ANNEXURE B

Engineering peer review report

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Barwon Ovoid Sewer Aqueduct

March 2025
Revision 4

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Limitations

Our review is limited to a desk top review of the briefing material provided at this time, our inspection of the site from outside the exclusion zone and attendance at a trial of the grout bag system.
We have not undertaken any physical testing or similar investigations.

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Contents

Executive Summary

The Ovoid Sewer Aqueduct was constructed between 1912 and 1915 and carried the Geelong outfall sewer across the Barwon River. It was decommissioned in 1992 when a new sewer pipeline was built under the river. Safety risks posed by falling concrete from the deteriorating structure have meant the area around the aqueduct has been closed to the public since 1995. In 1991, the Aqueduct was added to the Victorian Heritage Register as a place of architectural, historical, scientific (technical) and aesthetic significance to the State of Victoria. In November 2020, Heritage Victoria granted Barwon Water a permit to remove 4 of the 14 spans of the aqueduct. The permit came with many conditions, including conservation works (propping) to manage the potential for the catastrophic collapse of the Aqueduct structure.

This report reviews numerous earlier studies of the condition of the existing concrete aqueduct structure, methods to repair and support it, risk analyses and heritage assessments.

Some of the earlier assessments or condition and remediation options have lost their currency due to ongoing deterioration and the impact that this has on the ability to undertake any work in the vicinity of the structure in a safe manner. The condition of the structure also requires exclusion zones to protect the public from both spalling sections of concrete and a more severe partial or total collapse that could occur when steel reinforcement is corroded or otherwise compromised to the point where the structure cannot support its own weight.

More recent reports focus on designs and protocols for safe demolition of the river spans so as to restore public access to the waterway. They also provide options to provide some relief to the loads in the concrete structure with the aim of prolonging the time before the ongoing deterioration leads to collapses. There are no recent studies that identify feasible methods of repair of the spalling concrete and corroding reinforcement to safely restore the structure.

I have concluded that ongoing deterioration and eventual collapse is inevitable and that the structure poses considerable risk to the public and anyone who needs to work on or near it. Methods to add support will prolong the time before collapse but the duration is unable to be predicted with any confidence. Support systems that do not relieve the current loads on the trusses may not extend their ability to support themselves for any time at all. A seismic or major storm event are also major risks to the weakened structure.

I have considered the merits of the schemes presented to prop all or part of the structure, whilst removing the river spans, as well as the options of “Doing Nothing” beyond providing a robust, secure exclusion zone and of full demolition. I have reached the opinion that full demolition is most likely to address the mutually exclusive issues of public safety, ongoing cost to ratepayers, cultural and environmental heritage and the accepted significance of this heritage concrete structure.

1. Introduction

The Ovoid Sewer Aqueduct was constructed between 1912 and 1915 and carried the Geelong outfall sewer across the Barwon River. It was decommissioned in 1992 when a new sewer pipeline was built under the river. Safety risks posed by falling concrete from the deteriorating structure have meant the area around the aqueduct has been closed to the public since 1995. In 1991, the Aqueduct was added to the Victorian Heritage Register as a place of architectural, historical, scientific (technical) and aesthetic significance to the State of Victoria. In November 2020, Heritage Victoria granted Barwon Water a permit to remove 4 of the 14 spans of the aqueduct. The permit came with many conditions, including conservation works (propping) to manage the potential for the catastrophic collapse of the Aqueduct structure.

Access under the structure is unsafe and has been prohibited since 1995. This prevents movement along the Barwon River, both on the water and by land. Concrete regularly falls from the structure and poses a serious safety risk. There is also a risk of structural collapse. Barwon Water has obligations to manage this safety risk under the OH&S Act so far as is reasonably practicable (SFAIRP), which it currently does through monitoring, signage and physical barriers (both land and river based) to prevent people from accessing near, on or underneath the structure. This SFAIRP assessment is dependent on Barwon Water implementing longer term controls including removal of the 4-spans over the river and installation of robust permanent fencing.

Since the granting of the permit in 2020, Barwon Water has been undertaking detailed investigations and design to ensure construction and public safety, while balancing the interests of Aboriginal cultural values, historic heritage values, and environmental values. The area surrounding the aqueduct on the northern side of the river is Porronggitj Karrong. Porronggitj Karrong is a cultural and community precinct of potential national significance. Barwon Water is working in partnership with Wadawurrung to re-imagine the 66-hectare site which has high ecological, heritage, cultural and recreational value.

In seeking to deliver the primary objective of removal of the four river spans a redesign journey has been progressed in an attempt to develop an approach that does not require personnel working underneath or inside the structure, or within its potential collapse zone, due to the risks to workers. In the process, it has become evident that there are significant safety challenges to deliver the scope under the existing Heritage Victoria Permit (P32806), and any alternative option that includes propping.

This report provides a comprehensive independent engineering peer review by Phillip Gardiner, a Structural Engineer with considerable expertise with heritage structures. A copy of Phil's CV is appended to this report.

The report covers the engineering design options completed to date and recommended pathways forward. The engineering review of the design options considers safety and constructability factors, as well as consideration of the existing heritage structure and, in the event of retention, any implications for future uses of the surrounding area(s).

Image of a typical balanced cantilever truss and pier arrangement. Note that the top chord and diagonal members are in tension whilst the bottom chord and verticals are in compression

1.1 History of Construction (Paraphrased from Lovell Chen Heritage Impact Statement April 2020)

Designed and constructed by the partnership of Ernest J. Siddeley and Edward Giles Stone, the Aqueduct was constructed of reinforced concrete using an innovative reinforcement method promoted by French engineer Armand Considère.

The Aqueduct truss system (example above) contains more than 896 discrete concrete elements (64 main truss elements at each of the 14 piers, with additional lateral elements). These elements were poured in-situ using the Considère system of steel reinforcement and serve in concert to carry the loading of the structure. Many of the truss elements are narrow, with a very thin concrete cover (often less than 60 mm).

In addition to the truss elements, the Aqueduct structure also comprises the segmented walkway, ovoid pipe and connecting hangers. In between each truss span, these elements serve together as a bridging girder of varying length (Figure 5). The pipe and pipe hangers were precast, while the walkway, balustrades and pier structures were poured in-situ.

The Considère system includes an unusual set of elements that act purely in tension, a loading regime in which concrete is inherently weak and is rarely used. The Aqueduct was modelled after a steel truss railway bridge in Scotland, the Firth of Forth Bridge outside of Edinburgh, and the unsuitability of reinforced concrete in this type of application was seemingly not understood at the time of the Aqueduct's design and construction.

