Fulton Hogan

25 WAYS WE'RE ENGINEERING SOLUTIONS FOR THE FUTURE

Innovation Report 2019

Why we innovate

Cos Bruyn
Managing Director

It isn't possible for a single publication to capture all the innovations by individuals and groups occurring within Fulton Hogan every day. While, by necessity, this report gives just a taste, all our innovations have something important in common.

When people ask what Fulton Hogan does, an obvious answer is to build the infrastructures that make the modern world work – from bridges to waste water plants and from airports to roads. But these structures and developments are never an end in themselves - they are all a means to a greater end. The ultimate end, as we see it, is a better quality of life for us all, by making the communities in which we live and work better and safer.

In a world with growing pressures on individuals and communities' quality of life, we believe it's important for us to innovate to make things better and safer for our communities – as we have for the past 86 years.

The following pages have many examples of aspects of this in practice. These include:

- Reducing noise (our crumb rubber innovations in Australia)
- Creating 'living infrastructure' that beautifies the environment and improves air quality (the Manly Vale B-Line car park in Sydney)
- Reducing plastic in the environment (PlastiPhalt® in New Zealand and Australia)
- More careful management of our water (Wellington Water)
- Mitigating some of the effects of climate change through alternative fuel production (GreenFuels®)
- Increasing the safety of live road construction sites (eSTOP)
- Reducing congestion (Capital Journeys' Customer Impact and Risk process and Sydney's Northern Beaches B-Line traffic management system)
- Reducing stress by improving work/life balance (the Northern Corridor Improvement project)

Innovation must be directly relevant to the needs of our clients and partners - making them, in effect, our clients' innovations. After all, it is our clients and their customers who will own the better outcomes that result from these innovations. This reality has a major effect on why we innovate, where we innovate, how we innovate, and when we bring ideas to 'market'.

You'll notice many of the innovations in this year's report are 'co-innovations'. It's from this collaborative approach that we see so many other innovations come to fruition, as we work with our clients to develop fresh, new ways to ensure the best outcomes for the communities we both serve.

The many stories detailed in this Innovation Report highlight the passion of our people and the considerable investment being made across the business in achieving improved safety, quality, sustainability, programme and cost outcomes. This all translates to being 'fit for the future' and relevant to our customers.

Enjoy the read.

CONTENTS

SITE OF THE FUTURE®

FULTON HOGAN INVESTS IN BEING FIT FOR THE FUTURE

Site of the Future® is Fulton Hogan's test-bed for innovation, with a clear remit to increase productivity, safety, quality and sustainability. As such, the programme is as much about people as it is about developing new products and trialling new technology, and is part of a broader push across Fulton Hogan to lead the industry in innovation.

"Site of the Future® is all about engineering excellence and being 'fit for the future'. It's a chance for us to develop and trial new products, test new technology and showcase the latest plant to increase safety, quality and productivity. This will ensure we are agile and adaptive to new ways of working, so we can continue to be a leader in the infrastructure industry," Fulton Hogan National Innovation Manager Chloe Smith says. "The exciting part is seeing how engaged our people are in the process, and how excited they are to be involved in such an important project."

In phase one, projects are being delivered across five categories – Construction, Surfacing, Quarrying, Maintenance and Heavy Civil. Projects are operationally led and supported, with regional managers selecting particular sites to trial the latest equipment on. With Construction and Surfacing now complete, results are starting to prove the value of the investment, with productivity, safety, quality and sustainability improvements that far outweigh the targets that were set.

Construction

Led by Kerry Watkins, Regional Manager for Waikato, Fulton Hogan's Site of the Future® Construction project focussed on pavement construction and drainage. The project included a 2019 hydraulic excavator with GPS machine assist, a 12m, 6x4 grader with the latest in total station and GPS receivers, a 2019 D65 dozer with track mapping, a LiDAR road scanner, and the latest in roller compaction control. It also included the use of Building Information Modelling (BIM) for project delivery efficiencies.

Given the 'live test' nature of Site of the Future®, the use of the technology has been of considerable interest to the venders of the technology.

"We've learned a lot, but so too have our equipment suppliers," Fulton Hogan Project Engineer Sam Savage says. "You know you are market-leading when the suppliers are learning from you. The support we've received from them in testing different settings and approaches has been magnificent."

"The exciting part is seeing how engaged our people are in the process, and how excited they are to be involved in such an important project."

– Chloe Smith, Fulton Hogan National Innovation Manager

Fulton Hogan's Josh Wilkinson measuring the effectiveness and accuracy of the GPS-based tools

Health and safety

The latest plant comes ready-fitted with market-leading safety features. Although many of these features have been available on the market for several years, the step-up shown in the 2019 models mean these features are now more effective at minimising risk on site than ever before. Features include:

- High definition 360 degree cameras to give operators a complete view around the plant, therefore removing any blind spots. This includes high definition reversing cameras to provide operators a more detailed view of their work area.
- Inbuilt technologies to increase operator efficiency by up to 45% and lower operator fatigue, as well as high-quality, sound-absorbent lining in the cab to reduce exposure to noise.
- Avoidance systems using geo-fencing, physically preventing equipment from colliding with known hazards, critical when working under structures or near traffic.
- Improved reversing sensors that can differentiate between a windrow and a genuine obstacle.
- Ground level shut-off switch stops all fuel to the engine when activated and shuts down the machine.

Accuracy of results

It is often debated whether modern GPS systems can achieve the necessary specified tolerances. We knew that if we were able to show it could, we could remove the need for total station controlled grader equipment in favour of graders with GPS that had significantly less setup time, and increased productivity, or dozers capable of moving considerably more material in fewer passes.

Our trials showed the GPS systems cannot achieve consistent accuracy for Fulton Hogan's approach of 'quality from start to finish'. We discovered that fluctuations in the readings throughout the day can cause issues with ride quality, and they require regular checking against known survey points at least three times per day. We found that a GPS system is suitable for some operations, such as lower layers of road pavements and bulk operations, but not final surface finishing.

Click here to watch video

Fuel efficiency

One of the great opportunities Site of the Future® offered was the ability to be able to compare fuel efficiency with old plant to our new plant trialled through this project. The results were outstanding:

With an ever-increasing focus on reducing our carbon footprint, this data is vital in informing future procurement decisions.

14% **The modern 6x4 grader showed an improved fuel efficiency of up to 14% when compared to 2013 models**

32% **The 2019 dozer showed an improved fuel efficiency of up to 32% when compared to older models**

29% **The 2019 excavator showed an improved fuel efficiency of up to 29% even when compared to two year old machines of the same size**

Fulton Hogan's Spencer Pennington making full use of the new technology

Training and development

Given the industry's well known skill shortages, any opportunities to upskill and develop staff must be taken. We had previously believed machine control could help achieve this, but lacked the factual evidence necessary to support this. Until now, that is.

During the project, we were able to have inexperienced operators performing final trim work with the GPS dozer within three days. The first day was spent understanding the machine and how to control it, the second on understanding the process, and the third to understand the heights and final trimming process. This enabled them to start understanding how to handle and place aggregate using simpler controls than that of a grader, and creating an excellent training environment, without reducing productivity.

This makes the step of learning how to operate a grader a far less daunting prospect, evidenced by the fact we were able to develop one of our younger team members into a trim grader operator and foreman during the project. We have also found the crew's morale particularly high, engaging our staff at a level we have not previously seen and instilling in them the desire to strive to be the next generation of final trim operators. The introduction of the new technology is also appealing to a younger generation, which is well predisposed to technology.

Building Information Modelling (BIM)

On this project we used BIM to enhance project efficiencies. BIM is becoming an increasingly important aspect of project delivery in Australasia. The benefits include:

- Visual representation of methodology and programme
- Clash detection
- Stakeholder communication
- Design vs actual build comparison
- Reporting and analysis
- Link to machine control, with a visual representation of the outcome and the services that may be located within the working area.

BIM requires a significant input of time to deliver a quality output, including forward planning of design programmes.

Quarrying

Weighing up the benefits in our quarries

Ensuring trucks are loaded safely, consistently, efficiently and accurately is a critical need in quarries.

That's why we're automating weighbridges, with Fulton Hogan's Stevenson Clevedon quarry leading the way. The next site is the considerably busier Drury quarry.

The main benefits of the automated Weightrax systems are:

- Increased safety – drivers do not need to leave their trucks or come into contact with loaders
- Customers receive exactly the weight of product required and the risk of overloading is minimised
- An automated system prevents the truck leaving the quarry if the load weight is not correct

This means a quicker, safer process. The loader operator knows exactly what to load as soon as the driver enters the quarry, and they're ready to load the truck almost as soon as the truck arrives. The more trucks per day, the greater the relative benefit.

Drivers input truck details and product type into Weightrax kiosks, which automatically alerts the loader operator via a screen in their cab, ensuring the correct load and weight of load. The driver is taken through a series of questions, with a number of variables that are pre-programed either against a vehicle and/or a customer.

There is no need for the driver to leave the vehicle or to process any information. A series of lights flash to communicate with the driver to move on to the bridge, to wait, and to exit.

Weightrax is a leader in web-enabled weighbridge software. It captures site information via a POS (Point of Sale/PC) or kiosk system, information that is regularly synchronised between the site computer and Weightrax's cloud-based server. It is available through any web-enabled browser.

Fulton Hogan staff and customers have secure login-based access 24/7, allowing for regular checking of transactions, print reports, and reprinting of dockets where applicable or necessary. Weightrax can provide an automatic electronic invoicing process at the touch of a button, removing the need for manual intervention. It also provides secure off-site, web server, data storage and auto synchronisation of all data for protection.

The loader operator knows exactly what to load when the driver enters the quarry

Maintenance

While there will always be some need for manual road inspections, these have shortcomings.

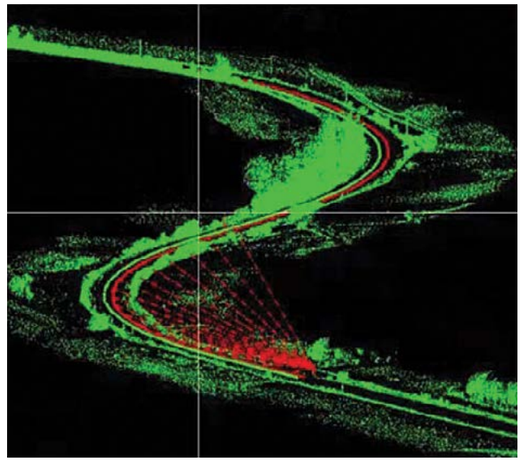
They're time-consuming, pose safety risks to road inspectors, have a degree of subjectivity and require significant inputting of data with the attendant threat of inaccuracy.

Fulton Hogan is working towards automating this process - leveraging LiDAR, 360° camera technology, artificial intelligence and machine learning for a step-change in road inspection surveying. In essence, 'removing the inspector from the road'.

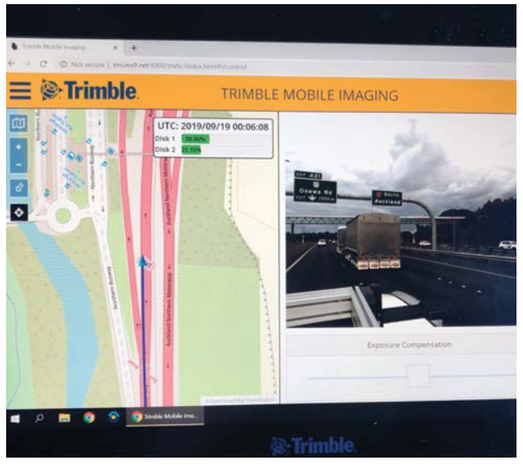
The means is a New Zealand first – a LiDAR with twin lasers, linked to a 360 degree camera to give a full colourised point cloud for more depth and context at a very high level of accuracy. The camera is, in effect the 'eyes', the GPS is the 'locator' and the LiDAR is the 'measurer'.

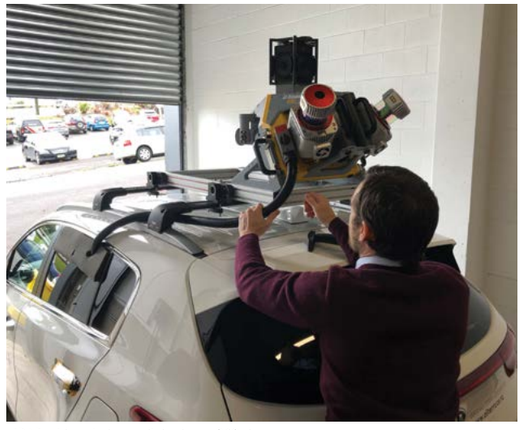
The company has been working with a range of vendors of LiDAR and video capture technology. As with all new technology and innovation, there are wrinkles to be ironed out and we're learning a lot along the way as we refine our processes to ensure outputs add significant value to the company and our customers.

