World Bank Group

Implementation of Innovative and Efficient Bridge Technologies

Progress Report (PG/R)

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Implementation of Innovative and Efficient Bridge Technologies project

The **purpose** of this Progress Report is to provide a general introduction to the World Bank Group's project: Implementation of Innovative and Efficient Bridge Technologies project ('the project') before setting out the applied methodology and evaluation techniques, analyses and results in relation to delivery of Phase A – Opportunities for Modular Bridges in Developing Countries (South Pacific).

Specifically, the report documents the initial evaluation and short-listing of 'in-market' prefabricated modular bridge technologies; market engagement with short-listed suppliers; the applied multi criteria analyses (MCA) and results. It also presents a Decision Tree matrix to assess site specific scenarios to determine the most effective modular bridges to be used for that site.

The **initial evaluation** of in-market pre-fabricated modular bridge technologies was undertaken in the first quarter of 2019 and identified nineteen (19) modular bridge options that were assessed against seven (7) technical criteria and an additional six (6) constructability and durability criteria. This evaluation resulted in the selection of five (5) short-listed options, as outlined below:

- InQuik modular bridging system
- Unibridge modular bridge system
- Wagners CFT modular road bridge
- Stahlton Engineered Concrete precast modular bridge system
- Waeger precast modular bridging system

The suppliers of each of the five (5) shortlisted options were given the opportunity to respond to **an online survey** designed to obtain pertinent information relating to structural specification and product characteristics; maintenance requirements; logistics (including storage) and constructability characteristics; as well as understanding any social and economic benefits that may be realised. All five (5) suppliers completed the online survey, however, some suppliers responded more comprehensively than others and provided supplementary information which was encouraged to evidence any declarations made in the completed survey.

Using information available within the public domain, coupled with that obtained via the online survey and direct engagement with the short-listed suppliers, **multi-criteria analysis** (MCA) was carried out to determine suitability of each short-listed option. The conducted MCA was based on a comprehensive list of twenty-eight (28) criterion that were identified, defined, and weighted to best represent the project requirements.

A working version of the MCA workbook (Excel based) has been issued separately to this report and has been promoted as a viable decision-making tool in relation to the selection and use of modular bridge technologies as bridge infrastructure investments.

The **results** produced:

- InQuik modular bridge, score 4.015 (80.3%), Rank 1
- Wagners CFT modular bridge, score 3.936 (78.7%), Rank 2
- Waeger precast modular bridge, score 3.761 (75.2%), Rank 3
- Unibridge modular bridge, score 3.749 (75.0%), Rank 4
- Stahlton precast modular bridge, score 3.480 (69.6%), Rank 5

Total project cost is estimated at between USD $2,250 - $4,500 per SQM

1 This document

This **Progress Report** provides a general introduction to the **World Bank Group's** project: **Implementation of Innovative and Efficient Bridge Technologies** project (**'the project'**) before setting out the applied methodology and evaluation techniques, analyses and results in relation to delivery of Phase A – Opportunities for Modular Bridges in Developing Countries (South Pacific).

Specifically, the report documents the:

- Initial evaluation and short-listing of 'in-market' prefabricated modular bridge technologies
- Market engagement with short-listed suppliers
- Applied multi criteria analyses (MCA) and results
- A decision tree matrix to determine the most effective modular bridges for a specific site scenario, (which has been added into Section 8 for the Rev A submission of this Document.)

The results presented herein include:

- A summary of 'in-market' prefabricated modular bridges including their advantages and disadvantages,
- A repeatable methodology for identifying issues associated with the application of pre-fabricated modular bridges and specific recommendations on the situations where modular bridges can be applied, and;
- The direct cost of modules, indicative shipping costs, and an outline of additional 'in-country' cost elements.

2 Introduction

2.1 Project context

It is well established that all over the world, infrastructure assets are facing numerous and increasing challenges. Growing population, ageing infrastructure, societal inequity and the impacts of climate change could result in a number of future scenarios. So, how can we build resilience, efficiency and adaptability into our infrastructure assets to make sure we have sustainable high performing assets for all segments of society in the years to come? How can we best serve the needs of developing countries whose assets must be generated and maintained in often the most challenging of environments? Which scenarios for the future are the most plausible? What actions can be taken now, to release value later on? How do government agencies and organisations balance Capex, Opex and asset productivity, while still being economically prudent? And how do we respond to the diversifying needs of people settlements?

The Pacific region, in particular, is highly vulnerable to the impacts of climate change and natural disasters. Each year disasters result in critical infrastructure being destroyed or severely damaged, leading to loss of life, injury, and disruption to social and economic activity. Bridges, which are often the most exposed to natural disasters, serve as vital connections between economic and social hubs, which exacerbates both the risk and resulting impact.

In essence, bridges in developing countries serve as example problem statements for infrastructure asset owners, where there is need to balance the trilemma of parameters being; resilience and reliability, sustainability, and affordability, where perhaps both exposure and criticality is at its greatest.

The World Bank Group is particularly cognisant of these issues, acknowledging bridges as critical links for transport networks, as well as emphasising their significant contribution to connectivity and economic production. Furthermore, deferred maintenance and an elevated exposure profile to natural disasters are also acknowledged, and collectively serve catalyst to the continuing efforts of donors to support the research, exploration, development and implementation of bridge solutions that make due consideration for local context, and in this instance, specifically that pertaining to developing countries in Pacific region.

2.2 Project overview

The World Bank Group have responded to the challenges presented under Section 2.1 herein, by developing and scoping a project brief, as outlined below. It is understood that the project will be funded through the Quality Infrastructure Investment (QII) Partnership, which is sponsored by the Government of Japan.

