



# BluSeal Tunnel Liner

GROUND WATER INFILTRATION MANAGEMENT

# BluSeal Tunnel Liner

## WATER INFILTRATION MANAGEMENT

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### WHAT IS IT?

BluSeal Tunnel Liner is a system of product supply, project management, training and site support to ensure desirable ground water infiltration control.





# BluSeal Tunnel Liner

## PRODUCT INFORMATION

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Bluey are leading Australian tunnel waterproofing specialists with proven experience on leading infrastructure projects

### WHERE DO WE USE BLUSEAL TUNNEL LINER?

BluSeal Tunnel Liner is chosen where there is a need for 'dryness' or management of groundwater infiltration in a tunnel.

BluSeal Tunnel Liner provides the highest surety of durability, environmental management and aesthetic outcomes required on a modern day construction project

### WHY BLUSEAL TUNNEL LINER?

Water infiltration control

Understand and manage the risks associated with ground water in an underground environment.

Proven large scale application and project management of major infrastructure projects



### SHEET MEMBRANE TUNNEL LINING PROJECTS

- Epping to Chatswood Rail Link, Sydney
- Eastlink Project, Melbourne
- Northern Gateway Project, Auckland (New Zealand)
- City West Cable Tunnel, Sydney
- NSBT Gibbon Street Shaft, Brisbane
- Boggo Road Tunnel, Brisbane
- Airport Link Project, Brisbane
- Electrified Double Track Tunnel, Berapit (Malaysia)

### SPRAY APPLIED LINING AND TUNNEL INJECTION SEALING PROJECTS

- Cross City Tunnel, Sydney
- North Kiama Bypass, NSW
- M5 East Tunnel Sealing, Sydney
- Eastern Distributor Tunnel Sealing, Sydney
- M2 Tunnel Widening, Sydney

# BluSeal Tunnel Liner

## EXPERIENCE

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Bluey's four key offerings in major tunnel infrastructure projects, with proven experience and successful results



### PROJECT MANAGEMENT ACTIVITIES

Selection and procurement of specialist membrane welding & testing equipment

Training and supervision of local installers to meet the demand of numerous concurrent waterproofing work fronts

Materials handling and delivery from abroad

Quality control of both material supply and site installation

General site management of the installation works

### TRAINING

Bluey's Engineers specialise in onsite techniques to ensure that the Client, its designers and applicators receive full support during the entire material selection, installation and testing process. Bluey is able to offer training and quality inspections on site either directly or through third party trained specialists accredited by Bluey. For all of our products we are also able to recommend competent applicators who have experience in applying our range of products.

### PRODUCT SUPPLY

When Bluey is engaged for work on your project, you can be sure that you will have access to the best value products around the World.

Due to our ongoing work on large projects in the region, we have a broad understanding of the most efficient manufacturers of each product depending upon the size, location and technical details of your underground structure.

Bluey will work through the design process and ensure that the right product is selected to give the best outcome. Consideration will be given to the local environment, tunnel methodology, installation techniques, and performance criteria. Bluey will also take care of some of the more complex logistical issues such as selection of membrane roll lengths to reduce wastage, roll widths, container packing methods and delivery schedules to keep ahead of construction activities.

### SITE SUPPORT

Onsite, Bluey uses its experience in tunnel lining to ensure that waterproofing and drainage works are well managed so that you can get on with the more important task of building the tunnel.

We ensure that the design of gantries and membrane details are developed to ensure installation can keep ahead of concrete lining. Our role onsite extends beyond project management of membrane lining, for example, we will work together with shotcreting crews to ensure the quality is acceptable for membrane placement. Our experience will keep all parties satisfied that activities are being coordinated to ensure a good outcome for the Client.

Most importantly of all, we will develop systems of safe work in the tunnel environment to ensure that the waterproofing and drainage systems are installed without harm to others. We will take care of the procedures for handling and storage of plastic materials within the tunnel environment to significantly reduce manual handling requirements and also eliminate fire safety issues. Our experience in this field will prove to be a valued asset.