Line-of-sight testing, in this case using LiDAR to understand road user visability



Live feed of the LiDAR capture, as the survey happens, in real-time





LiDAR with twin lasers linked to a 360 degree camera

The camera is in effect, the 'eyes', the GPS is the 'locator' and the LiDAR is the 'measurer'

Surfacing

The focus of our surfacing Site of the Future® has been to understand and test how we can improve quality, safety and productivity on reseal sites.

Led by Canterbury Regional Manager Stephen Lowe, Fulton Hogan has set itself the challenge of creating a new approach to road resurfacing.

This has included developing and testing different bitumen products to improve quality and productivity, such as investigating the benefits of the latest developments in emulsions compared with traditional cut-back.

Also included in the surfacing project has been using laser texture meters to measure road surface texture, applying 3D visualisation for traffic management and introducing automatic set-out for line marking.

One of the key areas for testing has been Timaru, working with Timaru District Council.

"Our trials with different bitumen products in Timaru have exceeded expectations, with results showing a reduction in chip-loss and therefore remedial works," Surfacing and Industries Manager Thomas McGeever says.

"This has led to an increase in customer satisfaction and a reduction in traffic disruptions."

Fulton Hogan's laser texture meters have gone through significant development over the past four years, and are now at a point where they can effectively measure road surface texture, without the need for people in a live traffic environment. We utilised our latest laser texture meter with wi-fi connectivity to measure chip texture before and after the Timaru reseal operation. In line with the desire to minimise the number of staff undertaking sand circles (determining road texture for the seal design), laser texture meters are becoming more common across our sites in New Zealand.

The use of 3D visualisation for traffic management proved a successful way of communicating with stakeholders. It has become an important part of managing high profile sites, where traffic levels and adjoining business complexities require significant management.

Following the success in South Canterbury, Fulton Hogan has expanded the trials into several other sites, including Waikato and Dunedin. Monitoring of these trial sites will continue, with ongoing refinement to the process and product.

3D visualisation of traffic management has been a key part of the project

Fulton Hogan Surfacing Industries Manager Thomas McGeever inspecting a fresh reseal

Click here to watch video

FORESIGHT TO THE FORE

DIGITAL ENGINEERING

Digital Engineering and BIM enable smarter engineering, value-based solutions, enhanced collaboration, and information sharing across the supply chain. The result is increased predictability of delivery and maximisation of the cradle-to-grave asset lifecycle.

It's one of the most powerful emerging tools for testing the possibilities of a project, and understanding the effect of any changes. It incorporates Building Information Modelling (BIM), 3D visualisations, Virtual Reality (VR) and Augmented Reality (AR).

With its roots in CAD architectural tools, we are applying this to civil works, roads, highways and bridges – and significantly extending its functionality. We're now using it for 4D visualisations - linking 3D model elements to a construction programme for detailed construction sequencing and staging – and, increasingly, for 5D visualisations.

5D models provide the cost implications of any change, from project specifications to product use, quality goals or sustainability objectives. BIM allows us to better understand complex design challenges; more easily predicting the performance of construction sequencing with simulation and visualisation; improving data control through a single data source for design through construction, operations and maintenance. Increasingly, this is also being integrated with Geographical Information Systems (GIS).

BIM is also a collaborative tool, with all participants accessing and using the single source of data, amalgamating 3D design with meta-data down to the component level.

The Ardmore water resilience project, digitally presented

The benefits

1. Improved collaboration and reduced waste – more information provides a clear understanding of how engineers, suppliers, and contractors can co-ordinate and collaborate for the best outcome on a project - optimising labour, resources, and reducing waste.
2. Improved project controls – greater visibility of potential clashes in construction prior to physical works starting, limiting lost time and money due to early detection and re-programming. By updating progress and methodology changes, and adding in variations as the project progresses, project managers can gain a real understanding of how the project will look when complete, based on the present.
3. Enhanced visualisation for communications – 3D modelling and BIM provides opportunities to communicate more effectively with project teams, stakeholders and during community engagements, giving greater visibility of the entire construction process and of the completed project.
4. VR and AR – not only important for communication, but can also be used to train project teams to better understand processes and hazard awareness on site.

Havelock North water treatment facility

3D traffic management in Wellington

Digital engineering for Riccarton Road, Christchurch

ALBION PARK RAIL BYPASS (NSW)

The Albion Park Rail Bypass (APRB) project extends the M1 Princes Motorway between Yallah and Oak Flats, completing the missing link between Sydney and Bomaderry, in the Illawarra region 85km south of Sydney CBD, bypassing the township of Albion Park Rail.

It is estimated the bypass will cut morning north-bound travel times by almost 65%, with south-bound travellers experiencing a similar saving during the evening peak.

The project is the first BIM project delivered to Roads & Maritime Services (RMS) to be used during design, construction and operation. Main objectives for implementing BIM is:

- Collaboration and information exchange between all project stakeholders
- Visualisation and communication during community engagements
- Coordination and clash reviews of all disciplines including existing utilities and services

FLINDERS LINK (SA)

The Flinders Link project will improve public transport, cycling and walking connectivity between the Flinders Precinct and the Tonsley Precinct.

Flinders Link will also provide improved connectivity between the Adelaide CBD and the Flinders Precinct and Tonsley Precinct as well as connecting the precincts to the broader Adelaide rail network.

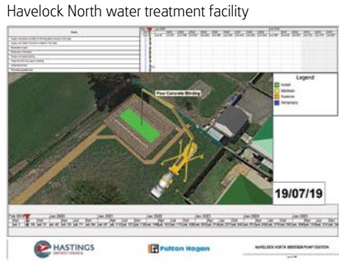
The implementation of Digital Engineering through BIM has provided a number of benefits to the Project and site-based project team. These benefits include:

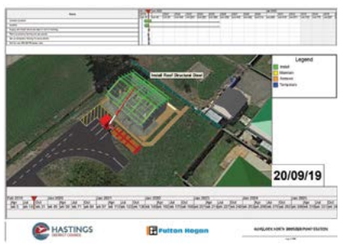
- Point cloud surveying of existing structures to identify clearances for safe and effective operation of plant and machinery.
- Point cloud surveys of the structural reinforcement for the uniquely-shaped viaduct headstocks, prior to them being craned into positioned. The point cloud used in collaboration with the designers models, gives the project team confidence the reinforcement will fit within the fiberglass mould and have sufficient concrete coverage.
- Accurate quantity take-offs to assist in the procurement of design packages.
- Reduced RFI's to design consultants as many are resolved using the designers models to identify dimensions and setouts.
- Use of Civil 3D in collaboration with vehicle tracking to produce highly-detailed and accurate traffic management plans.

ARDMORE WATER RESILIENCE PROJECT – CIVIL NORTH

Fulton Hogan Project Manager Hannes De Wet engaged the digital engineering team to produce animated sequences for building internal tank walls, pre-cast elements and temporary office set-up of the site. This included producing video animation showing basic construction sequence of internal walls, hydraulics and precast elements. Additionally, a large A0 print of the BIM produced by the team was provided to the project for daily pre-start communications.

Havelock North water treatment facility





HAVELOCK NORTH WATER TREATMENT FACILITY – CIVIL NORTH

Fulton Hogan Project Manager Quintin Prinsloo engaged the digital engineering team to produce animation to showcase digital engineering in the construction space. Animation was produced with specialised software for each element, combined with a model produced by the client's consultant, Stantec. The benefits were particularly evident during the tender stages, and is allowing project stakeholders to make split decisions before and during construction.

3D TRAFFIC MANAGEMENT

Fulton Hogan has a significant focus on 3D traffic management using animated visualisation of Traffic Management Plans (TMPs) and delineation space-checking with VR for our traffic management and construction departments. The primary goal is to cross-check equipment, spacing and flow of traffic. One example was Riccarton Road, where we utilised 3D TMPs to communicate with stakeholders, identify the best traffic management equipment to use, and prevent clashes prior to construction starting.

SCANNING FOR SAFETY, SPEED AND CERTAINTY

TRACKING THE QUALITY OF ROADS FOR MAINTENANCE AND FORWARD PLANNING REQUIRES ACCURATE AND REPEATABLE INSPECTIONS.

LiDAR ROAD SCANNER

LiDAR combines 3D scanning and laser scanning, using high-frequency laser pulses to gather information about a surface by measuring the distance to a target. It illuminates the target with laser light and measures the reflected light with a sensor.

Rapid increases in LiDAR scanner technology, giving up to 250kHz or 250,000 outgoing pulses per second, mean a truck-mounted LiDAR survey can now capture millions of data points travelling at road speed. Fulton Hogan's road scanner combines Real-Time Kinematic (RTK) GPS technology with LiDAR to collect a constant stream of data, delivering highly accurate positional surface data and allowing kilometres of road to be scanned in a short time, without the need for costly lane closures, re-work or risk to the crew on the ground.

In building the Huntly Bypass section of the new Waikato Expressway for the New Zealand Transport Agency (NZTA), we have monitored pavement settlement. Traditional surveys would require considerable traffic control, lane closures, and surveyors on the ground in a high traffic environment, and would take between 10 and 12 days.

Travelling at between 50 and 70 km/h, our road scanner downloads raw data to a laptop, scanning up to 2,500 points per second and collecting hundreds of millions of points, with an average scanning time of one hour for every 2km of run data.

Multiple overlapping scans capture the driven surface to sub-centimetre accuracy. Field checks on targets or ground control points are captured to further enhance the accuracy and confidence of the results.

Trial surveys undertaken on the Huntly Bypass section of the Waikato Expressway have resulted in consistent data sets and, combined with the field checks, have

The benefits are:

- Safety – pedestrian survey staff are not in a live traffic environment
- Major gains in productivity - roughly two days of site scanning capture time compared with 10 – 12 days for traditional surveys
- The scanning method achieves a dynamic data set compared with a point reference data set
- The scanning method avoids lane and road closures with minimal traffic disruption

The road scanner in action

STARTING SAFE, STAYING SAFE

Click here to watch video

PRE-START CHECKS ON EQUIPMENT ARE A CORNERSTONE OF A SAFE WORKING ENVIRONMENT.

As part of the ongoing refinement of our Living Safely initiatives, we've focused on developing a pre-start plant check application that's thorough, timely, intuitive, robust, requires minimal training, is able to be used across an entire team, does away with paper entirely, and makes each staff member a safety champion in their own right.

How hard can that be?

Given that a system is only as good as its design, we've fundamentally re-thought and redesigned pre-start safety checks so our operators are safe, the process is as easy as possible, and there's no loss of integrity of information.

All paper has been removed from this critical process. Whereas, formerly, people dealt with 39 paper-based questions, they now make their way through ten questions at the start of each day. These are on regular rotation, so that all questions are addressed over a shift rotation.

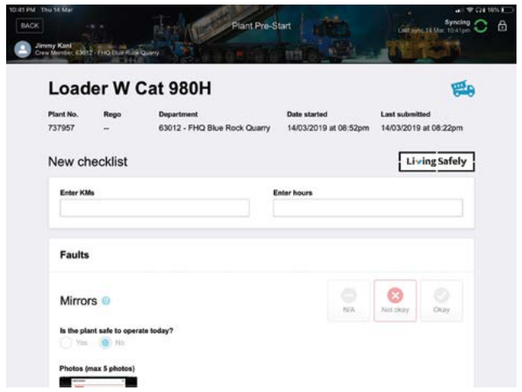
Victoria-based Resource Manager Surfacing David Snape says it's made a pivotal part of safe and efficient operation "extremely simple".

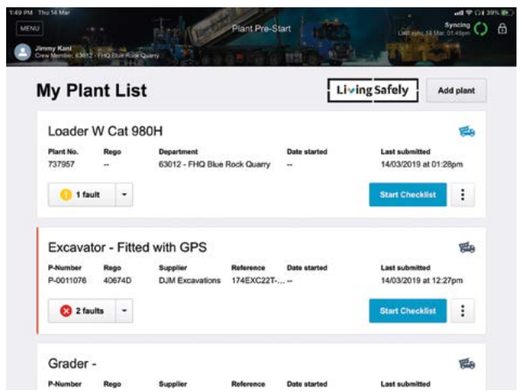
> **"The team in the field have a tool that drives active participation in safety – in effect, it's reinforcing the fact that everyone's a safety champion."**

"And whereas some of the team may not have had smart devices previously, they're now fully proficient with a safety and problem-solving tool at their finger-tips," says David.

David says a roller driver who's been doing manual paper-based pre-starts for 20 years can pick it up in minutes, and the time between detection of a fault and remedy is down to a fraction of what it was previously.