1.2 Initial Views Following Document Review, Site Inspection and Grout Bag Trial.

The issues the proposed conservation and demolition work to the Barwon Ovoid Sewer Aqueduct present are complex in the context of the aims to preserve engineering heritage, the need to ensure the safety of any workers or public, the aspirations to restore access to the river and flood plain and the economic implications of undertaking the works.

The objective of this report is to provide an independent structural engineering review of the options presented over many years and offer my opinion on their viability and likely outcomes.

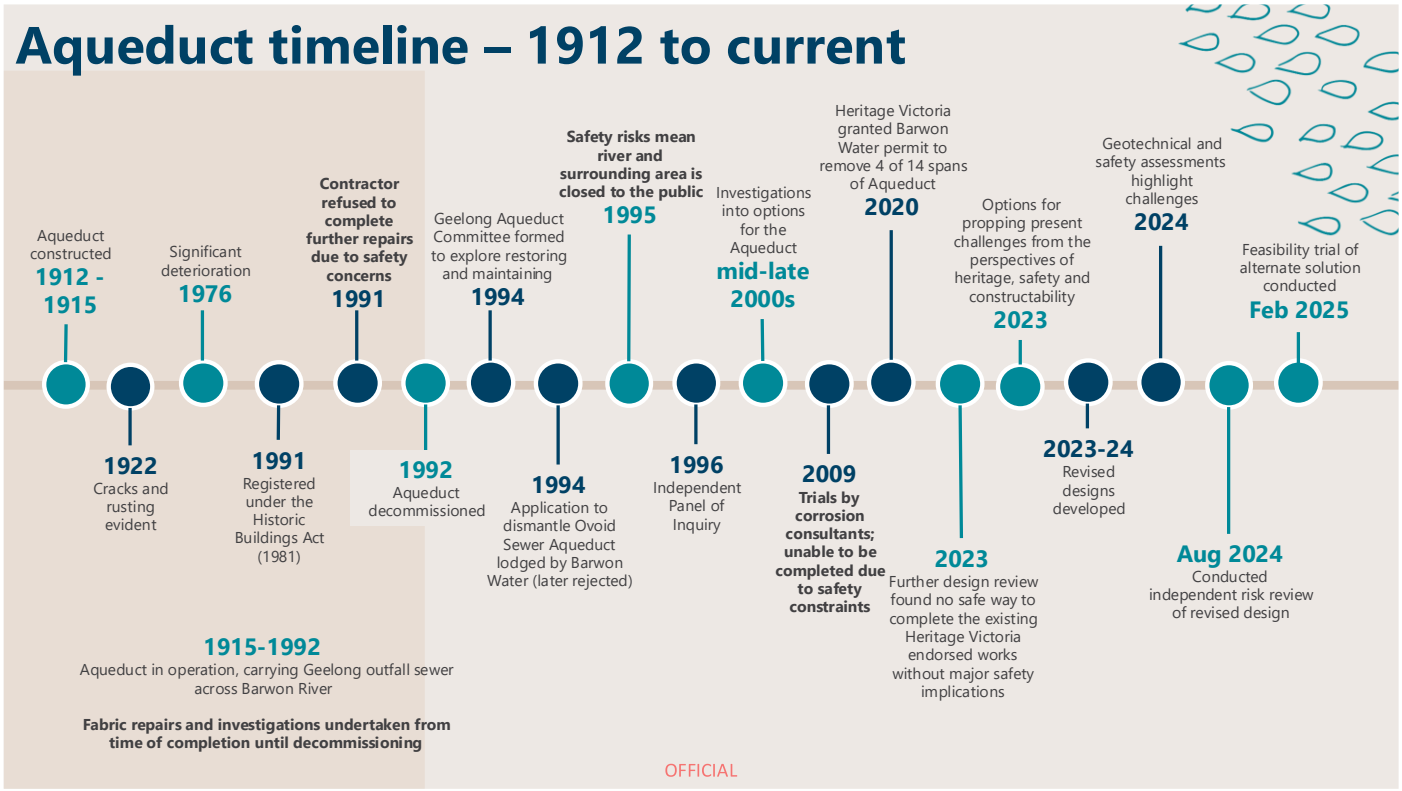
Numerous remediation solutions have been proposed going back to the 1990's. The timeline provided

below notes cracking soon after construction (perhaps to be expected given the construction type and methodology) with significant deterioration being present in 1976. The ongoing deterioration and increased safety risk since that time has reduced the viability and validity of the earlier proposals for remediation and conservation.

Whilst the earlier reports give good context and valuable background reading, we have focused our review on the more viable and contemporary proposals from 2014 onwards, starting with the MacLeod Consulting report.

These later reports were written when the level of deterioration was approaching what we see today.

Our comments on each follow.



Barwon Water Aqueduct Timeline

2. Review of Previous Reports

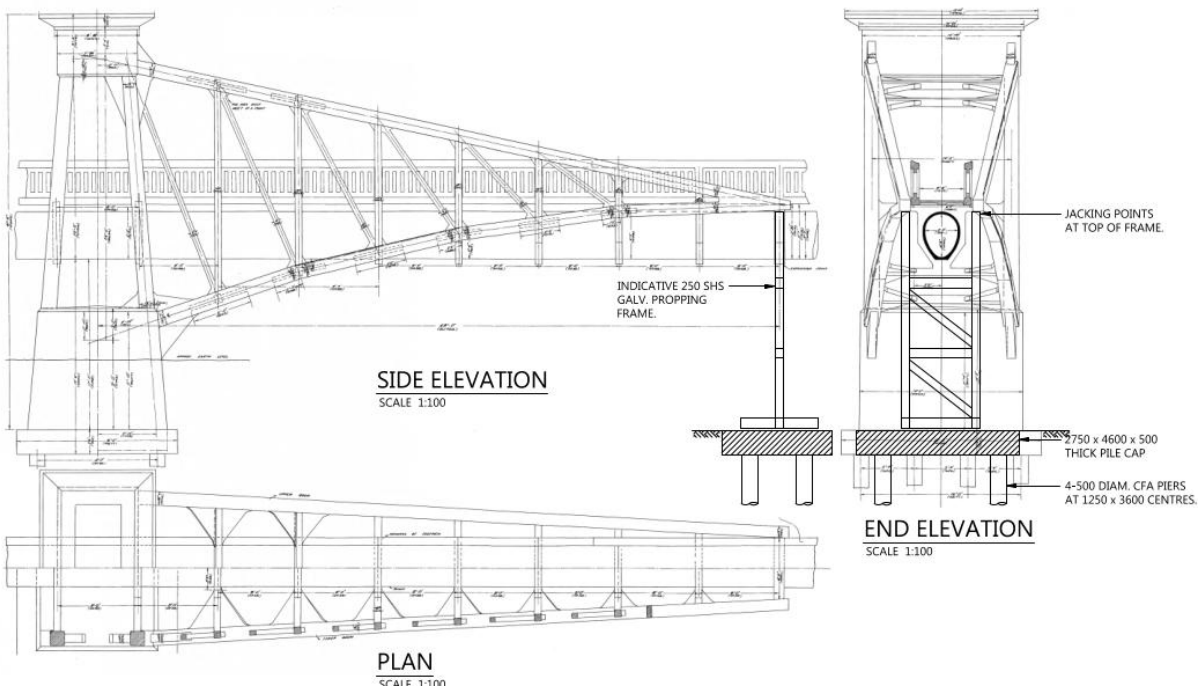
2.1 Barwon River Ovoid Sewer Aqueduct Engineering Study: Options for Partial Demolition and Conservation of the Structure. MacLeod Consulting 2014-2016

This report gives a good overview of the structure, its condition at the time and summarizes well the findings and recommendations of earlier reports.

