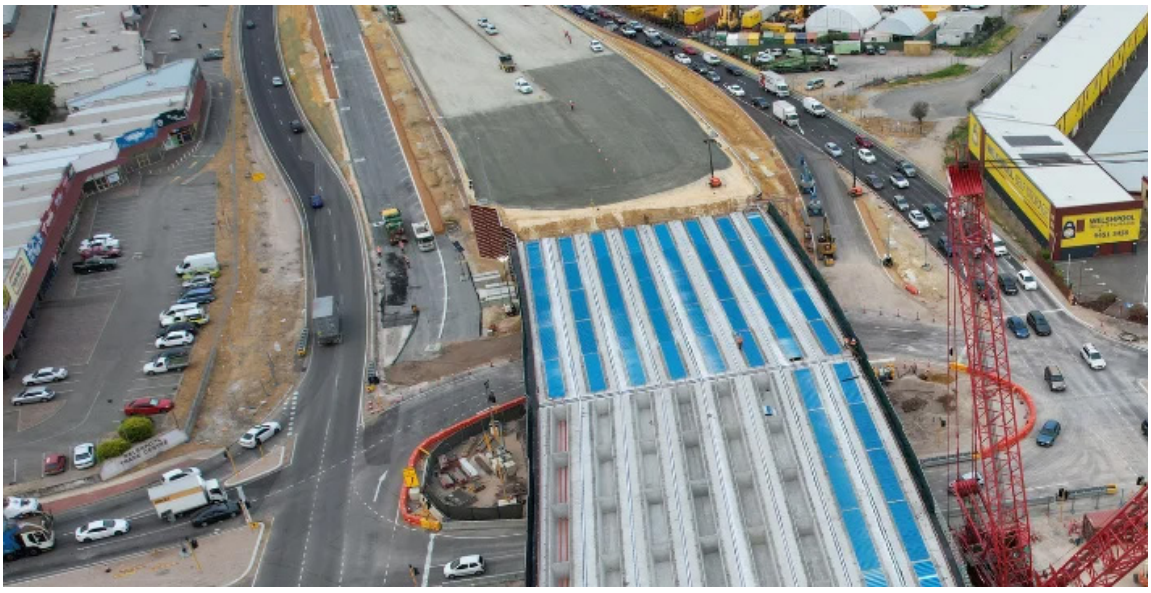
The BG&E Civil team proposed a major sustainability and congestion-saving innovation, transforming the client's preliminary design of a traditional grade separated interchange into a free-flow grade separated roundabout interchange. The oval shaped roundabout offered a compact design with straight 'long' sides to maximise the legibility of the change in curvature. The roundabout accommodates the swept paths of a 27.5 metre B-Double and 12.5 metre single unit truck turning simultaneously.

The bespoke Bridge #1882 is a new duplicate road bridge carrying southbound Leach Highway traffic over railway lines, Sevenoaks Street and Railway Parade.

The superstructure is a complex, haunched, continuous bridge comprising eight precast post-tensioned T-beams to match the profile of the existing adjacent bridge.

Designed to meet technical and weight requirements and fit within tight vertical clearances, each beam was precast in three lengths and post-tensioned with a slight angular change at the construction joints to accommodate the road geometry that is curved in plan and profile. The central beam was lifted into place and temporarily supported by the haunched cantilevered portions of the outer beams before final post-tensioning.

Leach Highway & Welshpool Road Interchange – Perth, WA, Australia.



NorthLink WA: Stage Three

PERTH, WA, AUSTRALIA
CLIENT: CPB CONTRACTORS

The $175 million NorthLink WA: Stage Three project involved the design and construction of 26 kilometres of new dual carriageway highway between Ellenbrook and Muchea, in the North East of Perth.

This project was the third component of the overall $1.12 billion NorthLink WA project, WA's largest ever road initiative that now services regional traffic movements to areas such as Kewdale, Malaga, Perth Airport, and the CBD.

In partnership with CPB Contractors, BG&E was the lead consultant to deliver the design and construction of Stage Three.