By the end of 2019, the system will be extended to the point where all mechanics, who are mobile, will have a 'workshop view'. This means the application will allow mobile mechanics to see the faults live.





SCiD²® SAFETY & CUSTOMER IN DESIGN & DELIVERY

CREATING WITH OUR CUSTOMERS

SCiD²® in a nutshell

SCiD²® is a new design approach that applies a collaborative customer thinking process. It introduces more meaningful customer (end user) engagement early in the project lifecycle, to make sure our customers' needs are fully understood, in conjunction with technical engineering or safety needs.

The insights gained from this part of the process are then incorporated into the design and delivery of our projects. Using SCiD²® on our projects will ultimately result in more user -centred solutions, whilst not losing sight of safety for both our people and those using the road or service.

OUR EVOLUTION OF CUSTOMER-CENTRED DESIGN AND DELIVERY

It's the same for any product or service. The earlier you engage with those who'll actually use it, the better it's likely to be.

Sound obvious? Yes, and it's something we all know instinctively. But how often are engineering solutions designed with the end-user's needs and realities uppermost in mind? How often do other, more pressing considerations get precedence in the design phase?

Our answer has the project title SCiD²® (Safety & Customer in Design and Delivery) and is designed to address this. It does this through human-centered design, ensuring the project's outcome is designed around the end users, right from the start.

SCiD²® Manager Kelly Marshall says that if human-centered sounds fuzzy or intangible, it's actually the reverse. It brings a more concrete focus on the end result for everyone involved.

It's about collaborating early to design an empathetic solution – approaching the project as if the end-user is in the room and the client and contractor are one organisation.

"This is a practical way of considering and canvassing as many possibilities as possible to meet end users' needs through understanding how the outcome will affect them."

In addition to collaborating on end-user implications, SCiD²® allows Fulton Hogan to work with clients to 'fast prototype' concepts to explore ways to reduce costs, increase sustainability of outcomes, reduce construction times and increase safety.

Kelly says contracting, by its very nature, is built on processes and problem solving.

"It's logical to harness these skills and problem-solving instincts to consider customer impacts early in any process, and have more insightful early conversations with clients to shape the design and delivery."

SCiD²® helps understand and explore the *'we don't know what we don't know'* factor by highlighting and addressing false assumptions.

"There are many assumptions on a project, and we want to minimise these by asking the right questions to achieve customer insights," says Kelly.

> **"This is a practical way of considering and canvassing as many possibilities as possible to meet end users' needs through understanding how the outcome will affect them."**
> – Kelly Marshall, SCiD²® Manager

The success of SCiD²® depends on all parties approaching projects with an open mind about the techniques applied, and the products and processes used.

"It's relatively early days, but we're seeing a sea-change in how our people and our clients consider customers, and think about how they approach projects. The potential gains for the multiple groups of end users are enormous."

Early perspectives on SCiD²®

"In the construction industry we're used to working to clinical specifications and sets of drawings, and have historically had limited end-user contact. We're talking about a step-change here – putting end-users to the forefront of everything we do. Part of the SCiD²® philosophy is about seeing ourselves as the end user, because we generally are. It's about treating others how we would like to be treated ourselves, as we go about a project."

– **Rob Hutchinson**
Fulton Hogan Hamilton Contracts Manager

"Everything we do in delivering a Network Outcomes Contract contact has an element of customer interaction and safety management, be it from trimming the trees, to renewing the road or coordinating the multitude of activities undertaken on the network. SCiD²® formalises the process we undertake to provide safety to everyone, while deepening our understanding of customers' needs to deliver a fully co-ordinated and consistent approach."

– **Daren Courtnage**
Capital Journeys® Contracts Manager

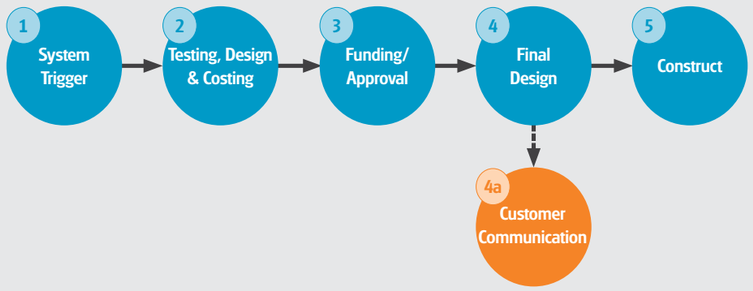
Stakeholder and contract managers at SCiD²® training, prototyping and testing a range of potential customer-centred solutions

SCID²® EMBEDS THE PRINCIPLES **OF HUMAN-CENTRED DESIGN** AT TWO CRITICAL PHASES:

- **DESIGN**
- **DELIVERY**

PREVIOUSLY

Typical design approach



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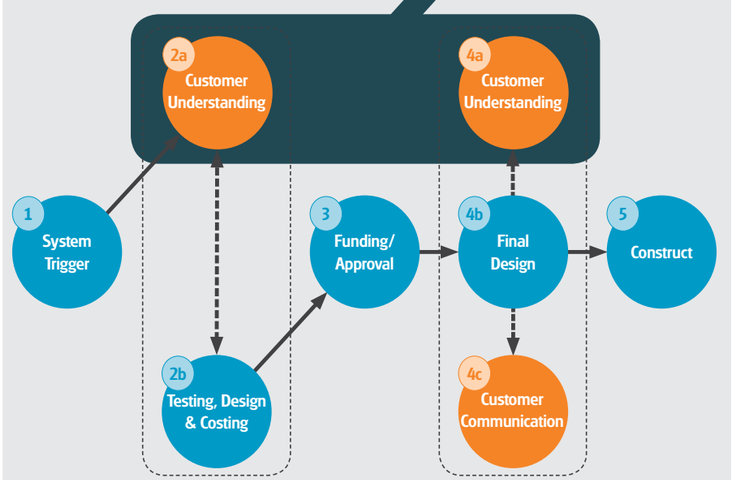
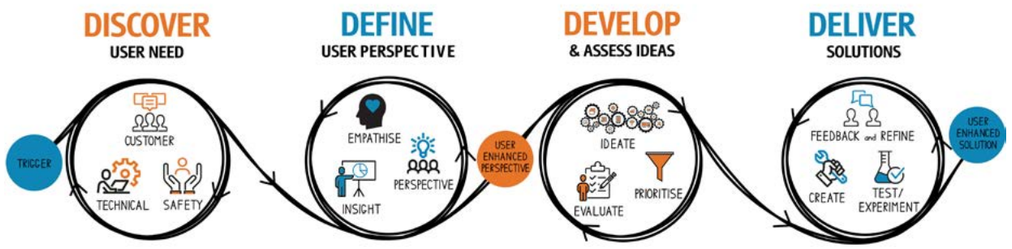
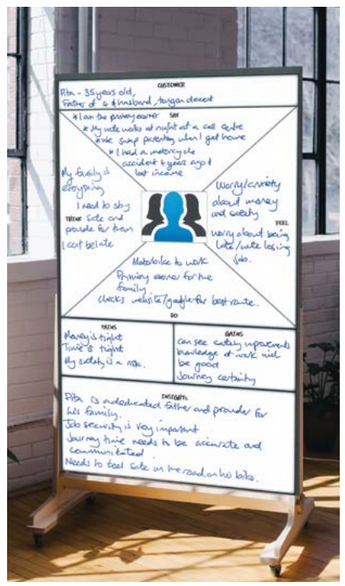
Design approach with SCiD²®





Customer insights have sparked breakthroughs in consumer categories, from mobile phones to e-scooters. There's no reason why they can't do the same in the development of roads and critical infrastructure – and you could argue that these make a bigger difference to peoples' lives, to safety, to the environment, and to business. Therefore, designing these services for best human outcomes isn't a 'nice-to-do' – we believe it's essential. In practical terms, this means engaging with our customers to get a good understanding of their customers' needs, and turning that information into customer insights. In essence, how do their customers think and feel, and what do they do and say?

Examples of 'personas', showing insights from a Discover phase.



Pita

Is a 35 year-old New Zealander of Tongan ethnicity and a father of four. He rides his motorbike to work, and at the end of the day needs to be home to relieve his wife Ngaire of parenting duties, as she does an evening shift at a call centre. Four years ago, he had a serious accident, skidding on loose aggregate on the road. He was off work for three months, putting considerable financial pressure on his family.

Sally

Sally is a 43-year-old ambulance officer who works in the area. It's critically important to her that whenever she's on a call-out she's aware of any roadworks that may be underway on local routes. She is utterly committed to her patients, and to doing her job to the best of her ability.

Betty

Is a 75-year old grandmother living next to the epi-centre of the roadworks. She has acute insomnia and related health issues, which means she needs to sleep when she can, including during the day.

Robert

Is a 48-year-old store owner. He recently relocated his brewery products store to the area after being priced out of an inner city location by rent rises. Key to the success of his business is easy access – foot traffic being essential to that. As the only brewery products retailer in the area, he's confident customers will continue to come, but only if they're well informed of how the road works will affect accessibility as the project proceeds.

A CLEAR VIEW OF THE CUSTOMER AHEAD

CAPITAL JOURNEYS® JV EXEMPLIFIES ASPECTS OF CUSTOMER-CENTRED DESIGN

Person-for-person, is anywhere in New Zealand more topographically challenged than Wellington?

With limited and narrow access-ways, and high daily commuter levels, the 200 'road treatment projects', and the thousands of routine maintenance activities done per year by Capital Journeys® need particular care.

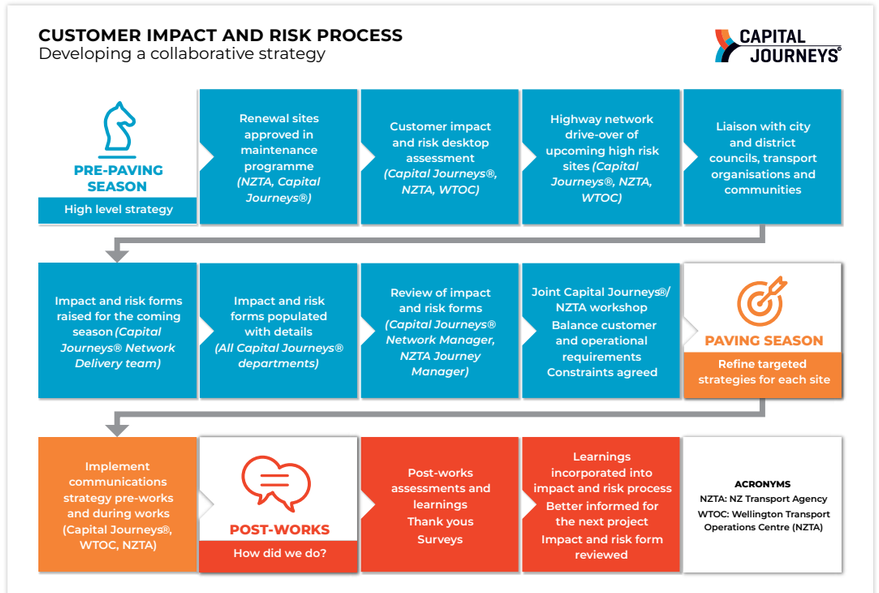
A JV between Fulton Hogan and Opus WSP, working collaboratively with NZTA, Capital Journeys® covers the traffic region from Wellington City to Levin in the northwest and Mt Bruce to the northeast.

Everything Capital Journeys® does – and plans to do – has something critically important in common. It's referenced against a rigorous roadworks impact and risk strategy that covers all responsibilities to the customer – the road user and neighbour – from beginning to end of each project.

The genesis of this customer-first approach was hard-won experience. Four years ago, two major road resurfacing programmes, through one of the busiest sections of State Highway 1, led to major traffic delays, irate drivers, residents and businesses. Capital Journeys® developed its customer-centric customer impact and risk strategy as a direct result, and continues to refine it.

"What road users and neighbours need from us is management of highway projects that takes them into account right from the start," Capital Journeys® Contract Manager Daren Courtnage says.

These need to demonstrate we're considerate of their needs and cover every base, from consultation, forewarning, safety, smooth traffic flow design, noise and dust containment, considerate site workers and thus predictable journeys."