Project overview statement

> *To undertake an assessment and pilot program to support implementation of two types of innovative bridge construction technologies; modular bridges; and, geosynthetic reinforced soil (GRS) abutments.*

Modular bridges are manufactured in a factory and shipped to site where they are assembled and completed, often with the placement of concrete. It is thought that modular bridges can cost 50% less than traditional constructed bridges. They differ from other low-cost bridges (such as Bailey bridges) insofar as they require much less maintenance, lowering the whole of life cost and improving efficiency.

Similarly, GRS abutments can be constructed at a cost 30-50% lower than piled or concrete abutments with standard contractor's equipment. With the right site conditions, GRS can also provide more resilience to this critical part of the bridge structure, particularly against seismic events.

The use of these technologies has the potential to significantly reduce the cost of bridge replacements/new construction, as well as greatly reduce construction time. It will also have major social and economic benefits through expanding the number of contractors who could undertake bridge replacements. While the concepts of these technologies have been proven in developed countries, they are new to most developing countries for a range of reasons. This consultancy will allow the technologies to be proven in the context of the Solomon Islands and Vanuatu, allowing performance, cost and maintenance benefits to be realised whilst maximising the economic efficiency and development impact of future bridge investments.

2.3 Scope of works

The scope of this work consists of the following three phases (phases 2 & 3 have been consolidated to reflect agreed delivery methodology and programme adjustments).

Phase A: Opportunities for Modular Bridges in Developing Countries (South Pacific)

Phase A involves identifying and evaluating a selected range of pre-fabricated modular bridges that could be applicable for use in the target countries in the South Pacific (Vanuatu and the Solomon Islands). This assessment involves understanding where modular bridges are manufactured, as well as identifying technical elements of the modular bridges and the expected performance during procurement, installation and construction, and eventual service life. The assessment focuses on countries that could realistically and cost-effectively transport the modular bridges (with a typical span range between 10m – 20m) to the target countries. Having identified a short-list of modular bridges that may be suitable, any issues that may affect the ability for these to be used will be identified as part of additional detailed analyses. A decision tree matrix can then developed that will clearly show the scenarios where specific modular bridge options can be effectively and efficiently applied.

Phase B & C: Supporting Pilot Testing of Modular Bridges and GRS Abutments

Having established the opportunity to use modular bridges in the pilot countries, this phase will support the pilot testing. The confirmed pilot countries and projects are:

- Solomon Islands Roads and Aviation Project (SIRAP), Solomon Islands, and
- Vanuatu Climate Resilient Transport Project (VCRTP), Vanuatu.

Working with the World Bank Group's local partners, specific locations where modular bridges can be tested will be identified. It is anticipated that – depending on the nature of the outcome from Phase A – at least two different modular bridge technologies will be tested. The project will also support pilot project procurement activities, as well as undertaking performance monitoring in terms of both construction and service life. Please note that implementation of the pilot projects will be performed by others, and that performance monitoring during construction will be undertaken via Arup's Online Services (OS) survey platform which will require co-operation by those delivering the projects (consultants and contractors).

In addition to the pilot testing of modular bridge decking solutions, and expanding on the work already done in Sri Lanka, this phase of work will also seek to identify opportunities for implementing GRS abutments. The previous work undertaken found that the current standard design documents are appropriate, so the focus as part of this scope of works will be to identify a methodology for getting these design approaches formally adopted and implemented. It is intended to inform the justification for incorporating the GRS abutments into the construction code, and where applicable, to embed the technologies into the line Ministry's standard designs. A key element of this activity will be development and delivery of capacity development training program to the local stakeholders: government, contractors, consultants and educators for application of GRS abutments. The project will hold workshops with clients, consultants and contractors to introduce modular bridges and how they will be constructed. Note, the proposed approach to delivery is to undertake phase B & C as one combined phase, including a combined approach to capacity training, the pilot projects themselves which will allow performance to be assessed individually and as an overall structural system.

2.4 Project objectives

The project objectives are to demonstrate the application, through pilot projects, the performance in terms of cost (Whole of Life), time (including fabrication and logistics), and quality (in terms of both construction and service) of:

- Factory pre-fabricated modular bridges; and,
- GRS abutments.

Performance achieved will be with reference to traditional bridge and abutment construction methods.

The project also aims to develop an informed, but standardised, approach to determining the suitability of specific, and proven, modular bridge technologies that can be utilised by donors and local agencies in developing countries, which achieve the most favourable affordability, resilience and reliability, and sustainability performance for a given local context.

The final objective is to build the capacity of local departments, industry bodies and contractors such that they are equipped with the necessary knowledge and expertise to plan, execute, monitor, control, maintain and operate bridge infrastructure which utilises the aforementioned technologies without the need for external parties.

2.5 Project success measures

With consideration for the project objectives, the following measures of success apply:

- To demonstrate through the application of modular bridge and GRS abutment technologies in developing countries in the South Pacific region, the achievement of whole of life cost reductions, time savings, without compromising structural integrity and code compliance, compared to traditional methods of bridge construction and operation and maintenance.
- To develop an informed, and standardised, approach to determining the suitability of specific, and proven, modular bridge technologies that can be utilised by donors and local agencies in developing countries, which achieve the most favourable affordability, reliability, and sustainability performance for a given local context.
- To plan and deliver high quality training content in the Solomon Islands and Vanuatu, that builds capacity with regard to the application of both modular bridge and GRS abutment technologies, so that both countries are able to make effective decisions as to the use of such technologies, as well as constructing and operating to a high standard. Furthermore, the training should also set out a blueprint approach to capacity training for adoption in other countries in the South Pacific.