Schematic drawings of a truss propping system, shown below, were presented along with a conclusion that the river spans should be demolished with propping of the remaining spans, capping of piers, safety fencing and an observation platform in a safe zone for public viewing. This assumes that the structure will continue to deteriorate and eventually collapse. There was no indication given about the extended life resulting from these works and we agree that this would be difficult to assess.

This also determines that there should be no public access under or near the structure.

These recommendations still have some currency; however, the propping detail is not resolved in detail, it is a concept only and does not lend itself to the safe work practices that would protect workers from the risk of loose and spalling pieces of concrete during installation, let alone a major collapse. It did include a jacking system to reduce the loads in the truss members. This would serve to further prolong the time before failure.



Macleod Consulting Propping Proposal 2016

2.2 Barwon Sewer Aqueduct, Structural Options Assessment. GHD 2017

This report elaborates on MacLeod's work to include the preliminary designs for alternative truss and catenary options for the support of the trusses and walkway spans, shown below, in conjunction with a potential solution for safe land access under the structure via a culvert. The GHD analysis identified the possibility of a sudden non ductile major collapse following the failure of a critical tension member in the existing concrete trusses. This could occur if the reinforcement corrodes to the point that it cannot carry the imposed loads. There is evidence that this form of corrosion is well advanced in a number of locations. See photos below from the GHD and Arup assessments. We also witnessed several heavily corroded tension members when we inspected the site.

We concur that this form of collapse is possible and a significant risk.

Photograph showing Spalled Concrete and Corroded Reinforcement to Truss Bottom Chord (Compression Member) and Truss Top Chord (Tension Member)

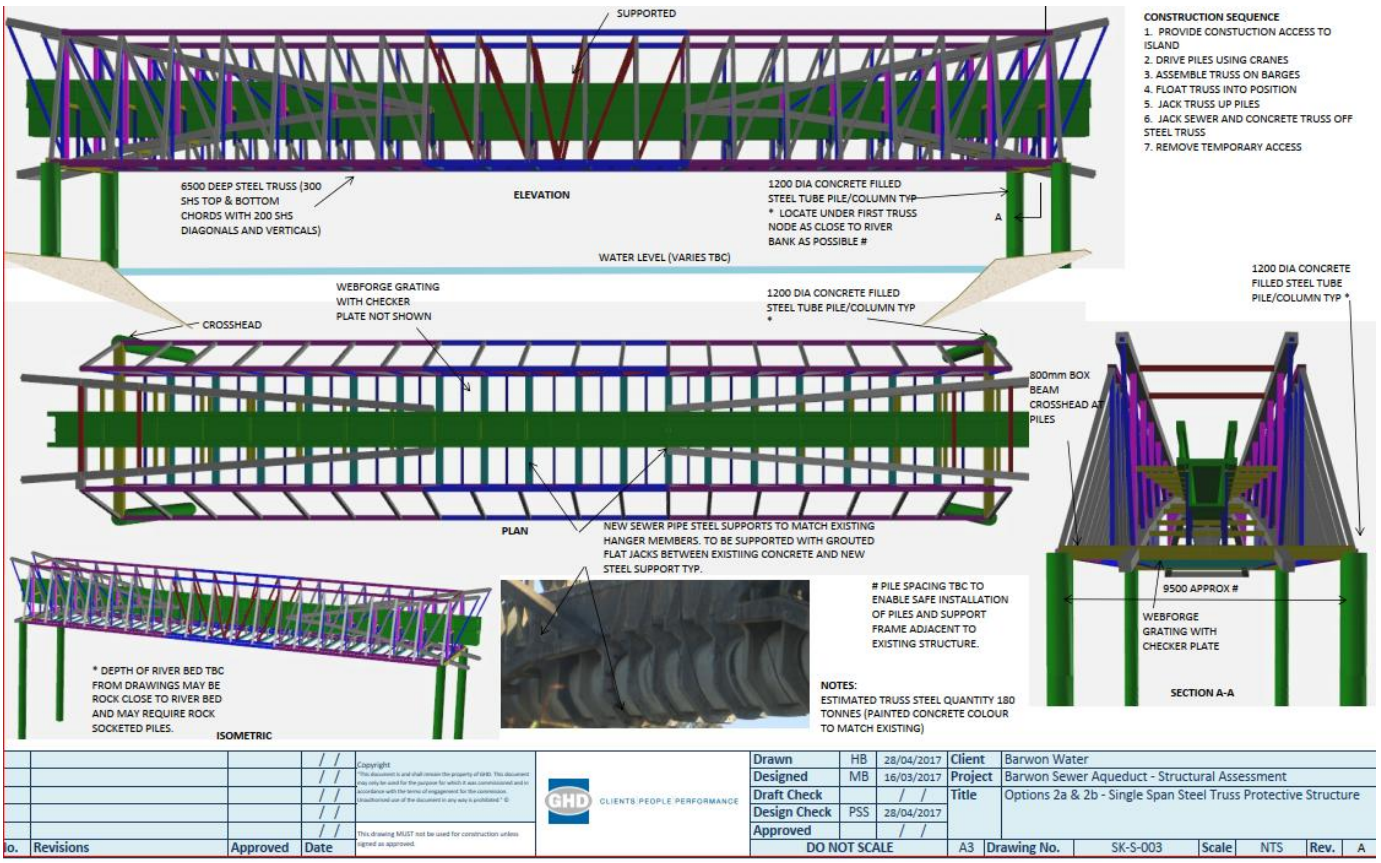
Extracted from GHD Report May 2017

Chord tension member with considerable spalling and corrosion of primary tension reinforcement. Note dislodged main bar. Extracted from Arup Condition Report August 2024.