There are eight cornerstones to the customer impact and risk strategy:

1 Customer centric
The customer is at the forefront of strategic planning

2 Personal
Assessment of customer impacts must be done in the field and from the customers' perspective – this is not a desktop exercise

3 Timing
Start analysis several months in advance of the paving season

4 Identify the risk
Sites are each scored to pinpoint high to low risk

5 Inclusive
Everyone has an input, both external customers and agencies and internal departments

6 Well-informed
We make sure we have all information to hand

7 End-to-end
The strategy starts with the identification of sites and doesn't finish until the final assessment

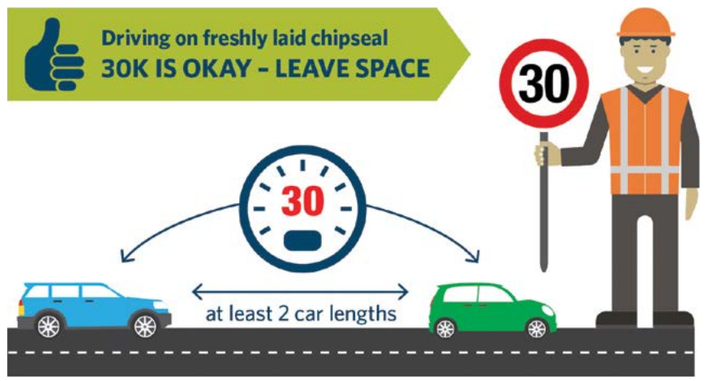
8 'Joined-uppedness'
Everything links and co-ordinates

The strategy ensures upcoming works by other bodies such as Wellington City Council and Wellington Water are factored into planning as early as possible.
Capital Journeys® brings all facets of the roadworks, road user and community strategies together through joint decision-making and co-ordination, discussing sites and strategies to minimise noise, loss of parking and business disruption, while maximising access to property, freedom of bus routes, adequate diversion routes and quality of life for neighbours.

The strategy also involves being proactive in educating the public and managing expectations. An example is working with NZTA to devise a communications programme on how to drive on fresh chip-seal, after complaints chips were damaging windscreens and bitumen was fouling the underbodies of cars. A range of media was used, including posters, graphics and 15 and 30 second animated cartoons to spread the word via NZTA's website, social media, radio advertising and letterbox drops.

Complaints vs works

The size of the downturn in customer complaints since the strategy was implemented has surprised even the most optimistic.



Communications is a key part of the strategy

MAINTAINING A **360** DEGREE **VIEW OF MAINTENANCE**

Click here to watch video

Archimedes

Fulton Hogan maintains a wide range of assets for local authorities, utilities, private enterprises and central government across New Zealand and Australia.

Roading assets are one of the largest categories of assets that we maintain – where the work varies from 'reactive' activities (filling potholes, clearing slips, replacing damaged signposts and clearing foliage and suchlike), to large programmes of work (such as pavement and surfacing renewals).

Clients expect their assets to be maintained using efficient asset management practices with a minimum of fuss - and without surprises. They like to know what we've done, what we're planning to do, and how we're progressing against those plans. This applies across the board, for both Local Authority and Network Outcomes Contracts (state highway). In the past, this information was generally provided once a month, via a monthly report and/or meeting.

One of the keys to operating without surprises is ease of access to accurate, up-to-date, information for both our maintenance teams and our clients. That's why Fulton Hogan has developed and - over the past 12 months - significantly extended Archimedes.

Archimedes is our proprietary business intelligence and analytics platform for tracking and analysing various aspects of road maintenance contracts. Archimedes dashboards, which automatically update every 15 minutes, cover categories including:

- Monthly programme achievement (contract-specific)
- Monthly programme achievement (nationally)
- Pavement and surfacing renewals (contract-specific)
- Pavement and surfacing renewals (nationally)
- Customer service/public requests (contract-specific)
- Culvert inspections (contract-specific)
- Culvert inspections (nationally)
- OPM - overall performance measures - (contract-specific)
- OPM - overall performance measures – (nationally)
- Event manager – monitoring remediation following a major event such as major storm

"It helps ensure we're prioritising activity by its significance to our clients and their customers, and each of our people has 'peripheral vision' of what else needs doing in the area."

– Information Systems Manager, Road Maintenance, Danny Fitzgerald

Clients can view our contract-specific dashboards at any time, from anywhere, with an internet connection, which stimulates continuous conversation. More frequent communication and collaboration leads to better contract performance for all parties.

Any public requests, comments or complaints are also kept highly visible to ensure they are front of mind.

"These assets belong to our clients and, ultimately, to the public," says Information Systems Manager, Road Maintenance, Danny Fitzgerald. "It's vital, therefore, that local and central government authorities can quickly track our response to issues raised by their customers, the public, and that we efficiently manage these activities on their behalf."

The growth of Archimedes has included, most recently, the addition of culvert inspection management. Innocuously out of human sight are tens of thousands of culverts which, when blocked or broken, can cause serious flooding.

Archimedes informs our maintenance teams and clients how long it's been since each of the culverts under our care has been inspected, and what condition those culverts were in at the time of their last inspection (graded from very poor to excellent), along with the percentage of culvert inspections that have been completed against monthly and annual targets. The data can be viewed across the contract as a whole, or narrowed down to a road or ward level, as required. All the information is live.

Fulton Hogan team members in the field can view all Archimedes data on their laptops or mobile devices. When an asset is identified as needing further attention, a job gets raised in our job management system, RAMM contractor, and these jobs can be immediately tracked to completion using Archimedes. By providing greater visibility of our open work, our teams can plan more effectively, which leads to less time spent travelling around the network, and improved outcomes for both ourselves and clients.

"Priority and proximity are two key themes with Archimedes," says Danny Fitzgerald.

"It helps ensure we're prioritising activity by its significance to our clients and their customers, and each of our people has peripheral vision of what else needs doing in the area.

"With over 30 road maintenance contracts under our care, being able to aggregate information across the country helps Fulton Hogan understand the relative performances of our teams, and quickly identify both areas of strength, where best practices can be quickly identified and shared, ensuring we are taking full advantage of our size and expertise, or weakness where more support could potentially be required."

New Archimedes dashboards and features are being created continuously, based on feedback from our clients and our maintenance teams.

Fulton Hogan Corporate Asset Manager William Silcock demonstrates Archimedes on the road, in the office and in the field

KEEPING AN **EYE ON THE ROAD...**

> **“This is a fundamentally different approach from what’s gone before and it’s generating a lot of interest within the industry”**
>
> – Specialty Products Manager, Infrastructure Services, Nick Canton

An exclusive arrangement throughout Australasia with artificial intelligence road monitoring technology leader RoadBotics has enabled Fulton Hogan to use machine learning to assess more than 1,500km of Australian roads.

RoadBotics uses similar technology to that developed for autonomous vehicles to measure and objectively grade (from 1 – 5) the condition of roads to assist in making future data-driven pavement management decisions.

“This is a fundamentally different approach from what’s gone before and it’s generating a lot of interest within the industry,” Fulton Hogan’s Specialty Products Manager – Infrastructure Services, Nick Canton says.

“The biggest innovation is in applying machine learning and artificial intelligence in pavement assessments to determine an overall condition rating. It takes a lot of guesswork and subjectivity out of a process that can give extremely valuable information for road management planning.”

RoadBotics involves conducting a survey, utilising cost effective smart phone technology, to collect visual and location based road data for evaluation using artificial intelligence.

Using the technology, Fulton Hogan has collected and processed approximately 1,500km of road data in Victoria (City of Whittlesea, Port Of Melbourne and VicRoads), at Sydney Airport and it is currently beginning to be implemented in South Australia with Holdfast Bay Council. There has also been a preliminary trial in New Zealand in the Waikato.

RoadBotics’ machine learning involves a computer identifying patterns in data, making predictions based on those patterns and building models that provide knowledge that allows road owners to act on it.

RoadBotics’ algorithms ensure that each time the machine receives new information, its level of precision increases. RoadBotics has been trained to identify roads, road features, and road surface distresses by comprehensively scanning high-resolution image data on a pixel-by-pixel basis at a level well in advance of what a trained engineer can do visually. Key areas of scrutiny include block cracking, alligator cracking, and potholes.

The 1-5 condition rating is automatically generated to describe the quality of every 3-metre section of asphalt, spray seal and concrete paving.

This is such new technology that the Fulton Hogan team is learning alongside the RoadBotics team. Key learnings include ensuring minimal dampness, quality light and avoiding disruptions – RoadBotics can only assess what it can see. It is effective on asphalt, spray seal and concrete surfaces only.

The team has been retesting the same pavements to ensure consistency of response, and to understand the effect of such factors as changing light and moisture levels. One of the next steps is a ‘change in condition’ reporting function through which RoadBotics will be used to calibrate the speed and nature of deterioration of particular stretches of road.

Port of Melbourne pavement condition data being displayed via RoadBotics web based portal Roadway.

Fulton Hogan Supervisor Chad Stevens and Project Engineer Sam La Vista carrying out RoadBotics data collection for Holdfast Bay in South Australia

eSTOP

A GREEN LIGHT FOR GREATER SAFETY ONSITE

eSTOP are remote-controlled traffic lights for roading projects that are managed by controllers who are well off the road - outside the ‘danger zone’.

The first eSTOP was used in a demonstration to NZTA in the Tasman Region, and it’s envisaged the company will use a significant number of these across the country. Fulton Hogan is the sole eSTOP distributor in New Zealand.

“eSTOP is an important step forward in keeping our suppliers’ employees safe when working on the state highway network and, ultimately, on all roads where this system will be used into the future,” says NZTA’s principal CoPTTM Advisor Neil Greaves.

“The champion for change has been Fulton Hogan’s Damien Houlahan, whose quiet perseverance and diligence over the past 14 months has been pivotal in this technology gaining approval for New Zealand roads.”

Damien approached the Fulton Hogan executive team in June 2018 with the ambitious goal of removing all manual traffic contollers from harm’s way by June 2020.

“It’s well documented that the manual traffic controller is the most vulnerable person on a worksite, with minimal protection from traffic,” Damien says. “They’ve also been receiving increasing verbal and physical abuse - including from a motorist with a firearm (Auckland Region, 2017) and a knife (Bay of Plenty, 2018).”

Damien says the issue is often exacerbated by manual traffic controllers attempting to stand in front of vehicles that appear not to be slowing or stopping.

“With eSTOP, traffic controllers are away from the live lane of traffic and they can monitor and control the traffic in real-time from a safe location. In addition to safety, this has major benefits when there’s ‘tidal’ traffic, in particular during rush hours.”

> **“eSTOP is an important step forward in keeping our suppliers employees safe when working on the state highway network and, ultimately, on all roads where this system will be used into the future.”**
>
> - NZTA’s principal CoPTTM Advisor Neil Greaves

The main difference between eSTOP and traditional traffic lights is portability (they fit in the back seat of a car), their remote control and price. eSTOPs are significantly less than the lowest cost approved traffic light system, which are typically bulky, require a 12 volt truck or car battery and can take up to an hour to set up. Traditional traffic lights also run autonomously, which can lead to significant traffic delays where there’s ‘tidal’ traffic flow.

The eSTOP can be set up in a couple of minutes and uses motorbike-sized batteries that last longer than a standard work shift. There is also considerable cost saving, given that in many situations only one Manual traffic contollers may be required. On that basis, the cost of the eSTOP can be recouped in only a few months’ use.

The eSTOPs will be distributed through Fulton Hogan Signs and Graphics.

GREENFUELS®
FUELLING DEMAND FOR BIODIESEL USE AND INVESTMENT

The ambition is for more New Zealand businesses to power their vehicles with biofuel. The response? GreenFuels®.

GreenFuels® is one of a number of 'circular economy' initiatives by Fulton Hogan, taking waste products and giving them a second and productive life in the development of infrastructure. In that sense, GreenFuels® is part of a family of sustainability initiatives that includes R.O.S.E (Recovering Oil Saves the Environment, Plastiphalt®, recycled asphalt (RAP) and (in Australia) crumb rubber asphalt.

25%	**Percentage of greenhouse gases produced by burning fossil fuels in NZ**
25%	**Fulton Hogan's NZ goal for reducing emissions by 2025**
20%	**Increase in demand for GreenFuels® in the last year**
20%	**Fulton Hogan's national truck fleet running on 20% biodiesel**
7%	**The maximum content allowed under NZ's engine fuel regulations**

The challenge

With fossil fuel responsible for around 25% of New Zealand's greenhouse gas emissions, and with increasing evidence of the effect climate change has on our lives, there's pressing need for new sources of environmentally sustainable liquid fuel.

The response

Fulton Hogan New Zealand has set a goal of reducing carbon emissions by 25% by 2025, in keeping, more broadly, with the government's new emissions reduction target to net zero by 2050. Part of achieving this involves producing our own biodiesel at our GreenFuels® plant in Christchurch.

The steps

1. Began using blended biofuel in vehicles in 2012.
2. Resolved to have our own source of sustainable diesel – our own refinery.
3. Identified the most practical means was via used canola oil from restaurants – a waste product once simply tipped into landfills – using a New Zealand-developed catalysed transesterification process.
4. Making GreenFuels® available to customers as well as for Fulton Hogan's own use.