Please note that the rest of this document relates to Phase A – Opportunities for Modular Bridges in Developing Countries (South Pacific) only.

3 Outline approach

The following approach was adopted to determine the suitability of in-market prefabricated modular bridge technologies.

- **Research and initial evaluation:** comprised of four (4) main components:
  - Establishing a preliminary design checklist outlining the key technical design criterion
  - Undertaking desktop research of in-market prefabricated modular bridge technologies
  - Concurrently documenting the key assumptions and conditions that underpinned the research
  - Summarise the identified list of in-market modular bridge solutions
- **Market engagement:** having concluded on a suitable short-list, the five suppliers were contacted and given an opportunity to respond to an online survey specifically designed to obtain information relating to:
  - Structural specification and product characteristics
  - Maintenance requirements
  - Logistics (including storage) and constructability characteristics, and
  - Understanding any social and economic benefits that may be realised.

  All five (5) suppliers completed the survey, however some suppliers responded more comprehensively than others and provided supplementary information which was encouraged to evidence any declarations made in the completed survey. More detail is presented under Section 5 – Market engagement.
- **Multi criteria analysis (MCA):** each option was then subject to MCA following a simple six (6) step process:
  - Step 1 **–** Define and document threshold criteria i.e. minimum requirements each option must satisfy such as to not preclude itself as a viable solution.
  - Step 2 – Define full assessment criteria and justification for inclusion and importance and basis for assessment using a one (1) to five (5) semi-quantitative approach.
  - Step 3 – Gather and summarise relevant evidence for each option as input into MCA.
  - Step 4 – Using the ‘matched pairs’ method, apply agreeable weighting for each assessment criteria.
  - Step 5 – Score each option in accordance with the prescribed one (1) to five (5) basis of assessment for each criterion.
  - Step 6 – Rank and interpret results.

  Full details can be found under Section 6 – Decision support tool.

4 Research and initial evaluation

4.1 Key assumptions

The key assumptions that must be met by each modular bridge technology, in order to not be precluded from research and evaluation in this Report were:

- Pre-fabricated modular bridge solutions must be available for procurement and installation as of March 2019, i.e. solutions must be 'in-market' and not in the research & development product phase, and
- Permanent solutions, i.e. not temporary structures.

In addition to that listed above, the initial research and evaluation focused on:

- Single span options between a 10m – 20m span range
- Superstructure only
- Straight alignment, no skew, and
- Square deck end at abutments.

The preferred single span range of 10 – 20 metres was determined as the most suitable span range for this investigation based on Arup's understanding of the typical bridge infrastructure asset base in the South Pacific.

The evaluation of the modular bridge technology has focussed on the superstructure only (deck structure) of the bridge due to the large variability that can occur in the substructure components. Some of the modular bridge manufacturers do offer the substructure components as well (abutments), and this has been acknowledged in the assessment. The design of the substructure is very much dependent on many site variables and code requirements, which makes it very difficult to standardise substructure components to suit all bridge sites. These include river hydrology, geology, embankments, and earthquake loads, which results in a customised design for each site. Whilst the evaluation focussed on the superstructure only for modular bridges, for comparison purposes, it is recognised that the substructure can't be ignored. Some modular bridges, which offer the substructure components, have integral connections between the superstructure and substructure, which eliminates the maintenance regime of bearings and deck joints.

In regard to earthquake loadings, the abutments are the components that are designed to resist the loads. The deck structure transfers the horizontal earthquake loads into the abutments, via restraint blocks and/or bearings, and down into the foundations. The lighter the deck structure, the lower the horizontal earthquake forces that need to be resisted, which will reduce abutment size/strengthen. Hence, steel deck structures can result in benefits through reduction in the abutments, as they are generally lighter than the equivalent concrete deck structure. Considering the high seismic loads that can be generated in the Pacific Islands, earthquake design and detailing of the abutments is important.

Other assumptions that have been made, is that the modular bridges can accommodate longitudinal grades of the roads of minimum 1.0% and maximum 4.0%-5.0% in order to provide adequate drainage. In addition, a cross fall should be included in the deck cross section and that drainage is via scuppers into the drainage below. This needs to be confirmed at each bridge site with regard to environmental and authority requirements.

It has also been assumed that the modular bridge does not have to be designed for flood debris loading or submergence and assumes that the bridge designer has positioned the deck level above predicted flood levels. In any case, traffic barriers should be open type barriers and tie down restraints may need to be provided in the unlikely event that floods occur at higher than predicted levels.

4.2 Preliminary selection

The following nineteen (19) 'in-market' pre-fabricated modular bridge solutions were identified and reviewed:

- Acrow Bridge, Acrow Corporation of America, America
- Country Bridge Solutions, Roads and Maritime Services, Australia
- Eastbridge, Markham Culverts / Eastbridge Ltd, Papua New Guinea / New Zealand
- HumeDeck , Holcim Pty Ltd, Australia
- Humes, Humes, New Zealand
- Hynds, Hynds Rural Ltd, New Zealand
- InQuik, InQuik Pty Ltd, Australia
- Kramer Ausenco, Kramer Ausenco PNG Ltd, Papua New Guinea (Offices in Australia, Vanuatu, Solomon Islands)
- Mabey Compact 200, Mabey Group, Australia (Offices in New Zealand)
- Novare Design, Novare Design Limited Wellington, New Zealand
- PERMAcast, PERMAcast, Australia
- PNG FP NiuBridge System, PNG Forest Products, Papua New Guinea
- Rocla M-Lock, Rocla Pty Ltd, Australia
- SMARTspan, BCP Precast, Australia
- Stahlton Engineered Concrete, Fulton Hogan Ltd, New Zealand
- Unibridge, Unibridge Australasia Pty Ltd, Australia
- Waagner-Biro, Waagner-Biro AG, Austria (Offices in Indonesia, Philippines and UAE)
- Waeger, Waeger Constructions Pty Ltd, Australia
- Wagners CFT, Wagners CFT Pty Ltd, Australia

Refer to **Appendix A1 – Structural Characteristics Table**, **Appendix A2 – Preliminary selection – photos,** and **Appendix A3 – List of Advantages and Limitations** for a basic product information, and a synopsis of the options outlined above.