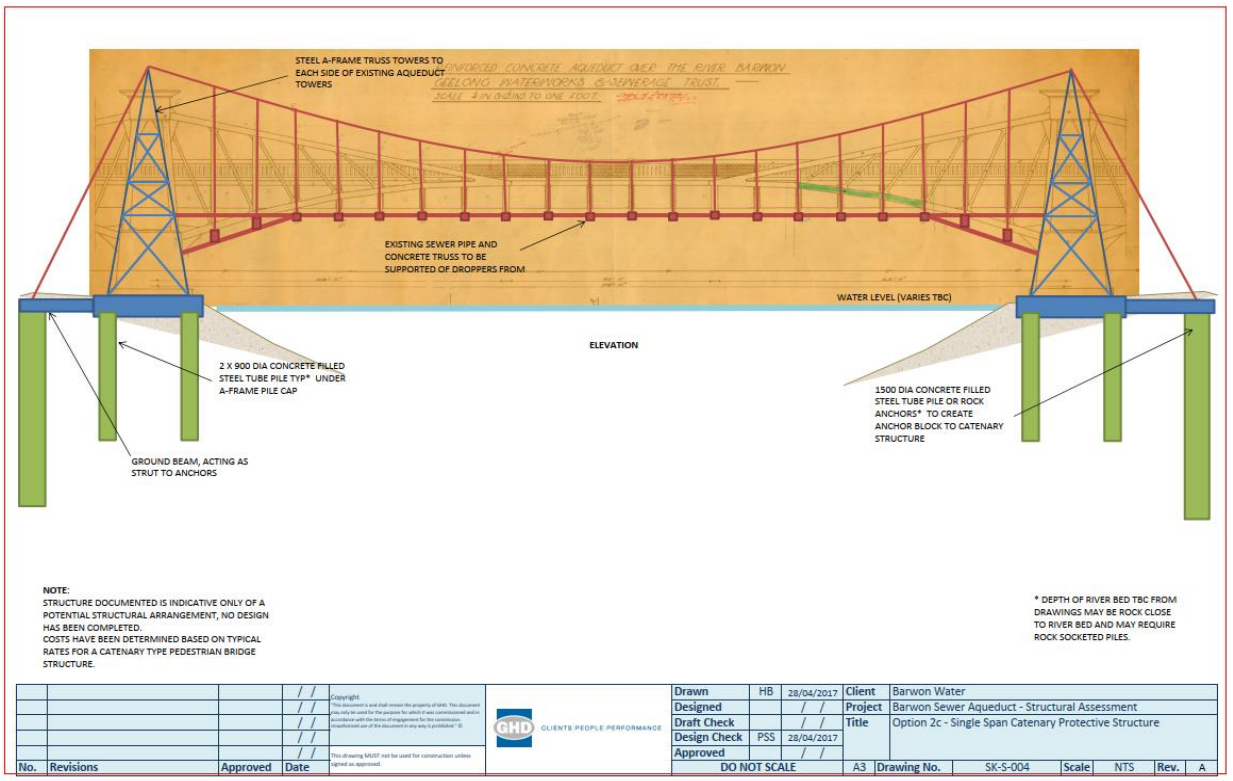
GHD's Structural Options Assessment Report (2017), also considered concrete repair options to be undertaken following the propping but concluded these were not feasible given the advanced state of deterioration and likely capital and recurrent costs.

The solutions proposed to provide support do not look as efficient as those of WGA or Arup that are discussed later. They do not address the buildability and safety of installation and again only extend the time before eventual collapse and do not prevent it.

They explored a full truss encapsulate-and-support system and a catenary suspension structure as shown below.



GHD Full Truss Support Option



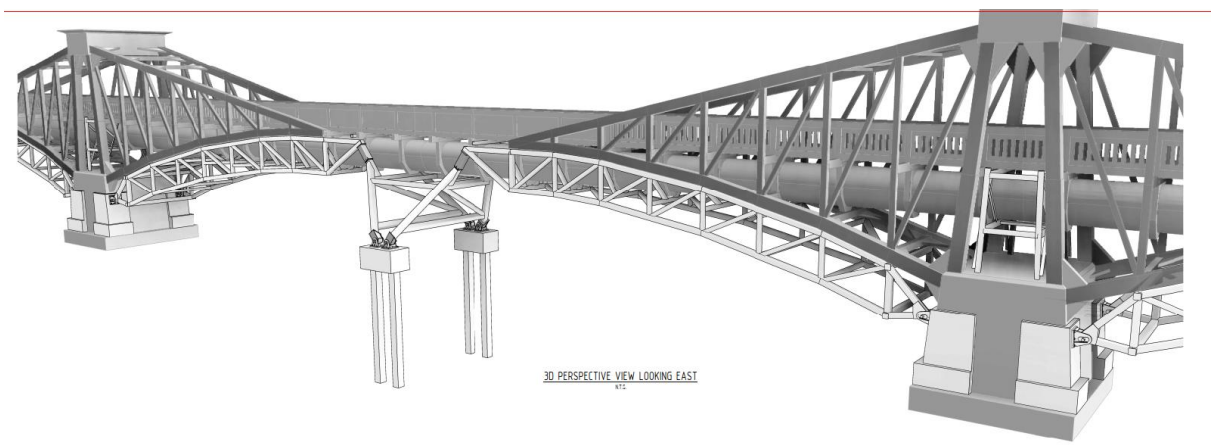
GHD Catenary Support Option

2.3 Barwon River Aqueduct, Demolition and Propping. WGA Full Prop Option Endorsed August 2022

The WGA design (endorsed August 2022) considers demolition of the river spans and full propping of the trusses in the remaining spans. It is a design proposal only and does not address the condition or remediation

The proposed new support structure shown below is elegant and well considered as it has a structural synergy with the original trusses but again is not likely to be safe to construct as currently documented as it requires work by personnel immediately beneath the structure where the risk of falling concrete or a more significant collapse is unacceptable. This solution would further extend the time before but not prevent eventual collapse and ongoing spalling.

This design option does not address capping or any other remediation to the piers but does take significant load from them above the foundation level. It does not provide safe public access across the site.