What we're finding

- GreenFuels® biodiesel is the easiest and most cost-effective means for many businesses to begin meaningfully reducing carbon emissions.
- Pure (100%) GreenFuels® can be used successfully in a range of equipment, and we now operate 20% of our national truck fleet on blends of up to 20% biofuel.
- Pure biofuel has been successfully trialled in Fulton Hogan vehicles and we're investing in a truck designed for 100% biofuel.
- Demand is steadily increasing, particularly among organisations whose customers are demanding verifiably sustainable supply chains for their products. During the year, customer demand for GreenFuel increased by 20%.
- Meeting all, or even a large portion of New Zealand's future biodiesel needs will require a diverse range of broader steps in environmentally sustainable diesel development and production, including using wood and other plant products and extracts.

14 MILLION LITRES

GreenFuels® total blended capacity of biofuel annually, when blended with mineral diesel to the 7% maximum retail blend level

GREENFUELS®
PART OF A WAY OF LIFE

There's nothing like being in a customer's world to fully understand the benefits that innovations like GreenFuels® can bring. Here we visit one of our most innovative GreenFuels® customers, Okains Bay Long Line Fishing Ltd.

To biofuel or not to biofuel? According to Okains Bay Long Line Fishing owner Greg Summerton, that is not the question.

The 35-year long-lining veteran says GreenFuels® is an obvious choice, environmentally and commercially.

For him it's as obvious as fishing to catch only what's needed, respectfully and humanely. Or as pragmatic as aiming to produce something that's carbon neutral.

"These things are all about kaitiakitanga (respect for resources) – respecting beautiful fish, the community that catches and processes them, the environment we share and the energy we use to recover them."

The way he sees it, his customers buy more than fish.

"The world's most discerning customers want to know the full story – and for that story to be part of their story. There's an awakening of conscience and people are prepared to pay a premium for ethically caught fish."

His biggest customer is one of the world's largest supermarket chains. They do a detailed annual assessment of Okain's business, people, fishing and environmental practices.

"It's an honour they're interested in how we do things – and each year there's something more for them to see," Greg says.

Long-lining since 1986, he comes from a family that "has only ever fished". They've been commercial fishermen since 1840.

"I am Ngai Tahu and our people have fished with hooks for centuries. In our type of fishing, the fish come to you – it's not humans going smash, bash into their habitat. We don't chase or harass fish, we respect them."

Greg says the differences start deep underwater off the Chatham Rise – a vast area between New Zealand and the Chatham Islands, where cold waters from the sub-antarctic meet warm subtropical waters from the north. There they lay lines with the smallest possible hooks to catch ling, deep sea cod, trumpeter, hapuka/grouper, deep sea perch, blue nose and blue cod.

"When the fish are hooked they don't tend to fight – they swim gently with the current and when they come to the surface they are remarkably unstressed.

"This is how I've always wanted to do it. Since I started fishing, I have never liked what I was seeing out there with the gill netting and bottom trawling, and I decided there's got to be a better and more traditional way."

Although it's "way more" labour intensive than "industrial fishing" alternatives, the product is sold eight months before it's even caught, at a significant premium.

Running the company's ship Kawatea on GreenFuels® biofuel is one of several parts of the Okains Bay story that, together, contribute to this premium.

"BioFuel is certainly one of these, and with fuel sitting at around 30 percent of our costs you could say it's a big one, too."

In addition to lower exhaust emissions, Greg says the fuel economy is improved, the GreenFuels®' biodiesel has better lubricating qualities and he likes the fact it breaks down in water.

"Toitu te marae a Tane Toitu te marae a Tangaroa Toitu te iwi."

– If the land is well and the sea is well, the people will thrive.

Greg Summerton on board Okains Bay's ship 'Kawatea': "I am Ngai Tahu and our people have fished with hooks for centuries"

The hooks in Okains Bay Fishing's story

- Use of Greenfuel's biodiesel in Okains Bay's ship Kawatea – and looking to introduce it to the vehicle fleet.
- Using hooks of no more than 40mm with long-lining – not netting or bottom trawling.
- A $150 per voyage contribution to any employee with children between the ages of three and 22 to advance their children's education.
- The purchase of a 3,000-hectare hill country property, Waikene Station – a 'carbon farm' which is regenerating into a variety of native bush and tree species and supporting 1,200 beehives.
- Various techniques to limit/mitigate bird catches.
- Maximising the use of the fish – only 1% of the fish is unused.
- Limiting the catch solely to ling, deep sea cod, trumpeter, hapuka/grouper, deep sea perch, blue nose and blue cod – leaving other species undisturbed.
- The cardboard used for packaging made from fibre produced from Forest Stewardship Council verified well managed forests and other controlled sources, and using water-based inks.
- Using QR code scanning on the packaging to inform purchasers of the date and location of the catch.

PLASTIPHALT®

THE CIRCULAR ECONOMY IN PRACTICE

With plastic in the environment becoming an ever more pressing issue, Fulton Hogan has been looking to put used plastic where it's useful. Our proprietary product PlastiPhalt® is the result of more than five years' development and turns a waste stream into infrastructure by using the plastic polymers from recycled oil containers as the 'binder' for high durability asphalt. Asphalt used for heavy traffic categories contains polymers for strength, but until now it has been almost exclusively from virgin polymers.

Australia:

The equivalent of more than 140,000 plastic bags are being saved from landfill through road surfacing works for the City of Port Adelaide, Enfield. Approximately 110 tonnes of PlastiPhalt® is being laid, added to a 20% recycled asphalt pavement (RAP) mix. This meets the Austroads guidelines and can be reused as recycled asphalt (RAP) in new road surfaces in future. Fulton Hogan began trialling PlastiPhalt® on a laboratory scale in 2014.

New Zealand:

In New Zealand we are using the oil containers from the Recovering Oil Saves the Environment (R.O.S.E.) scheme, which Fulton Hogan co-founded. R.O.S.E. recovers around 2.5 million litres of used oil annually from workshops and garages. PlastiPhalt® was trialled in 2018 at Christchurch Airport where 250 tonnes was paved (incorporating the equivalent of 3,100 plastic oil containers). This has been followed by paving almost 20 times that area at Auckland International Airport.

PlastiPhalt®: Same look, very different properties

The shredded plastic at the heart of PlastiPhalt®

What we're finding:

- PlastiPhalt® will have its greatest application in areas of heavy to extreme vehicle loading, especially airports and ports.
- The greatest initial interest in PlastiPhalt® is from organisations who need to be able to show a verifiably sustainable supply chain and/or carbon neutrality.
- Fulton Hogan is looking at how we can utilise more plastic in mixes suitable for low traffic environments without compromising performance.
- Currently we are able to produce PlastiPhalt® where blending facilities are in close proximity to the asphalt plants. More research is required to formulate a blend that is transportable long distances.

Technically speaking

PlastiPhalt® is made by shredding and granulating plastic. The plastic is incorporated into the asphalt mix by encapsulating the pieces in the binder with the percentage of plastic used based on the required performance of the mix. The process is controlled by a number of quality assurance tests. As part of Fulton Hogan's Asphalt Quality Regime all projects that utilise PlastiPhalt® follow the AQR process to ensure all risks are identified and managed appropriately. Asphalt mix designs are completed on the desired PlastiPhalt® mix with to ensure performance is not compromised. NZTA M/1A testing is conducted on the binder and the asphalt mix is tested to NZT M/10 requirements. This not only ensures the binder is at its optimum but that the asphalt mix will perform in the field.

31,000 USED PLASTIC OIL CONTAINERS IN RECORD NZ ASPHALT LAY

Fulton Hogan has completed New Zealand's largest project using asphalt made with recycled plastic.

The 2.1 hectares of PlastiPhalt® on aircraft taxi-ways at Auckland International Airport contains the plastic from approximately 31,000 five-litre oil containers.

Each year Fulton Hogan collects around 2.5 million litres of used oil for the 'Recycling Oil Saves the Environment' (R.O.S.E.) programme. The plastic from these oil containers provides the 'binder' in PlastiPhalt®.

In high load areas bitumen needs a polymer (plastic) to be chemically bonded within it for strength – the oil containers provide this and substitute for imported, virgin polymers.

This project follows an initial smaller lay of PlastiPhalt® at Christchurch Airport last year, and follows almost ten years experimentation by Fulton Hogan using recycled plastic in asphalt. The team began testing plastic milk containers, before settling on the heavier-grade plastic in the oil containers.

Fulton Hogan currently produces PlastiPhalt® in Auckland and Christchurch, and is working to increase the geographical reach over time.

Fulton Hogan Chief Executive Officer - New Zealand Graeme Johnson says PlastiPhalt® is an example of the 'circular economy' in action.

"It's about taking a waste stream through to an environmentally beneficial product to build infrastructure of critical value to New Zealand."

The team making the largest lay of asphalt based on recycled plastic

WHERE THE RUBBER HITS THE ROAD

OPEN-GRADED CRUMB RUBBER ASPHALT / GAP-GRADED CRUMB RUBBER ASPHALT

Fulton Hogan Australia has won two Australian Excellence awards for its innovation using crumb rubber as a core part of asphalt. Developed by Fulton Hogan's Northern Infrastructure Services Technical Team (Chris Lange, Warrick Cutler, Roberto Espinosa and Laszlo Petho) based in Ormeau, the asphalt mixes tick the sustainability box twice. In addition to re-using old tyres, they're designed and manufactured with warm mix technology, allowing lower mixing and compaction temperatures to reduce fuming and odour, and saving energy. As outlined below, they also bring significant performance advantages.

Crumb rubber modified bitumen used as a binder for asphalt mixes for community roads is a tangible contribution to the environment through recycling used-tyres, and a lower life-cycle cost of the resulting road pavement. Although it has been used elsewhere in the world, Fulton Hogan has demonstrated conclusively its recyclability and value in asphalt in Australia and that, when designed carefully, the mix becomes a high performing durable product, with improved engineering properties.

What is crumb rubber?

More than 50 million tyres reach their end-of-life in Australia each year. The majority of these end up in landfills. Tyres from various sources, including heavy and light vehicles, are granulated and processed to a specific particle size generally 100% passing the 1.18mm sieve and blended with bitumen at a rate of approximately 18% to 20% by mass of the bitumen. The rubber modified binder is used for the manufacture of hot and warm mix asphalt. On average, two standard tyres would be consumed for every one tonne of rubber modified asphalt manufactured.

Crumb rubber is one of the highest proportions of any recycled product used in the manufacturing of asphalt.

Open-graded crumb rubber asphalt

Fulton Hogan developed the crumb rubber open-graded asphalt mix in its Ormeau asphalt laboratory, ensuring the volumetric and workability properties of the asphalt mix met the desired requirements. It was manufactured with warm mix additive, allowing lower mixing and compaction temperatures to reduce fuming and odour.

The team placed around 1,000 tonnes of open-graded crumb rubber on a busy arterial road on the Gold Coast, providing safe driving conditions in rain and reducing wheel noise. It was produced and laid using pre-blended crumb blended in an off-site plant facility. A 'control' was used - conventional open-graded asphalt with polymer modified bitumen (the conventional binder used for open-graded Asphalt) to give a direct point of comparison.

This demonstrated that open-graded crumb rubber asphalt can be manufactured and paved at lower temperatures without compromising performance. We've found that it delivers longer lasting open grade asphalt surfaces due to the high binder film thicknesses and lower levels of binder oxidisation, promising longer lasting surfaces. As an OGA (open-graded asphalt) surface, it helps improve wet-skid resistance and reduce tyre noise, and thus has potential to reduce the need for expensive sound barriers on highways in future.

Gap-graded crumb rubber asphalt

Gap-graded crumb rubber asphalt differs from crumb rubber open-graded asphalt in that the open-graded is designed to be porous with insitu air voids of greater than 20% and the gap-graded is designed essentially to be dense with in situ air voids of 3% to 7%. The gap in the particle size distribution (aggregate grading) allows for a high binder content and thick binder film thickness (coating the aggregate particles). Gap-graded crumb rubber asphalt is an asphalt mix with a high crumb rubber binder content for durability, which is balanced out with a stable aggregate skeleton for stability.

More than 1,000 tonnes of wet-blended gap-graded crumb rubber asphalt mix developed by Fulton Hogan Infrastructure Services, Northern Region, has been successfully trialled on three projects in Queensland on the City of Gold Coast road network.

It provides a cost-effective treatment for roads with extensive block cracking, offers superior performance to traditional asphalt and potentially increases the use of recycled crumb rubber in Australia. The reduced maintenance cycles achieved through the use of gap-graded crumb rubber asphalt provides enhanced value to the asset owners, a cost saving passed on, in turn, to Australian road users.