The key features of this mega infrastructure project comprised:

- A 26 kilometre freeway, standard dual carriageway highway, fully grade separated.
- Three grade separated roundabout interchanges, each with two bridges to carry the highway over the roundabouts below.
- Two bridges over railways and local roads and two bridges over waterways.
- A four metre wide principal shared path extending the highway length.
- A pedestrian underpass and a pedestrian bridge.
- More than 100 culverts that required flood modelling to design and optimise.

BG&E provided structural and civil engineering services. Some of the key elements of BG&E's structural design included:

- An innovative continuous bridge design at the two railway crossings, with precast Tee-Roff beams that were made using a simple post-tensioned stress bar joint over the piers.
- Adoption of smaller 'winged-plank' precast girders to allow for an improved span-to-depth ratio and easy installation (of the small units).
- Full precast concrete barrier panels, attached to the bridge deck with a small stitch joint.
- Six variable message sign units.

BG&E also coordinated the other design services including electrical, geotechnical, pavements and landscaping - and represented the design team during the community and stakeholder engagement process.

NorthLink WA: Stage Three - Perth, WA, Australia.

New Fitzroy River Bridge

KIMBERLEY, WA, AUSTRALIA
CLIENT: MAIN ROADS WA

Flooding generated by Ex-tropical Cyclone Ellie in December 2022 and January 2023 caused significant damage to the sections of Great Northern Highway at Willare Crossing and Fitzroy Crossing in the Kimberley region of WA.

At Fitzroy Crossing, the Fitzroy River Bridge was significantly damaged along with 500 metres of road - cutting access to Indigenous communities east of the Fitzroy River as well as East Kimberley and the Northern Territory. Main Roads WA determined that a new bridge should be constructed at the same location, with repairs to the existing bridge not considered feasible.

Given the critical importance of this bridge to the state and national road network, Main Roads WA was looking to have a new bridge structure and access roads completed within the shortest practical timeframe, ensuring elements that could be impacted by flooding be completed before the next wet season.

The Fitzroy River Bridge replacement project was delivered by the Fitzroy River Bridge Alliance – which consisted of Main Roads WA, Georgiou, BMD, and BG&E.

BG&E provided bridge, civil, waterways and sustainability design services, which included:

- A new two lane traffic bridge over the Fitzroy River.
- Integrating a pedestrian pathway on the bridge.
- Reconstructing bridge approaches.
- Implementing flood and scour protection.
- Managing the protection and relocation of utility services.
- Flood modelling and hydrology.
- Temporary causeway.