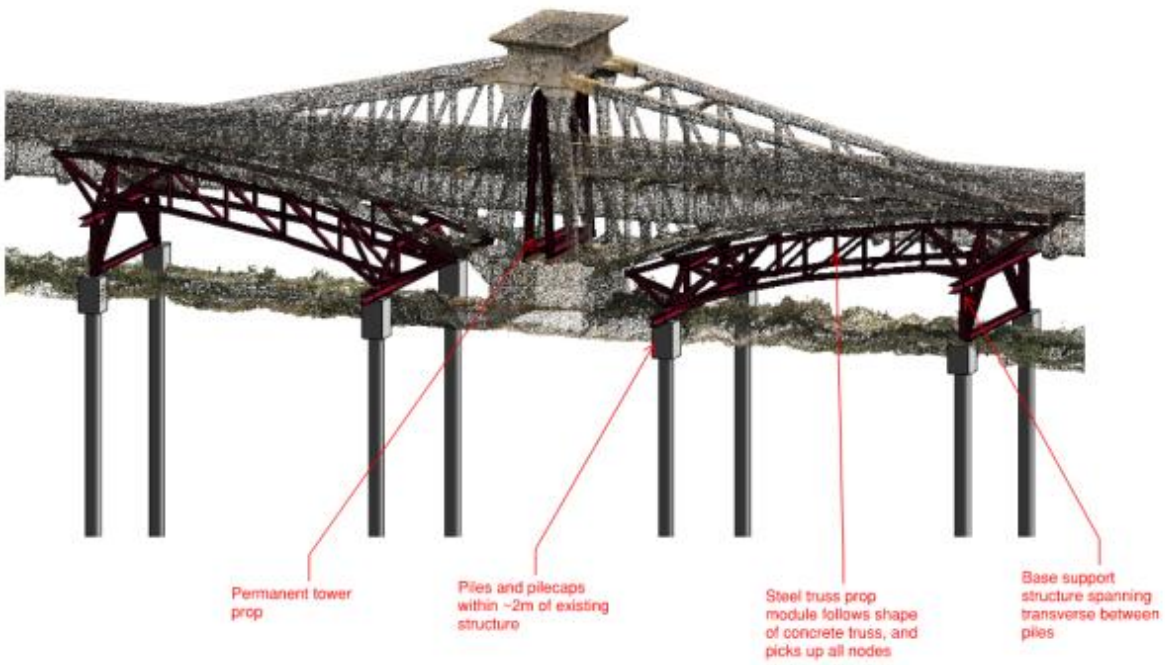
WGA Full Prop Option (endorsed design - August 2022)

2.4 Barwon River Ovoid Sewer Aqueduct, Demolition and Propping. Arup Option 1, Full Propping of Trusses July 2024

Arup have prepared multiple iterations of design options following extensive studies of the condition, risk evaluations and structural analysis of the implications of propping on truss member loads. The option shown below has a similar intent to the WGA proposal but with changes to add more piles to remove the need to support new propping from the existing pier base structures. They propose adding a restraining system to the piers to address a low-probability but high-consequence failure of a pier structure during the works. This permits a temporary 1m exclusion zone for the works to be undertaken. It is less effective to help preserve the structure in the longer term.

The structure is perhaps less elegant in appearance than the WGA proposal and has similar buildability/safety shortcomings albeit slightly mitigated by locating the new piers 2m from the footprint of the trusses and providing the potential to slide the trusses into position but still requires access to unsafe areas to complete the works.

Like the previous options, ongoing deterioration of the existing concrete structures and eventual collapse is accepted as inevitable and unsolvable.



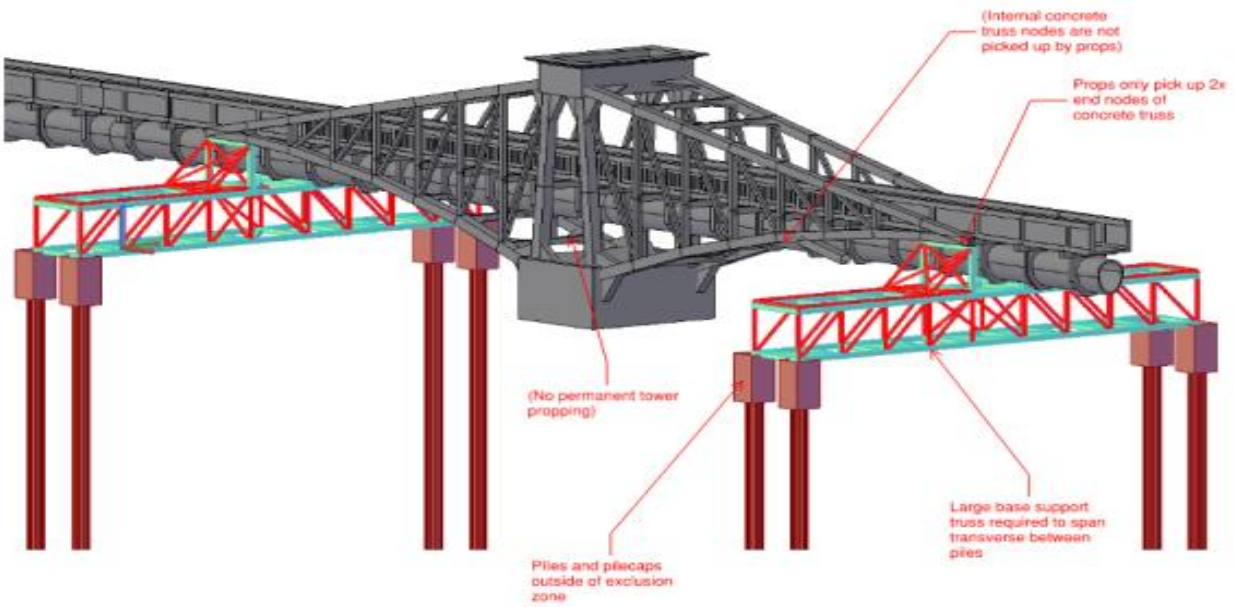
Arup Full Prop Option July 2024

2.5 Modular End Propping Feasibility Report and Concept Design. Arup Option 2, End Propping of Trusses. November 2024

This report was prepared to confirm the feasibility of an alternative design option to address concerns of the implications of buildability and safe work practices related to Option 1.

This report contains the proposal shown below which returns to something closer to the MacLeod propping and partial demolition proposal, but with a more considered solution that has the potential to be constructed with manageable risk to workers during installation. It will not prolong collapse for as long as Option 1 (refer section 2.4). The reduction in duration would be impossible to quantify as would the time of any collapse. A shortcoming of this proposal is that the system of support and restraint using the grout bags above the truss locks in the effect of the weight of the walkway sections of the spans after they are removed thereby not reducing the forces in the trusses. This therefore does not reduce the likelihood of failure due to corrosion and spalling of concrete. This propping is

effective as part of the safe demolition of walkway and river spans but does not contribute measurably to any extended life of the structure. This option may be considered less aesthetically pleasing than the proposals covered in earlier sections and still results in a “noble ruin” but with the addition of less relevant propping structures also in place until safe to remove.



Arup Modular End Prop Proposal

2.6 Simpson Buildability Proposals. Early 2023 – October 2024

These seem well considered for all options, addressing the safety risks for workers and buildability issues. They demonstrate the issues with the construction of Arup Option 1 and provide preliminary Safe Work method protocols for full demolition. Their alternative demolition and propping proposal shown below informed the development of Arup Option 2 and is consistent with the design proposed.