The New Zealand experience

In New Zealand, Fulton Hogan has worked on optimising crumb rubber binders with focus on stability and reducing odours. New Zealand operations are slightly different to Australia; this has resulted in challenges both in product performance and in product availability. Together with the Ministry for Business, Innovation and Employment (MBIE) and Opus, Fulton Hogan successfully laid a crumb rubber asphalt in Wellington. While the odour and stability can be managed and minimised using specialised modified crumb rubber pellets, this crumb rubber form is not available in New Zealand at the moment.

In future, it is expected that the supply of waste rubber tyres will be mostly used by a Portland cement operation in Nelson as an energy source. This limits availability of waste rubber to crumb for other industries, and industry has been advised to peruse other modifying or waste products. Importing used tyres is not necessarily an attractive option, given a core goal of our 'circular economy' initiatives is to benefit the local environment at a cost our clients can afford.

If this were to change, Fulton Hogan is ready and able to produce both crumb rubber asphalts and crumb rubber sealing binders in New Zealand.

What is crumb rubber?

More than 50 million tyres reach their end-of-life in Australia each year. The majority of these end up in landfills.

Tyres from various sources, including heavy and light vehicles, are granulated and processed to a specific crumb rubber particle size.

The rubber-modified binder is used for the manufacture of hot and warm mix asphalt. On average, two standard tyres would be consumed for every tonne of rubber-modified asphalt manufactured.

Quieter, reduced mixing and compaction temperatures and a more sustainable outcome

'BREATHING' NEW LIFE INTO A CARPARK

THE MANLY VALE COMMUTER CARPARK

Functionality meets asthetic design for improved wellbeing for users and residents, noise reduction and greater biodiversity

The Manly Vale commuter carpark is the world's first multi-storey 'breathing' carpark, with more than 9,000 plants in its façade providing beauty, functionality and cleaner air. As a piece of living infrastructure, it goes beyond simply 'green walls' to form a 'breathing building'.

Integrated with the Northern Beaches B-Line (fast transit) bus route, the carpark is wrapped in Junglefy Breathing Wall modules to reduce air pollutants such as particulate matter, CO_2 and volatile organic compounds.

The nearby residents are also rapt.

They've gone from opponents of a potentially stark, utilitarian carpark to strong allies. Not only does the new B-Line bus route ease congestion, they also have an attractive parking asset that would otherwise have been an eyesore.

MP for Manly, James Griffin, has been effusive. He called it an "exciting step towards creating more sustainable designs for infrastructure... to provide a green solution for the Northern Beaches".

While not the first carpark to have a green façade, it is our understanding that none has previously been designed to allow the plants to be cared for without the need for scaffolding and ropes, and with the goal of using the carpark walls as an air filtration system.

The building is now part of a three-year scientific study by the University of Technology Sydney (UTS) into the impact of plants in our cities on reducing pollution, particularly from cars.

The genesis

The original design had a structural steel façade, typical of traditional multi-level carparks. Under pressure from neighbours and the public, TfNSW held several workshops with Fulton Hogan to assess alternatives. Fulton Hogan proposed a fundamentally different façade and, with TfNSW, invited several companies to present options to realise it.

The challenges included how to maintain and operate the carpark safely and cost effectively, along with the safe maintenance of the façade system and the plants. The option of using scaffolding and ropes to maintain and care for the plants was discarded early in the piece, requiring a fundamentally different approach.

Fulton Hogan, Junglefly and the design team from BGE developed a proposal based on a simple steel balustrade style façade, with rotating breathing plenum panels fixed to the concrete slab. This allows maintenance to occur from inside the carpark slab itself simply by rotating the panels. Fulton Hogan worked with Junglefy from the initial consultation phase, which allowed them to develop and manufacture the bespoke rotating breathing wall panels, specifically for this project.

This building combines functionality, aesthetic design, improved health and wellbeing for users and residents, noise reduction and encourages greater biodiversity. It shows that no longer do carparks need to be buildings simply to house cars – they can be a source of beauty, health, comfort and biodiversity for locals and visitors.

Click here to watch video

USED OIL RECYCLING

FULTON HOGAN'S OIL RECYCLING PROGRAMME GAINED A SEVEN-YEAR TICK OF APPROVAL FROM THE GOVERNMENT, WITH THE R.O.S.E SCHEME BEING RE-ACCREDITED THROUGH UNTIL 2026.

Recycling Oil Saves the Environment (R.O.S.E.) was established and gained government accreditation seven years ago. A partnership between Fulton Hogan, Petroleum Services Ltd, Salters Cartage Ltd and the government, R.O.S.E has collected more than 100 million litres of used oil since 2011.

Associate Minister for the Environment Eugenie Sage delivered the R.O.S.E. accreditation at Fulton Hogan's Miners Road Laboratory near Christchurch.

"People and the environment benefit when businesses step up and consider what happens to products they use, and how to avoid harmful waste from them," Ms Sage said.

"Fulton Hogan and its partners have done this in operating the R.O.S.E. scheme. It's a good example of how we can shift away from a 'take-make-waste' economy to a 'make-use-return' one, where products are repeatedly re-used or recycled."

R.O.S.E. recycled oil is used in industrial applications by companies ranging from Fulton Hogan to Tegel to Oji Fibres' Kinleith mills. Further underpinning the scheme are distribution partners Allied Lubricants, BP Lubricants, Oil Intel (Total Lubricants), Lubricants NZ (Elf Lubricants) and Supercheap Auto (who enable the public to leave used oil at their stores for collection).

Across New Zealand the three partners have increased the number of collection sites to more than 8,200.

At the ceremony South Island General Manager Craig Stewart talked about the importance of multiple approaches to reducing carbon emissions and increasing sustainable production.

> **"People and the environment benefit when businesses step up and consider what happens to products they use, and how to avoid harmful waste from them."**
>
> - Associate Minister for the Environment Eugenie Sage

Associate Minister for the Environment Eugene Sage with Fulton Hogan South Island General Manager Craig Stewart at the R.O.S.E accreditation

In-pavement lighting - a primary means of defining lane boundaries

Click here to watch video

MILITARY ROAD INTELLIGENT TRANSPORT SYSTEM

The rollout of a B-Line in a high-density area, with no room for road widening, bus indents or road realignment poses a particular challenge. In meeting this challenge, Fulton Hogan helped develop and install what is believed to be the first fully automated 'tidal flow' system in Australia.

Military Road in Cremorne and Neutral Bay on Sydney's northern beaches is three lanes per side. Together, Transport for New South Wales (TfNSW) and Fulton Hogan developed a system that enables a 4:2 arrangement between 5am and 10am (two normal lanes, one T3/bus lane, and one for stopped buses).

Together with TfNSW and Roads and Marine Services' information technology, manufacturing and asset divisions, Fulton Hogan planned and developed a tidal flow intelligent transport system to improve traffic flow by giving priority to peak traffic direction. This creates a dynamic environment in which the direction of lane use is regularly changing, with considerable need to keep drivers informed for safety, avoiding disruptions and for traffic flow.

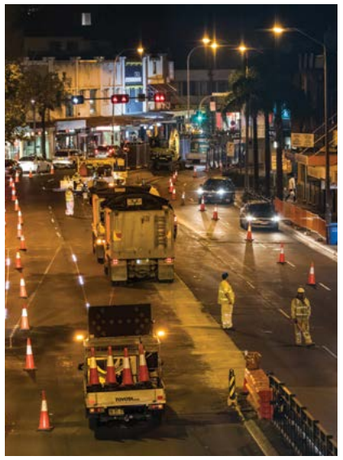
The first step was a series of workshops to define the scope, which was resolved as a requirement for:

- Automatic reconfiguration
- Remote monitoring and control
- Multiple devices, all controlled by a programmable logic controller
- Automatic fault alarming and handling, identifying and responding to faults based on multiple fault scenarios
- Full integration into Sydney's Co-ordinated Adaptive Traffic System (SCATS)

This required various, integrated field devices - primarily moveable mediums, in-pavement lights, usage lights and changeable message signs. Given that the risk of road accidents is greatest during transitions, the moveable medians are electrically motorised, remotely controlled and programmable for pre-set locations.

In-pavement lighting is the primary mechanism for defining lane boundaries and variable lanes, with lane usage signs and changeable message signs providing advance warning to motorists about upcoming merged lanes, added lanes and bus lanes. Thermal cameras with video messaging determine if there is an obstruction.

Planning for fault handling accounted for more than 1600 different fault scenarios, and the fault alarms are set to a range of different levels, based on the severity of a fault – from a malfunction of the moveable median barriers to a lane use lantern failing.



PUTTING ASPHALT TO **THE ULTIMATE TEST**

GENERAL MOTORS HOLDEN'S CIRCULAR TEST TRACK RESURFACING

When General Motors Holden needed to resurface their circular car testing track at Lang Lang, 70 km southeast of Melbourne, they needed one thing in particular. The parabolic-shaped pavement, varying from 17.9 to 23.7 degrees on the top two lanes, needed to be blemish-free both longitudinally and horizontally, and put back in place to the exact shape.

The circular track is where the company tests its cars at extremely high speeds, so for the test results to be meaningful and the driving safe, there could be no track-based variables.

Typically, tracks of this sort are made of concrete - in the United States in particular - but Fulton Hogan has shown it can be done as well, and more cost effectively, in asphalt.

The solution was the final word in bespoke. The unique nature of the track means there is no standardised equipment in Australia capable of doing it, and it's the only site where such equipment would ever be needed in the country.

"The alternative was to bring equipment in from overseas at considerable cost. We said we can make it here," says Phil Olsson, Fulton Hogan's Divisional Manager Assets and Production.

The team's approach was to modify conventional asphalt paving equipment significantly to allow for the asphalt to be removed and replaced on the embanked track.

Addressing the challenge of paving a parabolic surface, varying from 17.9 to 23.7 degrees

Modifications included:

- Building all the support frames to hold the equipment up on the top two lanes (up to 24 degrees crossfall) which was attached to a support paver
- Modifying the support paver linked to the working machine - adding additional hydraulics and electrical controls to allow for it to be steered from the working machine
- Fabricating a 10m long c3 conveyor for the shuttle buggy
- Profiler modification included building hydraulic legs, support brackets and counterweights, modify teeth spacings for cut accuracy - per lane profile
- Paver modifications including;
  - rebuilding hopper, conveyors, augers
  - building new fixed width screeds to suit the pavement profile of the top two lanes
- Steel roller modifications including:
  - fabricating roller drums to suit the profile of the track - two sets per roller
  - hydraulically driven built support legs with trainer wheels to keep the roller at the correct angle through accumulators
  - water, fuel and hydraulic line modifications
  - seat and floor modifications, water spray
- Bitumen sprayer modifications included extending spraybar (6m in length) and modifying spray jets to spray tack on the profile of lanes 3 & 4 from lane 2

To support the profiler and paver during their respective operations on the top part of the track, two pavers – a primary and support paver - were connected by a conveyor belt linked with flexible pivot joints. Both were steered by one operator – the support paver helping hold the other in position. Two new paver screed frames were built, with each screed having a different radius to recreate the track design parabolic curve.

Tandem steel rollers had new drums machined to match the paver produced curves. The rollers also had outrigger structures designed and installed to support the machines, as well as a hydraulic drum position system to ensure the roller drums and correct down force and position on the asphalt when rolling. Multi-tyred rollers had a similar system fitted; with tyres installed at different diameters, as well as altering tyre pressures to achieve correct point loading on each wheel across the curve.

As a 'mill and fill' operation, there was no room for error, requiring exactly the right profile and constant checking of every cut to ensure the profile was right throughout. The used asphalt was recycled on haul roads around the perimeter of the track.

Standard asphalt mix was not going to provide the long-term durability required for the track.

"We needed to allow for the damage inflicted by V8 cars – extremely high levels of compaction, stresses and sheer forces, so there was no half-way measure when it came to this job," says Aldo Lo Nigro, Fulton Hogan's Surfacing Operations Manager.

Fulton Hogan's technical team, led by Jackie Webster and Kevin Embleton, provided GM Holden with an alternative superior performing treatment option using proprietary MotoPhalt® asphalt - a mix specifically designed to resist high shear forces incorporating JetBind®, Fulton Hogan's proprietary elasto-plastomeric modified bitumen binder.

Manufacturing the MotoPhalt® meant diverting Fulton Hogan's Westall asphalt plant to MotoPhalt® production alone for the five months of the project.

At the end of the project, team members had the chance for the ultimate test of their job - travelling the track at the required high speeds in V8 Holden cars to assess overall ride performance. "We were extremely happy with the outcome and so, too, was the client," says Aldo.

"The expert understanding of the project requirements, teamed with Fulton Hogan's market-leading vertically integrated structure, gave us full control of every step of the resurfacing process, ensuring General Motors Holden got the best possible outcome at Lang Lang Proving Ground."