4.3 Technical design criteria

The seven (7) key technical criteria were:

- Single span range flexibility (10m – 20m)
- Local design standards – AS/NZS 5100 Bridge Design Code[1]
- Vehicle design loading (T44 vehicle loading considered suitable, as per AS/NZS 5100)[2]
- Suitable deck edging and traffic barrier performance, depending on anticipated traffic volume
- Number of lanes accommodated (One lane plus provision for pedestrian walkway required, with flexibility for additional lane considered advantageous)
- Bridge design life (100-year design life considered suitable)
- Marine exposure conditions (minimum B2 classification, or C4 corrosion category)[3]

In addition to the technical criteria listed above, broader criteria relating to durability and constructability were also evaluated. These included:

- Corrosion resistance & maintenance access
- Local industry set-up, Australia and New Zealand
- Supply and installation
- Constructability
    - Level of on-site activities required (reduced activity evaluated as more suitable)
    - Ease of transport
    - Lightweight bridge componentry

It should be noted that the shortlisted options can be modified to comply with the alternative NZTA Bridge Manual and HO-HN-72 vehicle loading, if that is the specified code and loading requirement by the local authority.

[1] The alternative NZTA Bridge Manual from New Zealand can be considered, but some of the modular bridge products may need to be modified to comply with the NZ Manual.
[2] The alternative HO-HN-72 vehicle loading, in accordance with NZTA Bridge Manual, can be considered, but some of the modular bridge products may need to be modified to comply with the NZ Manual.
[3] Marine exposure conditions - minimum B2 classification required for concrete structures, as per AS5100.5 Table 4.3, or minimum C4 corrosion category for steel structures as per AS5100.6 Table G1.

4.4 Qualitative evaluation

An initial evaluation against the criteria set out under Section 4.3 was conducted with the results presented in **Appendix A4 – Option Selection Matrix**.

A simple qualitative system was adopted to determine suitability as outlined below:

Class	Symbol	Definition	Example
Not Suitable	X	The in-market modular bridge technology **does not** meet the minimum technical criteria listed in the assessment matrix.	Mabey Compact 200 does not meet the minimum B2 classification exposure conditions and therefore has been assigned a "X" under this assessment criteria.
Suitable	✓	The in-market modular bridge solution **does** meet the technical criteria listed in the assessment matrix, however, there remains scope for improved performance.	HumeDeck includes low performance deck edges/traffic barriers within their bridge design (✓).
Highly Suitable	✓✓	The in-market modular bridge solution **exceeds** the technical criteria listed in the assessment matrix.	HumeDeck require minimal onsite activity during their construction process (✓✓), whereas InQuik require more substantial onsite activities (cast in-situ decking) (✓).

Table 1. Option Selection Matrix, Suitability Classification Key

4.5 Final selection

After applying the approach to evaluation detailed herein consistently to each of the nineteen (19) options across the listed criteria, the number of ticks (✓) achieved were tallied, with the top five (5) performing options (highest summation of ticks) serving as a short-list for more detailed investigation. The five (5) short listed options were:

- InQuik modular bridging system
- Unibridge modular bridge system
- Wagners CFT modular road bridge
- Stahlton Engineered Concrete precast modular bridge system
- Waeger precast modular bridging system

5 Market engagement

5.1 Survey participants

Each of the short-listed option suppliers were contacted and given the opportunity to complete an online survey using Arup's Online Survey Platform. This allowed suppliers to:

- Validate data available within the public domain and reviewed as part of the initial evaluation
- Provide contextual information for consideration, and
- Obtain both broader and more detailed information that would support the intended MCA

Each supplier was contacted via phone in the first instance, allowing project context to be conveyed as well as identifying the most appropriate supplier personnel to complete the survey; this was often a combination of engineering and sales staff. For clarity, the project or sponsor was not disclosed to suppliers at any point during the information gathering process. Following the phone call a follow up email was then sent to the party responsible, confirming the project context with a link to complete the survey enclosed.

All five (5) suppliers completed the survey, however some suppliers responded more comprehensively than others and provided supplementary information which was encouraged to evidence any declarations made in the completed survey.

5.2 Survey design and information gathered

To support the intended MCA, the survey was designed to cover:

- Structural specification and product characteristics
- Maintenance requirements
- Logistics (including storage) and constructability characteristics, and
- Understanding any social and economic benefits that may be realised.

The specific survey sections were:

- Section one – Time and cost
- Section two – Structural characteristics
- Section three – Operations & Maintenance requirements
- Section four – Procurement, logistics and constructability
- Section five – Social and economic benefits

The full survey and supplier responses can be provided upon request.

6 Decision support tool

6.1 Multi criteria analysis

Using information available within the public domain, coupled with that obtained via the online survey and direct engagement with the short-listed suppliers, multi-criteria analysis (MCA) has been carried out to determine suitability. Other decision-making tools (such as a decision tree, heat map etc.) were considered, however, MCA was selected as it accommodates a more diverse range of criteria and holistic understanding of value. It also supports better engagement with local partners as it can capture the needs of multiple stakeholders, including those that are not ordinarily captured, as are sometimes without a metric-based unit of measure.