Their proposal to use grout bags to account for irregularities in the truss shapes is a good one but we note the installation pressure of the grout is not sufficient to take any load off the trusses and the use of a restraining plate and bag on top of the trusses, whilst helping stabilize the structure during demolition of walkway spans, ultimately acts to lock stresses into the trusses that would otherwise be removed. We elaborate more on this in the following section.

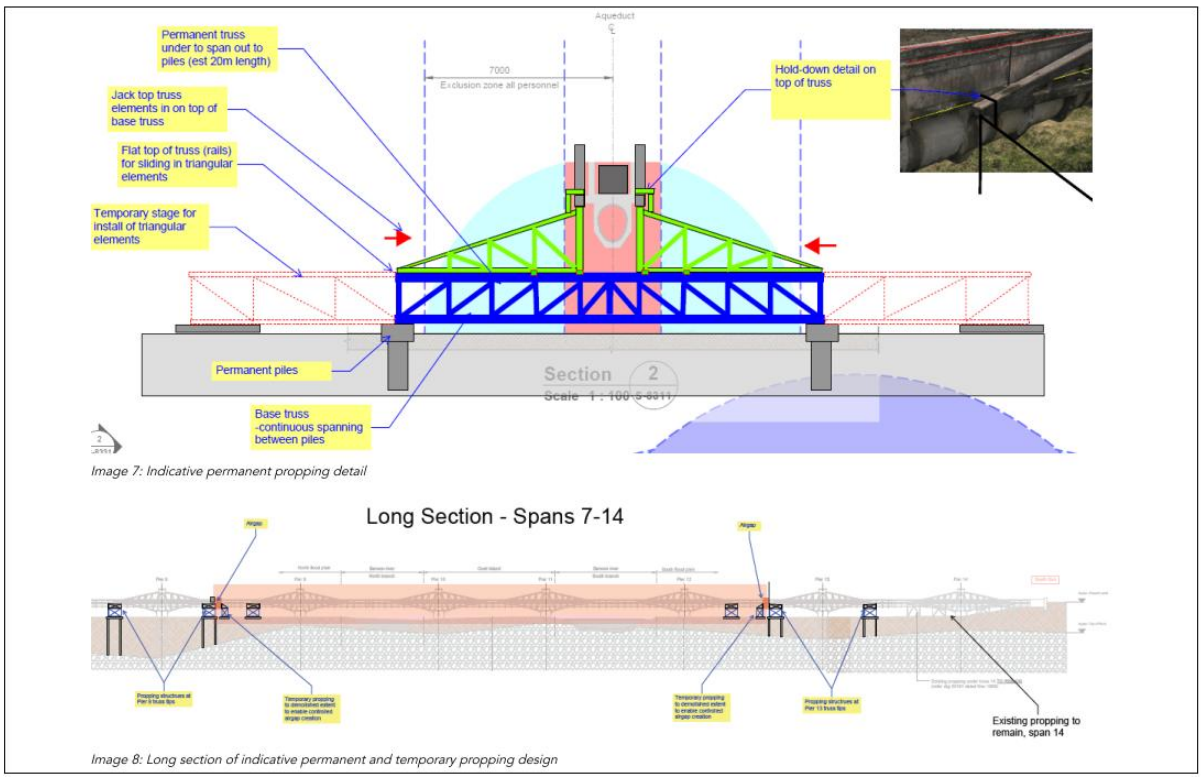


Image 7: Indicative permanent propping detail

Image 8: Long section of indicative permanent and temporary propping design

3. Current Opinions

Demolition of the river spans is a given as it is the only way to open the river for access to that part of the cultural precinct by both land and boat. Whether the associated piers are kept or removed requires more consideration. If the safety of demolition of the spans can be managed whilst keeping the piers they may remain standing for a considerable period once the load is removed from them.

The options for the remaining spans include –

3.1 Full Demolition

This requires little explanation. It deals with public safety, is safer than propping during the works and returns the flood plain to public access along with the resolution of environmental and cultural heritage issues that are dealt with by others. Demolition puts a full stop on the issue and removes any burden of ongoing costs for safety and maintenance.

3.2 “Do Nothing”

This presumes the structure will decay, collapse and remain a noble ruin. Collapse is likely to include continuing and accelerated spalling of concrete followed by the failure of truss members once the reinforcement is compromised to the point it can no longer support the imposed loads. This will result in a sag or a more catastrophic failure with a progressive collapse of adjacent members as they are subject to load redistribution. The balanced cantilever design relies on balanced loads as the name suggests. Removal of load from one side would cause a seesaw effect that could propagate along the fully length of the structure.

This option presents ongoing risks to public safety that will need to be mitigated by secure fencing to prevent access from both the land and the river, as well as monitoring, noting that the area is remote, in a flood plain subject to inundation and that fencing will require significant maintenance for many years.

There is also the risk that the area becomes unsecured during and after a flood event or that “trespassers” could scale the fences without much difficulty to access the structure.

The only advantage of this approach is that a piece of significant engineering heritage remains somewhat intact for a longer but indeterminate period before eventual collapse.

3.3 Arup Option 2, End Propping of Trusses

The Arup Option 2, or a similar propping system, appears most likely to be feasible if the benefits of propping are accepted. These benefits being an extended but unquantifiable period before the truss members fail under load due to deterioration. A critical tension failure, as described above, is likely if not imminent unless a propping system that removes some load from the trusses is used. The more load removed the longer the structure will stand before a significant collapse. This is discussed further below.

The life could be extended further by relieving load on the trusses. This could be done by jacking at the base of the new supporting steelwork via interlinked flat jacks with a rubber bearing or grout bag between new steel and existing concrete.

This accommodates irregularities in the shape of members, does not require physical access in an unsafe zone and allows jacking to be undertaken in a controlled and calculated way.