It is our job to plan every aspect of tunnel and drainage installation in your underground environment. Our Project Managers will guide you through the entire project to ensure that all aspects of the installation are considered and well planned for.



# BluSeal Tunnel Liner

## SYSTEM SELECTION

### WATERPROOF LINING SYSTEMS

Tunnel sealing and drainage systems typically fall into the following categories:

- Drainage Layer Linings
- Spray-on Liquid Membrane Linings
- Sheet Membrane Linings

### ASSESSMENT

These systems have varying application benefits and limitations

The system will generally be designed around final tunnel requirements for 'dryness'

Within the framework of other considerations:

- Site Conditions
- Economic Implications
- Concrete Lining Methodologies and Program
- International Standards

### SITE CONDITIONS

Ingress of water at the time of excavation and membrane application

Substrate preparations planned to be carried out

Underground access constraints



### ECONOMIC IMPLICATIONS

- Budget available
- Constructors risk perception depending on previous experience (fix it later)
- Not a budget priority to the contractor

### CONCRETE LINING METHODOLOGIES AND PROGRAM

- In situ concrete
- Shotcrete permanent lining systems
- Planned sequencing of the works

### INTERNATIONAL STANDARDS

- Specification for tunnelling, British Tunnelling Society and The Institution of Civil Engineers, 3rd Edition 2010
- DVS 2225 – Joining of Lining Membrane Made of Polymer Materials in Geotechnical and Hydraulic Engineering
- International Association of Geosynthetic Installers – HDPE and LLDPE Geomembrane Installation Specifications
- DS 853 - Deutsche Bahn AG - German Railway Standards

# BluSeal Tunnel Liner

## SURFACE PREPARATION

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### SURFACE PREPARATION

#### INSPECTION & ACCEPTANCE OF SHOTCRETE / SUBSTRATE SMOOTHNESS

Maximum aggregate size 4 to 10mm (depending on system)

Irregularities shall not exceed 200mm on any 1m curved edge

Cover or remove protruding objects such as rockbolts

Seal or divert running water

Maintain drainage prior to concrete pour



### DRAINAGE LAYERS

#### DRAINAGE LAYER LININGS

Technically not a 'watertight' liner

Provides an annulus drainage path

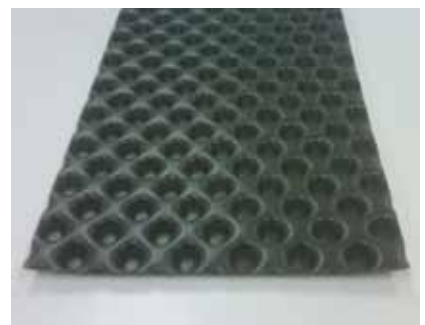
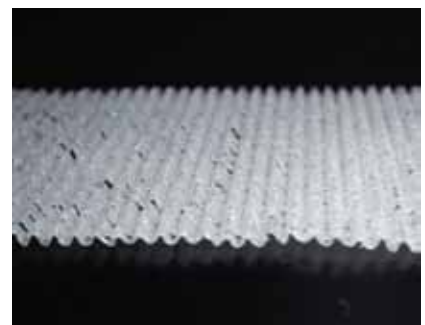
Alleviates the build up of external hydrostatic pressures on the structure

Typically used for tunnels constructed in good quality rock



### DRAINAGE LAYERS

#### DRAINAGE MEDIUMS





# BluSeal Tunnel Liner

## SURFACE MEMBRANE

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### SPRAY APPLIED MEMBRANE

#### SPRAY-ON LIQUID MEMBRANE LININGS

Developed out of their similar use within the mining industry

Have only been used on a limited basis world-wide for waterproof of tunnels

Materials include: acrylics / bitumen / cement latex / polyurethane / polyurea

#### SPRAY MEMBRANE USES

Remediation of rock-face weathering

Management of minor water infiltrations

Waterproofing membrane in specific cases



#### SPRAY-ON LIQUID MEMBRANE LININGS

Membrane can not be applied to damp or wet shotcrete surfaces

Consistent quality difficult to achieve in tunnel environment

Less durable than PVC or VLDPE sheet membranes

Generally not suitable for use in tanked tunnels



# BluSeal Tunnel Liner

## SHEET LININGS

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### SHEET MEMBRANE LININGS

Most robust and watertight protection for a tunnel structural lining

Impermeable water barrier between concrete lining and surrounding strata

Internationally recognised as the most reliable method of tunnel waterproofing

Used as either:

- 'Umbrella', shedding water from the tunnel 'crown' down into an invert drainage.
- Fully 'encapsulated' or 'tanked' structural lining, which limits water ingress.

### VARIATIONS IN SHEET MEMBRANE SYSTEMS

Material type and thickness

Drainage and protection layers

Welding and fixing methods

Secondary protection provisions

External compartmentalisation systems to maintain water tables

### INSTALLATION OF GEOTEXTILE FLEECE

Installed as membrane protection or drainage

Generally non-woven 100% polypropylene

Minimum weight of 700 g/m<sup>2</sup>

Flammability class B2







# BluSeal Tunnel Liner

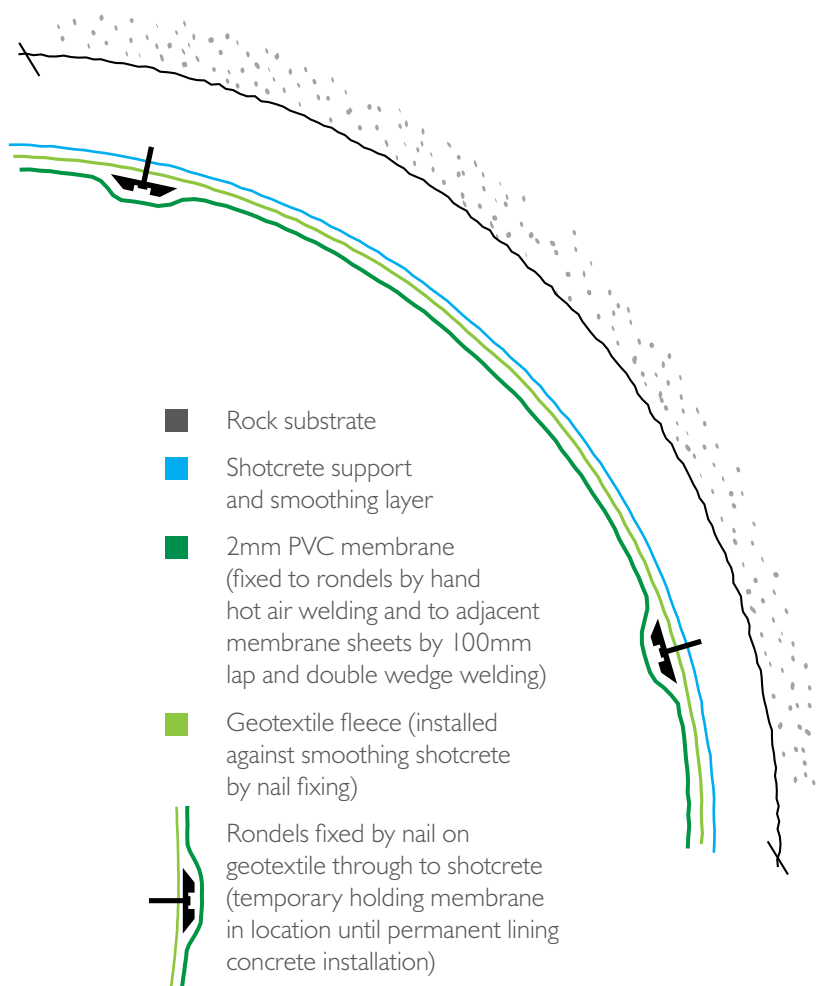
## SHEET LININGS

### INSTALLATION OF ROUNDELS (MEMBRANE FIXING DISCS)

Nail fixed through the geotextile fleece

Compatible for hot air (spot) welding to the sheet membrane

Fixed on an average of 1 per m<sup>2</sup> for walls and 2-3 per m<sup>2</sup> for crowns