6.2 MCA application instructions

A six (6) step outline as to how MCA can be deployed with local partners is set out below:

- Step 1 - Draft and agree threshold criteria. This threshold criteria to be used for selection of feasible technologies. Threshold criteria are those criterions that must be satisfied in order to not preclude an option. An example being, an option must be compliant with local structural standards and codes. The existing threshold criteria defined in the Excel workbook provided may be adopted without adjustment if preferred and agreeable.

- Step 2 - Draft and agree all assessment criteria, including basis of assessment and justification for inclusion. Where possible, the basis of assessment should be metric-based to avoid any subjectivity during scoring. Similarly, the existing assessment criteria defined in the Excel workbook provided may be adopted without adjustment if preferred and agreeable.

*Steps 1 & 2 are often undertaken in a workshop environment and agreement of criteria is required before proceeding through to subsequent steps.

- Step 3 - Identify technology solutions. The option selection matrix, as seen in **Appendix A4 – Option Selection Matrix**, may be used to select appropriate options for consideration, however, note the information captured is only current as of March 2019. Refer to Section 6.3 – Ongoing improvements as to how cloud-based data infrastructure could be used to improve and maintain a current dataset of pre-fabricated modular bridge technologies.

- Step 4 - Using the 'matched pairs' method, apply weightings to criteria. Upon agreeing all criteria (and the associated basis of assessment), Step 4 is the process of comparing agreed criteria against each other to establish comparative weightings. A two (2) is given to criteria agreed to be more important, one (1) where criteria are of equal importance, and zero (0) of lesser importance. The existing weighting matrix found in the Excel workbook provided, as seen in **Appendix A5 – MCA-Matched Pairs Analysis Matrix**, may be adopted without adjustment if it is deemed to be representative of the objectives of the local asset owner or operator. Note that the applied weightings will reflect how sensitive the result will be to each criterion considered. Step 4 requires appropriate endorsement before proceeding to Step 5.

- Step 5 - Apply scoring one (1) to five (5) for each of the solutions considered based on the evidence provided and the prescribed basis of assessment developed under Steps 1 & 2.

- Step 6 - Compare, interpret and present results. The results are assigned a weighted total score out of five (5), which is the sum of the product of each criterion score, which allows each option to be ranked. Care should be taken at this point to understand how the applied settings have influenced the outcomes produced, and sensitivity analyses by changing the weighting matrix; however, it is important that the results are not manufactured and remain a true reflection of the objectives and priorities of the asset owner and operator.

A working version of the MCA workbook (Excel based) has been issued separately to this report.

6.3 Ongoing improvements

It is recognised that moving the existing multi criteria analysis to an online-based decision support tool could bring tangible benefits to evaluating modular bridge suitability. The expected benefits include:

- Over time a single source of information on modular bridge technologies would be created. All information gathered from suppliers and the associated results from the MCA can be stored in a cloud-based data infrastructure. Suppliers would input information through a user-friendly web interface by using a pre-defined set of criteria and questions. This ensures that data is collected across all suppliers in a standardised format. This supplier data could then be run through the multi criteria analysis (using the existing weighting matrix or a bespoke weighting matrix specific to the needs of a country) where defined rules are checked against incoming information to produce a total weighted score. The analysis will automatically identify the top suppliers that match the criteria and produces an online report.

- Greater autonomy in its use by local agencies and less reliance on external consultants, as local partners would be able to access the results directly, only requiring some basic familiarisation training to help navigate the tool and interpret the results. Consultants would only be required to verify the results based on the input information from suppliers to ensure erroneous information is not conveyed and acted upon.

Note that the existing Excel based tool is sufficient to run the analyses and only needs to be codified and set up as an online tool, including designing the user interface and setting up the data infrastructure, in order to recognise the above benefits.

6.4 Assessment criteria and applied weightings

The current MCA workbook and analyses performed to date is based on a comprehensive list of twenty-eight (28) criterion that were identified, defined, and weighted such as to support the undertaking of MCA for each of the five (5) short-listed options. An outline of each criterion and their associated weighting as a percentage (%) is provided below. Refer to **Appendix A5 – MCA Matched Pairs Analysis Matrix** and **Appendix A6 – MCA Basis of Assessment** for full details.

- Local Design Standards AS/NZS, Technical (6.9%)
- T44 Vehicle Design Loading, Technical (6.9%)
- Whole-of-life cost, Cost (6.5%)
- Maintenance cost, Cost (6.3%)
- Build cost, Cost (6.0%)
- Installation time, Construction and logistics (5.2%)
- Construction plant and equipment requirements, Construction and logistics (4.8%)
- Fabrication time, Construction and logistics (4.8%)
- Shipment time, Construction and logistics (4.8%)
- Design Life, Technical (4.3%)
- Corrosion Resistance / Maintenance Access, Operations and Maintenance (4.3%)
- Maintenance Requirements, Operations and Maintenance (4.2%)

- Marine Exposure Conditions (B2), Technical (4.2%)
- Level of on-site activities required, Construction and logistics (4.0%)
- Ease of (Ground) Transport, Construction and logistics (4.0%)
- Lightweight Components, Construction and logistics (4.0%)
- Span Range Flexibility, Technical (3.4%)
- Storage Requirements, Operations and Maintenance (3.4%)
- Number of Lanes (1 or 2), Technical (2.4%)
- Relevant Track Record, Economic & Social (2.0%)
- Years of Operation, Economic & Social (1.5%)
- Local job creation (procurement, construction, service life), Economic & Social (1.3%)
- Local materials requirement, Economic & Social (1.3%)
- Local equipment requirement, Economic & Social (1.3%)
- Environmental impact, Economic & Social (1.3%)
- Supplier Annual Turnover, Economic & Social (1.1%)
- Deck Edge / Traffic Barrier, Technical (0.3%)
- Warranty Provisions, Operations and Maintenance (0.3%)

Figure 1 – Weightings Radar Graph illustrates the aggregated effect each area of consideration has on the MCA results. As mentioned earlier, care should be taken to ensure the applied weightings reflect the priorities and objectives of the asset owner and operator.