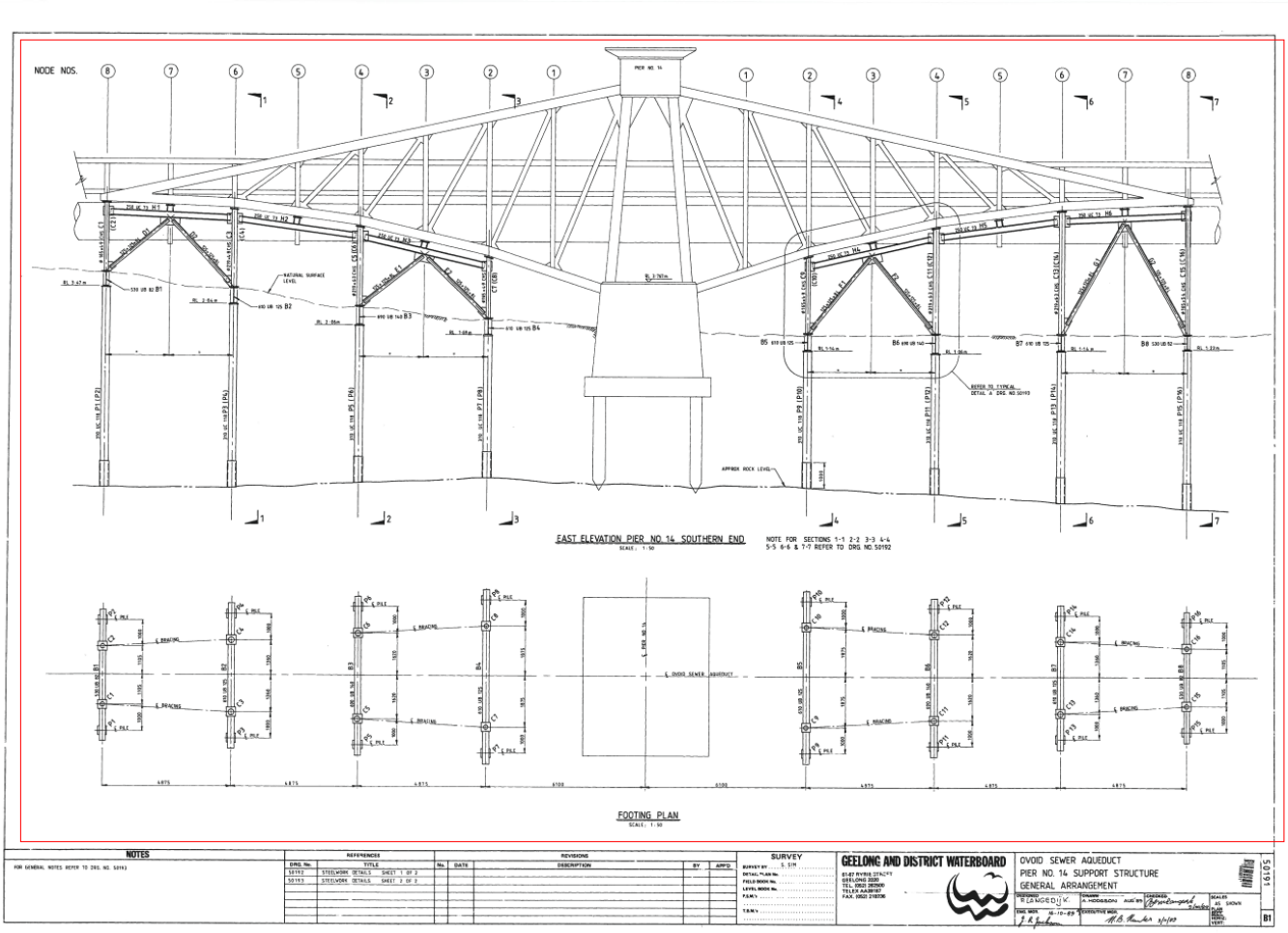
Further analysis would be required to calculate the optimum amount of jacking to relieve loads on the trusses. However, this will only extend the period before the inevitable collapse.

The risk of a sudden failure of a tension member remains if the load is not relieved. This could propagate further failures in truss or pier members as the load redistributes.

The durability of new steel structures is an issue that needs to also be considered as they will not be able to be safely maintained after installation. This is a major limitation on the value of any propping solutions.

Options such as cathodic protection could be considered but they also need ongoing maintenance. The steelwork may last until the inevitable collapse of the concrete structures or may not.

This is evidenced by our observation that the propping that already exists (refer images below) under the Southernmost spans shows signs of corrosion and notably the tops of the beams are holding many significant pieces of spalled concrete. We note the date on the drawing is October 1989 and understand the propping was likely installed in 1991. Planned further works were halted when the contractor withdrew due to safety concerns.



Existing Southern Spans Propping Design Drawing. 1989

This propping replicates but predates the intent of the WGA Full Prop and Arup Option 1 designs but with many more foundations along the truss span.

We note that it made no provision to jack load into the truss to relieve stresses but rather was there to support the truss if it "sagged" due to member overload as they deteriorated.

The image below taken during our site visit shows that it continues to do what it was designed for albeit it is showing signs of corrosion. Repainting or otherwise protecting the steelwork would not be easy to undertake safely given the advanced deterioration and spalling concrete.

Image Showing Spalling and Concrete Pieces on top of Steelwork Propping Southern Spans

4. Further Considerations/Options

What is the public benefit of the truss end propping if it only prolongs the life by a limited time and does not open the floodplain to public access given safety concerns and eventually results in a ruin impacting the access, ecology and cultural heritage?

If the do-nothing proposal is adopted the implications on access and ecology etc continue for an indeterminate time. If this is adopted fencing needs to be more robust, able to deal with inundations and hopefully have less impact on visual amenity.

Even with fencing the risk of unauthorized access remains as the site is readily accessible and the fences could be climbed putting any "trespasser" at risk from falling concrete or worse. Non scalable fences are usually constructed in a way that does not have hand or toeholds and is capped with an overhang or "barbed wire" to increase the difficulty of climbing. Such a fence will not be likely to meet the requirements for flood plain management and also unlikely to be aesthetically acceptable.

Full demolition resolves all issues except the preservation of structural heritage. A post-demolition option may include representative examples of this significant *Considere* structure could be carefully removed during demolition and relocated to a public place where they can be exhibited in their current state. Single truss and walkway elements would be relatively simple to retrieve as part of the demolition works. Maintaining more intact assemblies of members in a truss format would require a significant engineering exercise in itself. It could also be that any elements retrieved for display lose relevance once not seen in context.

The currently propped Southern spans could be left in place as a part “Do Nothing”option, acknowledging that the props are deteriorating and that this part of the concrete structure is perhaps in a worse condition than most of the other spans. This gives back access to most of the floodplain and keeps the sections that are most accessible for viewing. We need to acknowledge the risk though of injury to any members of the public who choose to enter the exclusion zone.

Safe work methods to maintain the steelwork would be challenging and without repainting the steel will also become compromised in time.

Hybrid alternatives have been considered including partial demolition, with full propping of a number of spans to preserve them for a longer period, in the way the MacLeod and Arup full prop options proposed. These considerations did not identify a way this work could be done safely. Public safety from unauthorized access to propped spans and maintenance of effective exclusion zones were also deemed unacceptable.

5. Conclusions

The time for preservation to be viable has passed and attempts to prop the structure come with considerable construction risk, at likely significant cost and with no guarantee of the structure continuing to stand for any reasonable time, to justify the expense. This also needs to be balanced against the restrictions on access to the flood plain due to safety concerns and other impacts on the environment, natural and cultural heritage. I also note that demolition incurs a significant cost and some risk, albeit a lower safety risk than propping for partial retention in both the short and long terms.