### INSTALLATION AND WELDING OF MEMBRANE SHEET WATERPROOFING

Drained tunnels shall generally be 2mm thick

PVC-P or VLDPE

The membrane shall have a 'signal' layer

Flammability class shall be appropriate for the site

Heat weld to previously installed roundel fixings

Install with sufficient slack to avoid potential overstressing

Install 'snug enough' to avoid folds developing during concrete placement

All seams are pressure tested



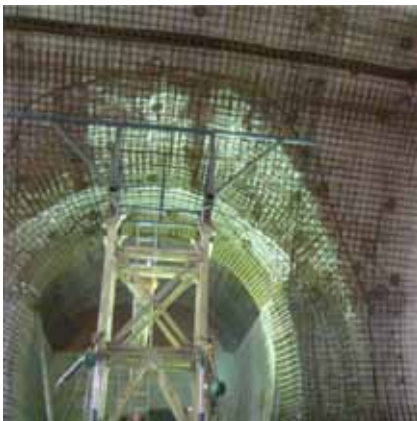
# BluSeal Tunnel Liner

## SHEET LININGS

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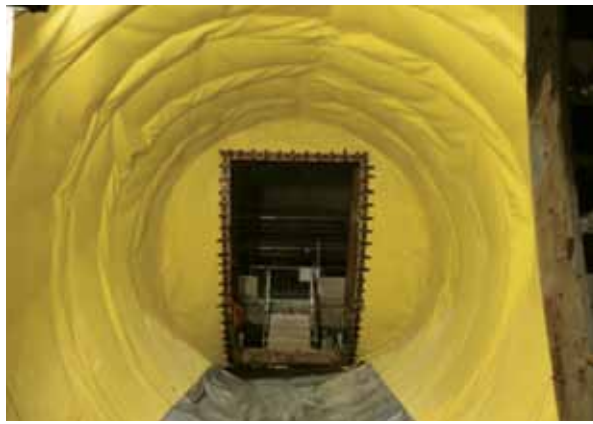
### PORTALS AND CROSS PASSAGES

Three way curvature  
Heavy reinforcement



### TBM CROSS PASSAGES

Connection to precast segments





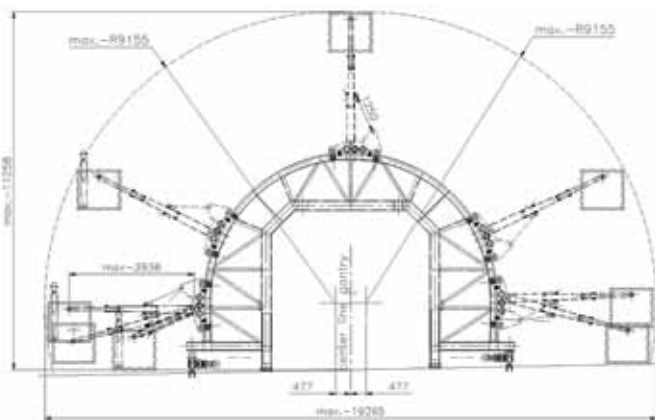
# BluSeal Tunnel Liner

## SHEET LININGS

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### INSTALLATION ACCESS EQUIPMENT