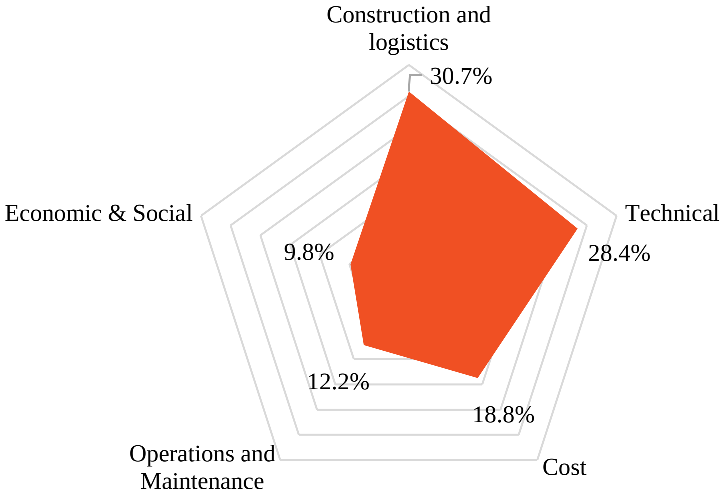

Figure 1. Weightings Radar Graph

6.5 Scoring

A simple one (1) to five (5) semi-quantitative approach to scoring was adopted. In general, the following principles underpinned each assigned score:

- 1 – The option does not meet the performance of traditional bridge construction methods
- 2 – The option marginally meets the performance of traditional bridge construction methods
- 3 – The option meets the performance of traditional bridge construction methods
- 4 – The option exceeds the performance of traditional bridge construction methods
- 5 – The option is superior to the traditional bridge construction methods

However, some deviation from these general principles were applied as a means of responding to the specific requirements of the project or there was not a 'typical' level of performance associated traditional bridge construction to serve as a reference case. Examples of deviation include:

- **Storage requirements:** scoring the ability for bridge components to be stored easily, without overly onerous environmental conditions, was defined without comparative assessment to traditional construction that is in-situ in nature (there is not a typical level of performance associated with bridge construction to serve as a reference case).
- **Design life:** achievement of a 100-year design life was assigned a score of "3" as it was deemed to best represent the requirements of the project as communicated by the World Bank Group (responding to the specific needs of the project).

Refer to **Appendix A7 – MCA Scoring** for full details.

7 Results

7.1 MCA ranking and scores

Refer to **Appendix A8 – MCA Results** for full details.

Table 2. MCA ranking and scores

Modular bridge option	Supplier	Score	%	Rank
InQuik modular bridge	InQuik Pty Limited	4.015	80.3%	1
Wagners CFT modular bridge	Wagners CFT Pty Limited	3.936	78.7%	2
Waeger precast modular bridge	Waeger Constructions Pty Limited	3.761	75.2%	3
Unibridge modular bridge	Unibridge Australasia Pty Limited	3.749	75.0%	4
Stahlton precast modular bridge	Fulton Hogan Limited	3.480	69.6%	5

7.2 InQuik modular bridge system (preferred solution)

The MCA results have highlighted the InQuik modular bridge system as the preferred modular bridge option achieving a score of 4.015 out of 5 (80.3%).

The InQuik modular bridge system from InQuik Pty Ltd (Australia) complies with Australian Standard AS5100 (2017) bridge design code (certified by SMEC Australia), satisfies minimum AS5100 loading (SM1600), and can also provide lower rated loadings at T44.

The solution is a fully reinforced cast-in-situ concrete structure with permanent sacrificial steel formwork and can achieve a 100-year design life (B2 classification, coastal environment) by using 50MPa concrete.[5] It has an integral bridge deck and it does not have bearings or tie-downs which eventually wear out and require replacement, and consequently is expected to require low maintenance over its useful life (the main parts that may require regular maintenance are the barriers). The Magnelis-coated material used by InQuik is more resistant to corrosion than galvanised steel and in high salinity coastal environments, the material has an expected lifetime before first maintenance (steel perforation) of greater than 50 years i.e. the material is expected to require replacement once during the design life.

[5] A 100-year design life can also be achieved using 40MPa concrete under a B1 classification, near coastal environment (1 km to 50km from coastline).

7.3 Wagners CFT modular bridge

The MCA results have highlighted the Wagners CFT modular bridge as the second ranked modular bridge option achieving a score of 3.936 out of 5 (78.7%).