FIBREDEC®
SOLVING REFLECTIVE CRACKING IN PAVEMENTS

We've all seen asphalt with minor cracks running through it, the result of age, wear-and-tear, ground movement and the effect of temperature extremes. At face value, this 'reflective cracking' looks relatively harmless, but the fissures can allow water to seep into base material, leading to greater long-term damage.

At the same time, the cost of re-milling and resealing to address reflective cracking can far outweigh the scale of the problem and be a hindrance to traffic. Alternatively, applying new layers of seal over the existing surface adds not only extra cost and holds up traffic, it can raise issues with the relativity of the road-to-curb height.

Enter FibreDec®. After being applied by Fulton Hogan in Victoria and New South Wales, the Fulton Hogan engineering team in Christchurch has built a FibreDec® dispenser for New Zealand – a truck-mounted 8000L sprayer that blows fibreglass fibres in a membrane sandwiched between two layers of polymer modified emulsion. The membrane is then covered with aggregate to form a tough strain-alleviating waterproof seal.

After testing FibreDec® within Fulton Hogan in New Zealand in 2018, it's now been applied commercially in several centres in the Wairarapa, and trialed in Wellington.

Because FibreDec® has been used commercially for less than a year in New Zealand, it will be some time before its long-term performance is known in the New Zealand environment. The Fulton Hogan trial and the results in the Wairarapa show no impairment, and significant gains compared with traditional fabric chip seals.

A truck-mounted 8,000-litre sprayer that blows fibreglass fibres in a membrane sandwiched between two layers of polymer modified emulsion

JETBLACK®
TREATING SEGREGATED, ERODED AND AGED ASPHALT

Aged and oxidised pavements are less flexible and can damage vehicles and aircraft. Their deteriorating surfaces make the asphalt vulnerable to additional wear from use and the weather, leading to further degradation, with the ultimate risk of surface failure.

JetBlack® is a new option for asphalt and spray seals developed by Fulton Hogan to give airports and councils a new option for extending aged pavements' lives. The objective is to delay the need for asphalt overlay for up to five years.

JetBlack® is a blend of premium bitumen emulsion (high solids, polymer modified and stabilised) special additives and mineral filler. When applied, the voids are filled with mineral filler, returning the asphalt to an as-new appearance. The bitumen emulsion is modified with a blend of performance-enhancing additives that is proprietary to Fulton Hogan, to enrich and extend life of the pavement.

JetBlack® works by the polymer modified bitumen binder adhering to the existing asphalt surface and holding the mineral filler in place. The binder also replaces the bitumen lost during the ageing process. The mineral filler replaces the asphalt's lost fine aggregate, and assists in retaining large aggregate particles in the asphalt surface.

JetBlack® can also be used on localised patches which, due to their hand-placed nature, tend to be more segregated and coarse in appearance than paver-laid asphalt. JetBlack® protects the patch and adds fine aggregate.

What sets JetBlack® apart:

- Extends pavement life by enhancing the oxidised surface
- Gives a uniform black appearance to the seal
- Locks aggregates down by filling in voids in the seal
- Adheres strongly to existing pavement surfaces
- Seals and protects the pavement from UV and water damage

The objective is to delay the need for asphalt overlay for up to five years

INCREASED EFFICIENCY,
SAFETY AND ACCURACY IN ROAD DRAINAGE

PERFORATED PIPE AND GEOTEXTILE CLOTH DISPENSING

Innovative thinking has worked well for the team building the 15km Huntly Bypass section of the Waikato Expressway.

The Huntly section, which takes State Highway 1 east of Huntly town and over the Taupiri Range, is being built by a Fulton Hogan joint venture for NZTA.

The project has required 45km of perforated pipe for drainage, and a similar amount of geotextile cloth. The problem is perforated pipe is heavy (around 50kg a bundle), unwieldy and, when cut, it 'spits out', making it difficult to control.

This previously necessitated laying by hand, with several people doing battle with lengths of hose. The geotextile cloth comes in even larger rolls of around 100kg and, previously, the entire roll needed to be laid, then manhandled into a trench.

Fulton Hogan's response was to design and build a multi-purpose device holding a roll of geotextile cloth. This roll sits in a cradle that one person can manage as the loader reverses, unrolling it directly over the trench to save double-handling. Once the geotextile cloth is in place and a binding layer of drainage metal is down, the perforated pipe is installed.

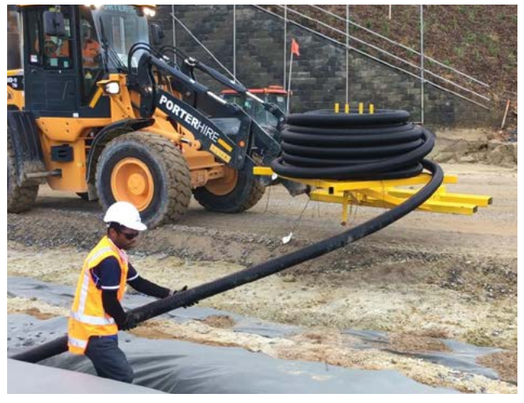
Being on a turntable, the perforated pipe can be pulled out by one person, laying the pipe directly into the trench behind the loader.

This invention has a number of benefits for the crews on site - increased efficiencies by eliminating the twisting of the pipe and the heavy lifting required for both perforated pipe and rolls, hence reducing the risk of sprains and strains of those working. It's improved efficiencies in both time-to-install and manpower, as there are only two people required - one laying and one on the machine.

Across New Zealand and Australia, Fulton Hogan lays around 300,000m² of geotextile cloth per year.

The Huntly section is due to the public in 2020.

Increased efficiency, removing twisting, reduced the risks of sprains and strains - just some of the benefits of this innovation



Across New Zealand and Australia
Fulton Hogan lays around

300,000m²

of geotextile cloth per year

REVOLUTIONARY NEW BRIDGE BUILDING TECHNIQUE

> **"It is extremely gratifying to see an idea that was dreamed up at tender time in the middle of 2018, carried all the way through to completion."**
>
> - Project Director James Weller

A purpose-built boat has been built and launched as a safer, more efficient and quicker way to construct the two piers of the new Auckland Manukau Eastern Transport Initiative (AMETI) Eastern busway bridge across Tamaki River, adjacent to Pakuranga bridge in Auckland.

The AMETI Eastern busway is being built to boost bus, cycle and pedestrian connections between Panmure, Pakuranga and Botany. Pakuranga bridge carries more than 30,000 vehicles per day.

The usual method of constructing piers is to install piles and, using a crane, lift and place a framework over them. In this instance, the team built a boat with steel sides and eight large steel hatches in a concrete base that acted as the framework.

The boat was then floated into position and hung from a temporary support frame.

At low tide, the hatch covers were removed and steel pile casings installed through the holes. Project Engineer Alison Craigie says an added environmental benefit of the technique was that any spoil from excavating the piles was fully contained, removing the risk of any spillage into Tamaki River.

"This innovative method meant less impact on the environment," says Alison. "This was the first time anything like this has been done anywhere and it went pretty well – we're pleased with the results."

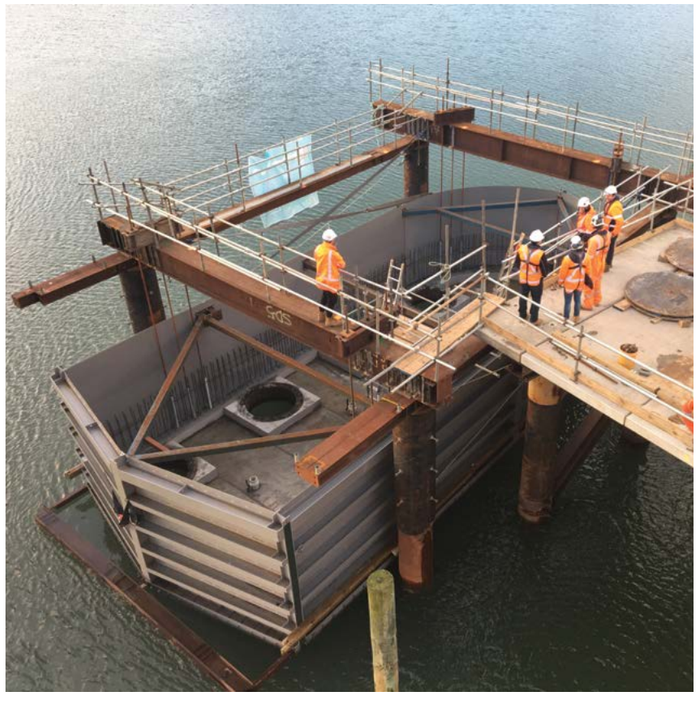
Project Director James Weller says; "This innovative engineering solution allows us to have an environmentally safe area for piling, a dry area for constructing the pile cap below the tide levels, and temporary formwork for the pile cap already in place.

"It is extremely gratifying to see an idea that was dreamed up at tender time in the middle of 2018, carried all the way through to completion."

Construction began at the start of 2019 and will happen in four stages, with completion in 2025. After piling was completed, the joint between the piles and the concrete bottom section was sealed to create a dry working environment for steel reinforcing.

After the concrete pour, the boat's steel sides will be removed, then reassembled to form the boat for construction of the second bridge pier.

Launch day



Fulton Hogan Project Engineer Alison Craigie

Click here to watch video

Darlington Upgrade Project
Bridge move November 2017

Click here to watch video

Darlington Upgrade Project
Ayliffes Road Bridge installation
September 2018

BRIDGING A GAP IN BRIDGE BUILDING TECHNOLOGY

In an Australian first for a large-scale construction project, two large bridges have been constructed off site by Gateway South, as part of the $620 million Darlington Upgrade project in South Australia. Gateway South is a joint venture between Fulton Hogan and Laing O'Rourke on behalf of the South Australian Department of Planning, Transport and Infrastructure.

The Darlington Upgrade is an important part of the Adelaide North-South Corridor project, and spans 3.3km of the Main South Road. Funded jointly by the Australian and South Australian state governments, it also includes non-stop motorways, connecting surface roads and interchanges, and is due for completion this year.

The 180-metre long 3,000-tonnes bridge shown on this page was built on adjacent land and installed using self-propelled modular transporters (SPMTs), following more than a year of planning and four months of off-site fabrication and assembly.

Gateway South's industry-leading achievement began in the bid phase, with an ambitious idea that challenged traditional approaches with the goal of minimising disruption to traffic and maximising safety for travellers and the construction crew.

The design embraced principles of Design for Modular Assembly (DfMA), with steel box girder sections and U-shaped precast concrete deck units fabricated off-site and assembled in the yard adjacent to the highway. Deck topping slab was poured and the complete superstructure was ready to move, minus only the final asphalt surfacing and expansion joints at the ends of the deck.

Using SMPT technologies by specialist subcontractor, Belgian company Sarens, the structure was moved 500 metres along the project corridor. Given that the ground was uneven – varying by a factor of three degrees – a sophisticated measuring system was installed on the bridge to monitor deformations and using jacking towers on the end trailers so operators could avoid deformations and stresses to the bridge. For the transporting, SPMT bogies at each support position were linked into separate groups for stroke adjustment, controlling the SPMT platform levels. All SPMTs at each support position were linked and connected to a master computer which enabled them to be lifted or lowered simultaneously in small increments.

The move took just 22 hours, 24 hours less than was scheduled, minimising disruption to a section of road with an average of 73,000 vehicles per day.

"Building the bridges in this way means keeping disruptions to a minimum during construction for the tens of thousands of vehicles which travel through this part of Main South Road every day. While this type of bridge installation is common in Europe and America, the method has never been used on this scale before in Australia," the Transport and Infrastructure Ministry said in a media statement at the announcement of the innovation.

An ambitious idea, challenging traditional approaches to minimise disruption to traffic and maximise safety for travellers and the construction crew

INNOVATING OUR WAY

TO A FASTER TURNAROUND

It's not unusual for changes of projects' scope to delay completion dates.

However, it's rarer for project scopes to increase significantly and the time frame not to change. This was the reality for the Eastern Access Road Project in Queenstown and it led to some innovative thinking and action by Fulton Hogan's project team, led by Richard Lee and working closely with consultancy Stantec New Zealand.

The Eastern Access Road is a new 2.5km section of road and underground services. Early on, it was found a section of a nine-year-old sewer needed replacing because the concrete pipe had eroded and collapsed. The contract was expanded to include this and, with several design changes and weather delays, there was three months' additional work - an increase in scope of almost 30 percent. The client, Queenstown Lakes District Council, needed the road completed and open before Christmas, given the influx of summer holiday makers. This was achieved, reducing traffic waiting times through Frankton from an average of 18 to two minutes.

Faced with 15 months to complete 18 months' work, the Fulton Hogan team and Stantec New Zealand developed a number of innovative solutions to minimise cost and deliver the project within the timeframe.