Fixed gantry, mobile or automated gantry



# BluSeal Tunnel Liner

## SHEET LININGS

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### TERMINATIONS

Pressure terminations  
Epoxy tape terminations



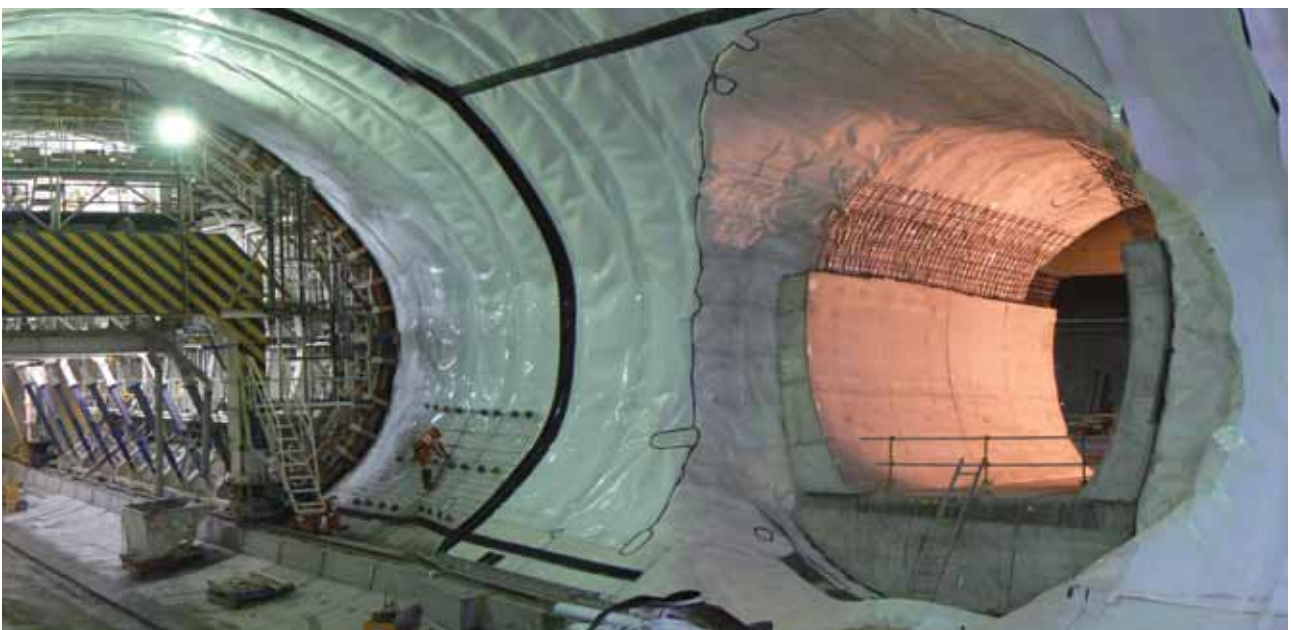
### PENETRATIONS

Through fixings (condom bolts)  
Drainage and grouting



### WATERSTOPS

Compartmentalisation  
Longitudinal and Radial





# BluSeal Tunnel Liner

## CASE HISTORIES

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### BRISBANE AIRPORT LINK PROJECT

Twin 5.1km tunnels connecting Brisbane city with the northern suburbs and airport precinct.

#### PROJECT DETAILS

- Drained tunnel
- TBM bored
- Cast insitu concrete lining
- 1 litre/s/100m tunnel length inflow
- No damp patches

#### SOLUTION

- Bluey designed unique dimple sheet fixings
- Materials selected to allow double seam welding and testing
- Manufactured in Norway to Bluey specification
- Bluey partnered German Installer Naue
- Project complete with no damp patches

#### FEATURES

- Drained and tanked tunnel profiles with associated groundwater drainage systems and external compartments between profiles
- System compatibility for both insitu concrete and shotcrete permanently lined tunnels
- Tanked connections between mined and TBM tunnels

#### BENEFITS

- Tunnel functionality for high speed tollway traffic flows with no 'drips' from above or visible damp patches from below
- Groundwater impacts minimised with tunnel inflows controlled and handled by the designed drainage and pumping systems



# BluSeal Tunnel Liner

## CASE HISTORIES

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### MELBOURNE EASTLINK PROJECT

Twin 1.6km tunnels under the environmentally sensitive community parkland area of Mullum Mullum Creek