Wagners CFT modular road bridge solutions from Wagners CFT Pty Ltd (Australia) comply with Australian Standard AS5100 (2017), achieve a 75-year design life, with two (2) road bridge options available:

- The concrete hybrid road bridge (prefabricated composite fibre girders with concrete deck unit) which satisfies SM1600 loading, and
- The full composite road bridge achieving lower rated loadings at T44

Key advantages of Wagners CFT modular bridge solution include:

- The composite fibre componentry is not subject to corrosion, and has minimal inspection and maintenance requirements, possibly achieving 20 years in-service until the first inspection is required[6]
- The componentry is lightweight, making it easier to both transport and install, and
- a seven (7) year warranty is offered on materials

Although the Wagners CFT modular bridge solution has performed well under the MCA, a major disadvantage of this option is the 11.8m maximum single span length, potentially limiting its application. For context, Arup understands that as part of the Malaita Road Improvement and Maintenance Program (MRIMP), condition assessments were undertaken on the three main roads (North Road, South Road and East Road) on Malaita, Solomon Islands, accounting for nearly 60% of the road network, and was inclusive of 103 bridges for which the length was recorded for 97 of these bridges; approximately 33% of the recorded lengths were less than, or equal to, 11.8m. This suggests, based on span length alone, the Wagners CFT would only be a viable single span replacement option for approximately one third of the surveyed bridges. By comparison, those options able to achieve a single span length of 15m, would be viable single span replacement options for almost half (47%) of the surveyed bridges, and those able to achieve a 20m single span length could serve as a single span replacement option for almost two thirds (64%) of all surveyed bridges.[7] A major advantage of single span solutions is that they avoid the cost of interim support piers and the associated sub-structure.

7.4 Waeger precast modular bridge

The MCA results have highlighted the Waeger precast modular bridge as the third ranked modular bridge option achieving a score of 3.761 out of 5 (75.2%).

The Waeger precast modular bridge from Waeger Constructions Pty Limited (Australia) utilises prestressed concrete girders and double tee precast concrete deck units, complying to Australian Standard AS5100 (2017) bridge design code, satisfies minimum AS5100 loading (SM1600), and can achieve a 100-year design life. Although typically designed to a B1 classification, it can be customised to meet the requirements of more aggressive environments (such as B2, coastal environment), and is also adaptable in length and width to best suit the sub-structure, site and project requirements.

Despite the quick construction time, where installation of the decking is estimated to take two (2) to three (3) days before being trafficable,[8] the large decking units necessitate the use of a either a single 160t crane or dual

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[6] The scope and frequency of inspection and maintenance activity reported is based on the information received from the manufacturer (Wagners CFT Pty Ltd) and has not been directly verified as true and accurate by Arup through pilot testing or otherwise.

[7] Maximum span lengths for all nineteen (19) preliminary modular bridge options is given under Appendix A1 – Structural Characteristics Table.

[8] Bridge ready for traffic once the grouting used in longitudinal shear key/s has reached design strength, after decking units have been lifted into place and grouting applied. Time to allow depends on products used.

cranes depending on the lift access provided, whilst also requiring more onerous transport and logistics arrangements.

It is also expected that the bearings will need to be replaced after fifty (50) years i.e. replaced at least once during a 100-year design life.

7.5 Unibridge modular bridge

The MCA results have highlighted the Unibridge modular bridge system as the fourth ranked modular bridge option achieving a score of 3.749 out of 5 (75.0%).

The Unibridge modular bridge solutions from Unibridge Australasia Pty Limited comply with Australian Standard AS5100 (2017), satisfies minimum AS5100 loading (SM1600), and can achieve a 100-year design life, with two (2) road bridge options available:

- The classic all steel Unibridge, prefabricated steel box girders with steel decking, and
- The Unibridge composite model, prefabricated steel box girders with either a pre-cast or in-situ concrete decking

The Unibridge modular bridge solutions can accommodate C4 exposure; however, regular inspection and maintenance requirements apply, with annual inspection and maintenance activity recommended. Although it is only expected to take approximately a day to install the superstructure, with no time allowance required for concrete curing for either the classic all steel or composite pre-cast options, the fabrication facilities are in France, and utilise major French shipping ports. Fabrication is expected to take nine (9) weeks, and due to location of shipping ports, shipping to the South Pacific is expected to take a further nine (9) weeks, requiring a total of eighteen (18) weeks from purchase order and approved shop drawings, through to delivery on-site. Therefore, without the deployment of in-country storage, Unibridge modular bridge solutions may have limited disaster response application in the South Pacific.

7.6 Stahlton precast modular bridge

The MCA results have highlighted the Stahlton precast modular bridge as the fifth ranked modular bridge option achieving a score of 3.480 out of 5 (69.6%).

The Stahlton precast modular bridge from Fulton Hogan Limited (New Zealand) utilises precast concrete girders and double tee prestressed precast concrete deck units, and complies with the New Zealand Transport Agency (NZTA) Bridge Manual SP/M/022 (2018) and NZS 3101:2006 Concrete Structures Standard, with a maximum vehicle loading of HO or 0.85HN applying.

It can also be designed for coastal environment classifications (B2, coastal environment).

The principle disadvantages are:

- the lower rated maximum loading (HO or 0.85HN)
- heavy componentry impacting upon transportability and ease of construction, albeit not as heavy as the Waeger precast modular bridge (which requires oversized vehicles for ground transport as well as significant craneage requirements during installation), and
- the lesser **50-year design life** compared to the other short-listed options

As can be seen in the applied MCA weightings, these concerns had considerable influence on the overall performance achieved by the Stahlton precast modular bridge.

7.7 Disaster response

The suitability of modular bridge technologies for disaster response has been considered a critical component when assessing the overall results. This will ultimately allow Pacific Island's government bodies to make informed decisions based on both specific needs for modular bridge technologies, whilst also considering their current disaster response strategy.

As a result, several observations were made throughout the assessment process around which of the five (5) short-listed modular bridge technologies proved to be most suitable for disaster response situations. Based on the survey responses provided to Arup in February 2019, it was established that the InQuik modular bridge system would be the most effective and efficient modular bridge solution for disaster response based on its lightweight componentry, ease of transportability, and effective time for fabrication, shipping and construction. The reduction in cost and complexity within the InQuik modular bridge system, accelerates the bridge construction process and provides a cost-effective and efficient disaster response solution.