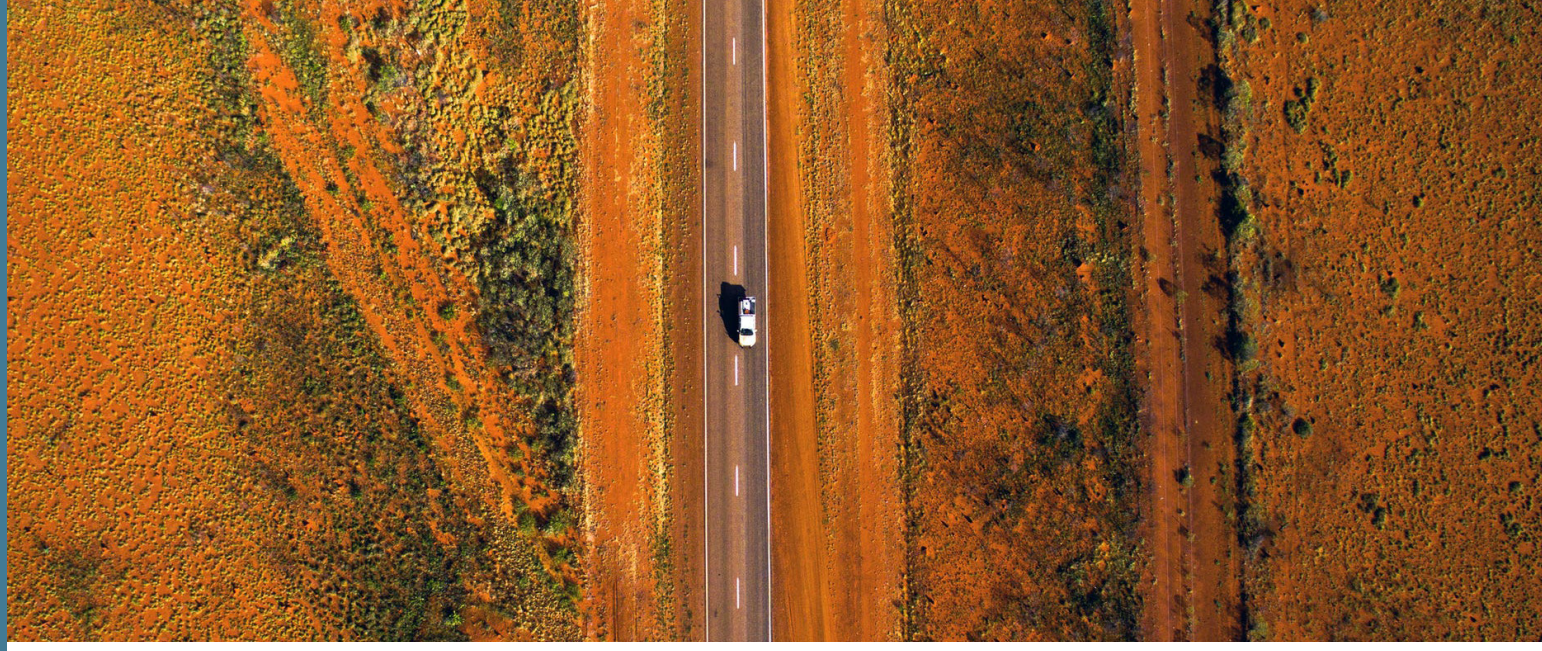
The new bridge is 100 metres longer than its predecessor at 270 metres long and twice as wide at 12.4 metres wide. The bridge is an eight span bridge with weathering steel-concrete composite deck construction, consisting of six welded steel beams made composite with concrete in-situ deck. The bridge superstructure was incrementally launched from the western abutment and completed in 32 days.

Blade wall piers with pile caps were installed and supported by 1200 millimetre diameter cased piles with concrete infill. The supporting piles of the bridge substructure were placed significantly deeper than the old piles to cater for scour in the riverbed during extreme flood events, reaching a maximum depth of 40 metres into the riverbed.

BG&E also had a senior bridge engineer on site for the duration of the construction works – to ensure that any issues could be expediently addressed and suitably resolved.

In December 2023 the New Fitzroy River Bridge officially opened to traffic, more than six months ahead of schedule, marking the official reconnection of East and West Kimberley.

New Fitzroy River Bridge – Kimberley, WA, Australia.



Outback Way (Great Central Road)

WA, AUSTRALIA
CLIENT: MAIN ROADS WA

Outback Way is an iconic 2,700 kilometre west to east route from Laverton in WA to Winton in QLD through central Australia via Alice Springs – often referred to as 'Australia's Longest Shortcut'. Over half of the route (1400 kilometres) remains unsealed, including 736 kilometres of Great Central Road which forms the WA section.

The Outback Way project aims to upgrade and seal the Great Central Road. Since 2013, packages of work have been gradually delivered by the Wongutha Way Alliance (WWA) - the most recent being a 40 kilometre section east of Laverton, completed in September 2021.

BG&E was engaged by Main Roads WA through the ETS panel contract to undertake the detailed design for two sections of the Great Central Road. The length of upgraded road sections undertaken by BG&E totaled 290 kilometres.

The scope of work included:

- Construction and sealing of the road to 10 metres wide on a 10 metre formation, including parking bays and rest areas.
- Floodway and off-road drainage construction.
- Installation of culverts, all signs and pavement markings.

The BG&E team developed a high standard design for Main Roads WA which were provided to other consultants as a bench mark.

At BG&E, we are united by a common purpose – we believe that truly great engineering takes curiosity, bravery and trust, and is the key to creating extraordinary built environments.

Our team of more than 1100 highly skilled people, in 15 offices across Australia, New Zealand, South East Asia, the United Kingdom and Middle East, design and deliver engineering solutions for clients in the Property, Transport, Ports and Marine, Water, Defence, Energy and Resources sectors.

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