#### PROJECT DETAILS

Fully tanked tunnel lining

40m water head

13 cross passages

#### SOLUTION

International Standard waterproofing design conformance

2mm and 3mm membrane double seam welding

Radial waterstop at every block joint

Bluey DVS qualified supervision

Every membrane seam pressure tested and verified

#### FEATURES

150,000 square metres of 2mm LLDPE sheet membrane to both the invert and obvert (arch) of the tunnels

Waterstop joint protection and lining compartmentalisation

External lining z-profile compartments

Post completion injection systems

#### BENEFITS

Minimal long term environmental impact on the surrounding water tables with nil effects on the Mullum Mullum creek water levels above

Negligible water inflows that needed to be handled by operational drainage pumping systems for the life of the tunnels





# BlueSeal Tunnel Liner

## CASE HISTORIES

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### EPPING TO CHATSWOOD RAIL LINK

12KM TWIN TUNNELS 7M DIAMETER

#### PROJECT DETAILS:

Drained tunnel  
TBM bored  
Cast in-situ concrete lining  
1 litre/s/100m tunnel length inflow  
No damp patches

#### SOLUTION:

Bluey designed unique dimple sheet fixings  
Materials selected to allow double seam welding and testing  
Manufactured in Norway to Bluey specification  
Bluey partnered German Installer Naue  
Project complete with no damp patches



### AUCKLAND NORTHERN GATEWAY PROJECT

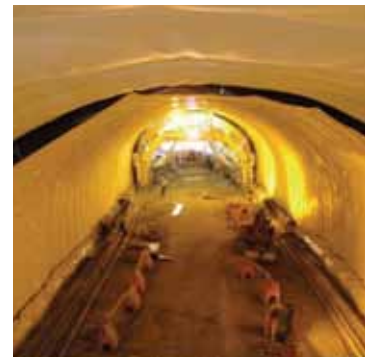
300M TWIN TUNNELS DUAL CARRIAGEWAY ROAD TUNNEL

#### PROJECT DETAILS:

Drained tunnel lining  
Environmentally sensitive  
Cross passages  
Road header excavation  
Cast in-situ concrete lining

#### SOLUTION:

International Standard waterproofing design conformance  
2mm and membrane double seam welding  
Radial waterstop every 50m  
Bluey DVS qualified supervision  
Client supplied labour for installation  
Every membrane seam pressure tested and verified



### SYDNEY CITY WEST CABLE TUNNEL PROJECT

SHAFT, BACK DRIVE AND CAVERNS

#### PROJECT DETAILS:

Fully tanked lining  
Aggressive ground water  
Sensitive electrical equipment  
Road header and hand excavation  
Cast in-situ concrete lining

#### SOLUTION:

International Standard waterproofing design conformance  
2mm and membrane double seam welding  
Radial waterstop at every construction joint  
Bluey DVS qualified supervision  
Subcontractor labour for installation  
Every membrane seam pressure tested and verified



# BluSeal Tunnel Liner

## PRODUCT SUMMARY

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### SUMMARY

Australia is an international leader in tunnel waterproofing applications.

Work standards have improved significantly in recent years through training and partnering programs.

Contractors are saving time and money by engaging the right methods, equipment and people at the early phases of project planning.

There is now a rapidly growing list of successfully sealed tunnels completed in Australia in terms of cost, program and final outcome for water infiltration.

We are striving to improve this record by working together with industry, learning from our experiences and continuing to engage international expertise.







# BluSeal Tunnel Liner

## PRODUCT SUMMARY

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# Bluey Technologies

## PRODUCT RANGE

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### bluCem

BluCem API0  
BluCem RF20  
BluCem FC  
BluCem HB range  
BluCem HE10  
BluCem HE80  
BluCem HE80AG  
BluCem HE80HT  
BluCem HS100 range  
BluCem HS200 range  
BluCem EA02  
BluCem GP60  
BluCem UF40  
BluCem UW range