The ultimate decision is a sensitive balance of cost and benefit that is beyond our expertise to determine.

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Arup, Modular Propping Grout Bag Trial (drawing) December 2024.

StructexAu

Phil Gardiner
Director & Engineer
Structex Australia

Phil has over 45 years' experience in engineering consultancy across all types of buildings and engineering structures. For 20 years he was Managing Director of Irwinconsult before its acquisition to WSP in late 2018 where he was a Principal Director. He founded Structex Australia in 2024. Phil's broad experience includes low, medium and high-rise commercial and residential buildings, large clear span and high bay industrial developments, heritage and cultural institutions, educational, sporting and healthcare facilities, as well as maritime, transport and other civil engineering structures.

A major contributor to both structural and multidisciplinary design teams, Phil is known for his innovative and lateral design solutions and his support of significant and challenging architecture. His expertise is highly sought for significant architectural structures across Melbourne and for tall buildings and modular remote developments in Darwin.

Phil's project base includes structural consultancy in Hong Kong, Malaysia and the United States as well as all Australian mainland states. He is a leader both technically and managerially and regularly invited to present at seminars and tertiary institutions. Phil is a keen contributor to the property industry, having sat as a committee member for the Victorian Property Council, a National advisory committee member for the Property Council Mentor program, a member of the Victorian government design review panel for the OVGA and on the Victorian Committee for the Council on Tall Buildings and Urban Habitat.

CAPABILITY SUMMARY

- Structural Engineering
- Design Management
- Multi-disciplinary Project Coordination
- Value Management

PROFESSIONAL QUALIFICATIONS

- Bachelor of Engineering (Civil) (Hons), 1979

PROFESSIONAL ASSOCIATIONS

- Fellow of the Institution of Engineers Australia - Chartered Professional Engineer
- Victorian Registered Building Practitioner, Endorsed Building Engineer PE0001522
- Registered Professional Engineer Queensland (RPEQ)
- NT Practitioners Board Registration - Certifying Engineer (Structural)
- SNXG, Swinburne Engineering Excellence Group, Industry Fellow
- Hon.FRAIA, Honorary fellow of Royal Australian Institute of Architects

EMPLOYMENT SUMMARY

- Director Structex Australia 2024
- Director Technotia Laboratories 2024
- Principal Director at WSP in Australia , 2019-2024
- Director Irwinconsult a WSP Company Irwin consult a WSP Company - Jul 1987 - 2023 · 36 yrs

HERITAGE PROJECT SUMMARY

Phil has led and acted as structural designer on a wide range of heritage structures over his entire career. The following is a sample of some of his experience.

- **Riversdale Gallery, Illaroo, NSW (2017 - Present): Bundanon Trust, Kerstin Thomas Architects, Project Director**

  The design for Riversdale showcased the Trust's $43 million collection of Boyd works. A Creative Learning Centre will house the Boyd Gallery and contemporary spaces for performances and learning. The new residential wing tripled the Trust's current accommodation capacity.

- **State Library of Victoria, Melbourne, VIC (2015 - 2019): Department of Infrastructure, Project Director**

  An $83.1M redevelopment including restoration of the historic Queen's Hall, the reopening the library's Russell Street entrance, an e-Town Hall and new spaces for early learning, digital media, entrepreneurship and exhibitions.

- **Geelong Library & Heritage Centre, Geelong, VIC (2016): City of Greater Geelong, Project Director**

  This culturally significant and state of the art institutional structure, features a discontinuous GRC dome shaped roof and façade. A cascading arrangement of irregularly faceted floorplates, some of which are suspended from the roof structure infill the dome shape.

- **Royal Exhibition Building, Melbourne, VIC (2015 - Present): Major Projects Victoria, Project Director**

  Major conservation works as well as a project to greatly improve access for the public to visit and appreciate this magnificent world heritage building.

- **Shrine Galleries of Remembrance, South Melbourne, VIC (2012 - 2016): Development Victoria, Project Director**

  Structural design for the internal environment and new courtyards, ensuring the preservation of the heritage artefacts on display. This was achieved within and below the heritage icon that is the Shrine of Remembrance.

- **Warrnambool Entertainment Centre (Lighthouse Theatre), Warrnambool, VIC (2010 - 2012): Warrnambool City Council, Project Director**

  The Warrnambool Lighthouse Theatre redevelopment and revitalisation provides the complex with modern facilities including a 'Black Box Theatre', new seating in the theatre, lift access to the civic hall, back of house facilities and an enlarged foyer, bar and cafe.

- **Hotel Windsor Redevelopment, Windsor, VIC (2009 - 2016): Halim Group Pty Ltd, Project Director**

- **Beaurepaire Centre Pool, Parkville, VIC (2003 - 2014): University of Melbourne, Structural & Building Services Director**

  As part of the University of Melbourne, the 1953 Robin Boyd designed Beaurepaire Swimming Pool is a six lane, indoor heated 25m lap pool.

- **Palais Theatre, St Kilda, VIC (2008 - 2012): City of Port Phillip, Project Director.**

  Structural advice for reroofing, new rigging, staging and access systems over a four year period.

- **Regent Theatre Melbourne Enhancement, project Director and Structural Concepts.**

  Major structural alterations to add extended seating to balcony to meet contemporary staging requirements along with alterations to bars and public spaces.

- **Dandenong Performing Arts Centre, Dandenong, VIC, Project Director.**

  The new theatre incorporated parts of the original Dandenong Town Hall Offices wing with major alterations and connections to the new Drum Theatre.

- **The AIA Centre, Olympic Park, VIC (1981 - 2018): Vic Government and Collingwood Football Club,**

  Project Director of the redevelopment of the original swimming stadium for the 1956 Melbourne Olympics. Located in Australia's premier sporting precinct, the AIA Centre serves as a centre for excellence for professional organisations and elite athletes. Phil has worked on numerous alterations to the "pool" since its conversion in 1981.

- **Melbourne University Boat Club, Melbourne, VIC, University of Melbourne, Structural & Civil Director**

  This project included a major addition to a significant heritage structure.

- **Ian Potter Museum of Art, Melbourne, VIC (1900 - Present): University of Melbourne, Principal Director**

  Significant multi-award-winning landmark development fronting Swanston Street and incorporating the heritage Physics Building

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- **140 William Street, Melbourne, Vic. The Former BHP House**

  Numerous alterations and changes to this heritage icon over the last 40 years as well as presentations on its unique design.

- **Trades Hall, Melbourne.**

  Alterations additions and conservation works including new levels and considerable interventions into the existing masonry structure.