"We're really proud of how much engagement there was between the various arms of Fulton Hogan and the engineers – and vice versa. With things changing as we went we needed to plan, then re-plan, almost constantly - always ensuring the right and left arm were working together," Contract Manager Anna Sinclair says.

"For all of us necessity became the mother of invention, and we developed some significant innovations along the way."

> "For all of us necessity became the mother of invention, and we developed some significant innovations along the way."
>
> – Contract Manager Anna Sinclair

1. Resourcing

After calibrating the degree of change, an immediate step was to call upon additional resources from Fulton Hogan's Waikato, Southland and Dunedin regions, and from Fulton Hogan's Civil South, as well as additional external subcontractors.

2. Alternatives to traditional piping

A technically challenging aspect involved laying a five-metre deep trench for pipe up a 50% slope laid in engineered fill in the Runway End Safety Area (RESA) of Queenstown Airport. This would normally require the embankment trench to be benched, disrupting the existing stable engineered material and requiring 11-metre wide excavations. Instead, the team excavated a 2-metre wide trench, where only the upper part of the embankment required benching for welds. The polyethylene pipe was joined using electrofusion sockets, eliminating the need for people to enter the trench to bolt and tighten flange joints.

The pipes were placed and inserted into the socket of the previously laid pipe with the weld connections exposed along the top, enabling easier access for the welding team. The pipe was then laid and backfilled using pourable concrete at 17-20MPa, again to remove the need for anyone to enter the trench.

This was poured to provide a flat surface, and covered with compacted topsoil with a digger-mounted plate compactor. Again with safety in mind, this removed the need for anyone to work on a steep slope with a 400kg compactor, and saved time and increased safety significantly.

3. Automatic kerb levelling

Another time/cost saving solution introduced due to the new scope was the 'automatic' kerb leveller. Fulton Hogan fabricated a levelling box attached to a grader blade for levelling the kerb base, prior to laying the concrete kerb itself. This allowed the team to use a GPS control system on the grader to achieve more accurate horizontal and vertical levels.

This method was developed after seeing a subcontractor's GPS controlled bobcat, and we realised we could achieve the same solution and greater productivity by further developing our own plant with minimal expenditure. This also reduced aggregate wastage, manual labour and time.

4. Staggered road openings

Fulton Hogan devised a plan whereby Stages 1 and 2 of the road were opened temporarily to allow a section of the road to be opened for this ski season. The team moved on to Stage 3 and returned to complete the earlier stages later. This greatly reduced the traffic queues through Frankton during the ski season.

Creatively fitting 15 months of work into 12 months: Central Region Business Manager Christine Hilton, Corporate Asset Manager Kelly Marshall and Contract Manager Anna Sinclair

THREE WATERS ONE INFRASTRUCTURE

IT'S NOT A PERFECT STORM, BUT IT'S CLOSE.

Click here to watch video

On either side of the Tasman, a growing number of underground pipes are nearing obsolescence; a changing climate is upsetting rainfall patterns; New Zealand sits on the edge of a tectonic plate; and human populations are growing, urbanising and are increasingly health conscious.

Consider we're talking about something that's the essence of life, and you can see why water's under the microscope like never before, literally and figuratively.

The Havelock North water contamination crisis is a recent sign of how wrong things can go.

Yet, infrastructurally speaking, water doesn't exist on its own. Increasingly, our bridges are designed and built to carry water, telecommunications and even gas. Our roads are drains for storm water. Most of our three waters infrastructure is under existing roads (which means repairs inevitably mean roadworks). And many of our roads and other network infrastructures go over (and even under) the 'fourth water' – rivers, streams, estuaries and harbours.

"Customers assume contractors can fix pipes. What they most want and need is the quality of data and analysis, real-time and future-oriented feedback on their assets."

- Mark Christison, National Water Manager

That's why when we think about the future of water it's with all infrastructures in the frame. It's no coincidence, for example, that Fulton Hogan's National Water Manager Mark Christison's background spans infrastructural endeavours, from design to infrastructure management to energy reticulation.

Fulton Hogan has a 'three waters, one infrastructure' approach – integrating the thinking, planning, building and managing of all infrastructures as far as possible.

This means significant investment in operational systems for asset management to account for future water management needs and neighbouring infrastructures. The prize is greater durability and longevity of assets, fewer disruptions to the public in its ongoing management, and increased efficiencies in the management and maintenance of the different infrastructures. One logical extension of such an integrated approach – although no-one is quite there yet – is joint ownership of assets.

"Customers assume contractors can fix pipes. What they most want and need is the quality of data and analysis, real-time and future-oriented feedback on their assets," says Mark.

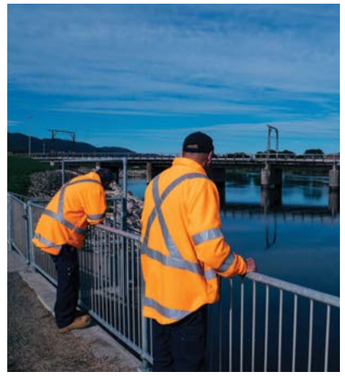
Mark calls it 'smart contracting', and it's at the heart of Fulton Hogan's partnership with Wellington Water.

It's an integrated alliance where the goal is a 50:50 sharing of human resources between Wellington Water and Fulton Hogan, and each working for the one team on a no-blame, shared risk and reward basis. Wellington Water is owned by Wellington City Council, Porirua City Council, Lower Hutt City Council, Upper Hutt City Council, and Greater Wellington Regional Council.

There's strong logic for such integrated water planning and management. After all, every drop of the stuff comes from the one place – the sky – and actions by a neighbouring local authority almost invariably effect, in some way or other, others. By working as one they also achieve the scale, efficiencies and capabilities that aren't possible individually.

The goal is to minimise duplication, maximise collaboration and to co-design where possible, thereby doing more for the same amount of money.

At the heart of the benefits, though, is information and innovation. Data that the infrastructure owner needs to prioritise, make the inevitable trade-offs in investment decisions, model alternative approaches, and to plan, long-term.



50:50

The integrated alliance goal of sharing human resources between Wellington Water and Fulton Hogan

Wellington Water has gone for the Maximo enterprise asset management platform. This allows real-time integration of job management, asset management, financial management, GIS and call centre data.

Having all data in one place helps give a three-dimensional view of the asset and customer service, therefore, greater proactivity in condition monitoring and planning. This puts the team on the front foot, increases staff capability, and provides better resilience and back-up.

It also helps ensure Wellington Water is well positioned to meet further developments in national standards in future.

Considerable benefit and experience has been drawn from Fulton Hogan's experience with the Stronger Christchurch Infrastructure Rebuild Team (SCIRT). This introduced a uniquely high level of spatial geo-linking of infrastructures – water, telecommunications, gas, electricity, road and rail, all using the same GIS platform.

FLOATING A NEW IDEA FOR SOUTH AUSTRALIAN WATER

South Australian Water has a series of 90 storage tanks whose roofs needed replacing over the past four years. Traditionally, this has been done by emptying the tanks and using a scissor lift, with the replacement roofing manufactured off-line.

This, however, has drawbacks. Among them are loss of capacity during the repair period through the need to use smaller temporary tanks, the cost of obtaining and installing these tanks, the time taken to install them, and the need to work during the winter when water demand is lowest because of the reduced storage capacity.

In Minlaton and Dark Range, this was not feasible as their tanks are the primary source of water for their communities. Fulton Hogan's response was to replace the badly corroded sheeting by building floating pontoons that allowed the roof repair to be done from within the un-emptied tank.

South Australian Water managed the water level at a consistent two metres below the top of the tank, providing sufficient height to work under the lid from the pontoons. In addition to allowing uninterrupted water supply for the Minlaton and Dark Range communities, it saved South Australia Water around $600,000 by removing the need to install a 130,000-litre temporary tank at Minlaton and a 656,000-litre temporary tank at Dark Range.

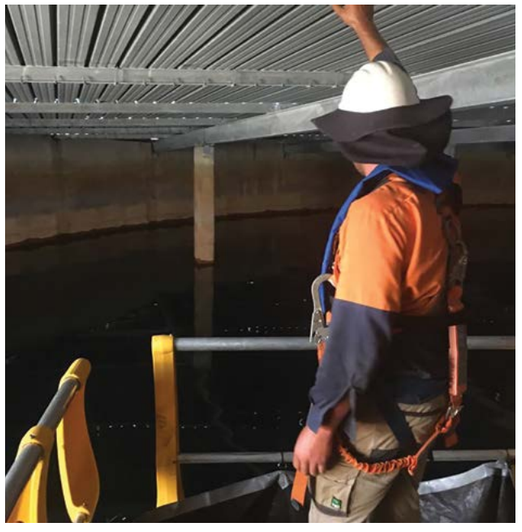
Chlorine was used to ensure the pontoons did not affect water quality, and the water was tested twice a day during the project.

The mitigation strategies led to no loss of water quality and, by not requiring the additional tanks to be installed, reduced the time of the project. There was no loss of water supply to the community, nor any need to change the configuration or pressure of the mains supply.

The innovation has been welcomed by South Australian Water.

"The ability to perform these works online safely has provided greater certainty on our delivery schedule and enables South Australian Water to maintain our service reliability to our customers throughout construction," says Rob Nadin, South Australian Water's Tanks Programme Manager.

Working from within... for an altogether better outcome



BESPOKE METHODOLOGY **AND TEAMWORK**

THREE OLD SOUTH AUSTRALIAN TRESTLE BRIDGES BROUGHT BACK TO ALMOST TO NEW

Fulton Hogan has led a group of product suppliers, specialists, trainers, emergency rescue organisations, designers, fabricators and construction personnel to revive three ageing trestle bridges between Sellicks Beach and Myponga Reservoir in South Australia.

Spanning deep ravines at up to 30 metres and carrying water pipe of approximately 1050mm, this highly collaborative design-and-build project guaranteed the bridges could be saved and rejuvenated in a cost-effective, safe and efficient way for South Australian Water. More than 50 years old, the trestle walkways were rotting and the structural steel rusting, and the walkway widths and handrails were outside current code.

The primary challenges:

- The maintenance on the pipe, scour valves and expansion joints could not be safely undertaken due to the unsafe nature of the trestle bridges.
- The wooden plank walkways and galvanised steel handrails are suspended from the MSCL pipe via galvanised steel hangers which severely limited the admissible weight of any new infrastructure.
- Varying dimensions of bridge sections.
- The upgrade was not feasible from scaffolding or from an airborne machine due to the steep valleys and severe wind within the valleys.
- The use of different metals during the upgrade posed the threat of future corrosions unless fitted correctly.

In design, Fulton Hogan specified light-weight materials, including Fibre Reinforced Panel grate to replace the wooden planks, and aluminium cross beams and handrails to replace galvanised steel infrastructure.

This reduced the safety risks associated with manual handling at height, and minimised weight.

The aluminium cross-beams were bolted to galvanised steel sections from the pipe, using non-conductive spacers and surface coatings to address the potential for corrosion between the different metals. The construction methodology and safety management plan was developed in close consultation with Vertigo (rope supplier), MMM, Nobles (safety equipment supplier), State Emergency Service (SES), Allwater (SA Water's Maintenance and operations contractor) and South Australian Water, all of whom were encouraged to bring their best ideas to the table.

The key phases included:

1. An airborne visual inspection of all corrosion and the integrity of existing welds with drones
2. Prefabrication of structural aluminium cross-beams and handrails
3. Prefabricating bespoke trestle trolleys spanning multiple cross beams to provide safe working platforms and access hatches to perform works beneath
4. Site-specific working-at-heights and rescue recovery training, construction of access and extensive use of safety and rescue equipment and
5. Each panel of the bridge decking needed to be individually measured, cut and fit
6. The level of packing beneath each cross beam had to be adjusted to negate some movement in the bridge since its original construction

The trestle trolleys locked onto the existing pipe hangers and, from the platform created by the trolley and the use of hatch doors in the floor of the trolleys, the crew were able to work beneath the pipe hangers to remove existing wooden planks, treat rust and install new cross beams and handrails at each span.

By connecting a section of walkway grate to the back of the trolley, the crew could haul each section of walkway grate behind them as they moved to the next span. From the safety of the trolley and the already completed walkway behind, the crew was able to afix each end of the grate to the newly installed cross beams.

External training providers provided the crew with working-from-heights training and on site rescue recovery training.

Much of the credit for the innovative methodology goes to the full range of suppliers, specialists, trainers, emergency rescue people, designers, fabricators and construction personnel. This collaborative approach guaranteed the cost effective, safe and efficient delivery of a challenging trestle bridge upgrade.

Fulton Hogan Utilities Operations Manager John Herbert inspecting the Myponga Reservoir water pipe

Below: Fulton Hogan Mechanical Fitter Brad Staples on a partially completed section of the trestle bridge

innovation@fultonhogan.com