### bluGeo

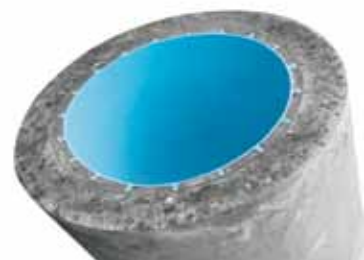
BluGeo Powerthread range  
BluGeo SD Anchors range  
BluGeo ST Rock Bolts range  
BluGeo Swellex range  
BluGeo Tekflex

### bluRez

BluRez Crackseal III  
BluRez Crack Seal 150  
BluRez Crackseal NV  
BluRez Carbostop  
BluRez Carbostop 42D  
BluRez Epoxy 225  
BluRez Epoxy 480  
BluRez Epoxy 480UT  
BluRez Epoxy 575 CG  
BluRez Epoxy 655

### bluSeal

BluSeal Anchor Knob Sheet  
BluSeal Britdex Membrane  
BluSeal Moulding Putty  
BluSeal Dust Control 10  
BluSeal Road Sealer 10  
BluSeal Containment Liner  
BluSeal PVC Tunnel Liner  
BluSeal Injection Kit





# Bluey Technologies

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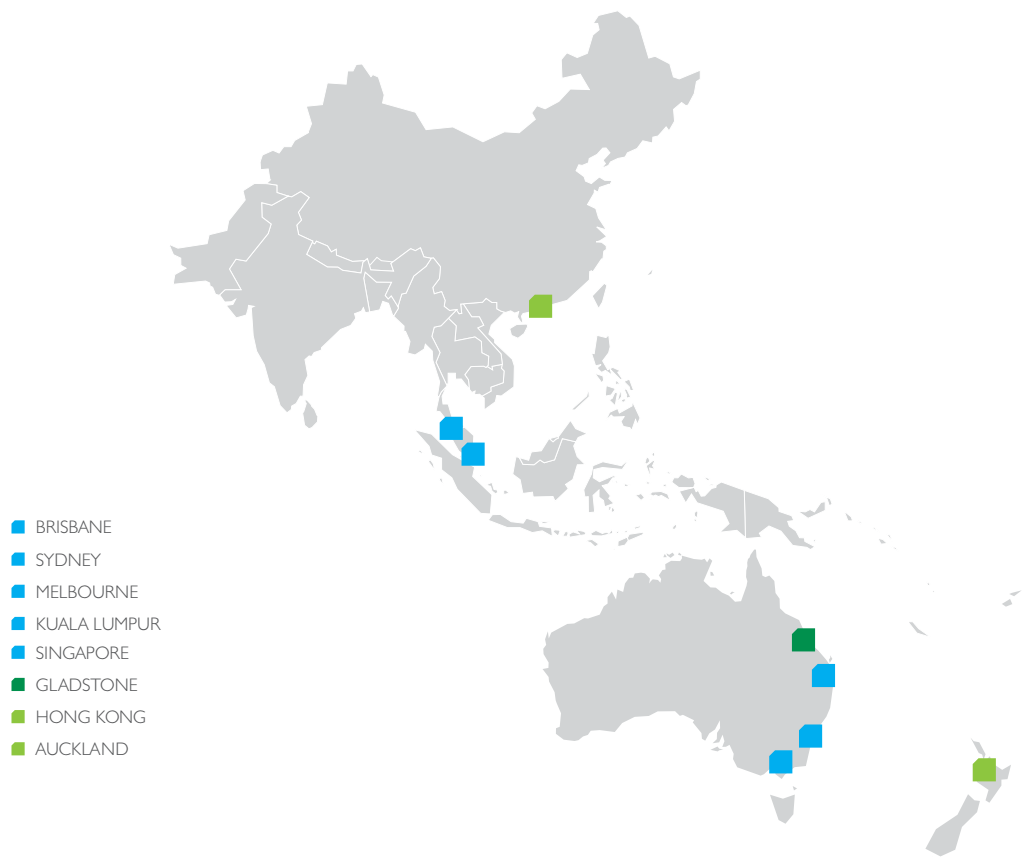
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