Whilst the other solutions could still be considered effective modular bridge solutions for disaster response, depending on the in-country storage requirements and local labour requirements, there were elements within the subsequent modular bridge solutions that were less favourable. Unless stored nearby the site, the Unibridge modular bridge has a significantly longer fabrication and shipment time, making it less desirable for disaster response. The Waeger precast modular bridge units are progressively heavier than alternate modular bridge solutions, requiring larger craneage, which may not be as suitable for disaster response. Stahlton bridge components also require a longer fabrication time than other modular bridge alternatives.

Table 3 presents basic programme and storage information relating to each of the short-listed modular bridge technologies. Please note the information presented in Table 3 is based on the responses provided to Arup by the suppliers as part of the online survey, and the intended pilot programs should provide an opportunity to verify this performance for two (2) of the modular bridge options. In addition, the information specifically relates to:

- Single span – 15m requirement
- One traffic lane (no pedestrian walkways) only
- Fabrication time measured from purchase order received and shop drawings approved
- Shipment time assumes destination is in Melanesia, such as the Solomon Islands and Vanuatu
- Construction time assumes manufacturers prescribed resourcing requirements (plant, equipment and labour) are met, ideal site conditions and simple sub-structure solution

Table 3. Short-listed modular bridge option - programme and storage information

Modular bridge option	Fabrication time (weeks)	Shipment time (weeks)	Construction time (weeks)	Est. total project time (weeks)	Storage requirements
InQuik modular bridge	4 – 5	4 – 5	1 – 2	**9 – 12**	- Can be stacked - Stored under cover - Designed to be containerised
Wagners CFT modular bridge	4	4	1	**9**	- Can be stacked
Waeger precast modular bridge	4	6	1	**11**	- Can be stacked - Decks are prestressed, so should be supported no more than 0.6m from beam ends - Dunnage should be supported on stable, level ground
Unibridge modular bridge	9	9	1	**19**	- Can be stacked - Protected surfaces required
Stahlton precast modular bridge	6 – 8	6 – 8	1	**13 – 17**	- Can be stacked on dunnage over lifting points

7.8 Cost information

The below estimates are based on the information provided to Arup by the modular bridge suppliers and shipping companies as of June 2019. The ranges provided reflect the concentration of costs around the median price point, however, there are occurrences where products sit outside of the defined minimum and maximum range. For example, the Wagners CFT modular road bridge was quoted with an upper bound value of USD$1,760 per SQM (superstructure only).

- **Superstructure:** between USD $800 - $1,500 per SQM.
- **Shipping costs:** between USD $200 - $500 per SQM
- **Indirect construction costs:** 20% on direct construction costs
- **Engineering and professional fees:** 10% on total construction costs

Total project cost: site specific costs, most notably the sub-structure, cannot be reliably estimated without knowledge of the individual site characteristics (specifically ground conditions), however, based on the information made available to Arup, we would expect the total project cost for a simple single span (approximately 15m), single lane modular bridge to range between USD $2,250 - $4,500 per SQM.

InQuik modular bridge (preferred solution)

The cost information below relates specifically to the InQuik modular bridge system which was highlighted as the preferred solution under the applied MCA. Cost information relating to the all short-listed options can be seen in **Appendix A7 – MCA Scoring**.

Superstructure only: 13.7x4.8m integral bridge deck, Magnelis formwork, T44 load rating, flat side, integral estimated at AUD $77,000 (approximately USD $54,500) which is equivalent to AUD$1,170 per SQM (approximately USD $830 per SQM).

The InQuik abutment components for a 4.8m-wide integral bridge (no wing walls), 1.2m-high, including integration tie-bars, clad with Magnelis formwork is estimated at AUD $23,000 (approximately USD $16,250).

Other expected costs:

- Geotechnical investigations and reporting, site surveys, flood studies and site design
- Foundations (the InQuik system can be used with all major foundation types, including mass footing, driven steel piles, precast/bored concrete, and screw piles)
- Concrete supply
- Labour and plant hire/installation costs

The total project cost is estimated at AUD $3,500 per SQM (USD $2,470 per SQM) plus shipping costs and port fees.

Please note:

- As agreed with the World Bank Group, Arup will continue to seek verification of the provided bridge repair/upgrade unit rate (USD 20,000 per linear meter) associated with traditional bridge construction methods, used as a benchmark in our cost studies. Should further information become available, Arup will seek to make the appropriate adjustments to analyses performed and reported herein as an update to this document.
- All figures were given in AUD and converted to USD using 0.70562 (AUD:USD) exchange rate.
- All figures exclude GST and are current as of June 2019 i.e. subject to escalation beyond this point.

8 Scenario-Based Assessment Matrix

In addition to the MCA discussed in the previous sections, a scenario-based assessment matrix has been developed to recommend modular bridge systems based on specific site constraints and client requirements. The tool empowers the user to control the level of scenario-filtering and accordingly narrow down modular bridge system recommendations.

It should be noted that the assessment matrix tool is a guiding tool only. It can be subjective, and different results can occur depending on the judgement of the user. It should be stated that once a particular modular bridge system is adopted, then detailed assessment should follow with the particular manufacturer in regard to the site design characteristics, design performance requirements and site constraints, together with the bridge designer and the Authority. In addition, it should be noted that reliance on the manufacturer's design and technical brochures should be verified and certified by an independent bridge designer, before adoption on a specific site.

8.1 Assumptions

The fundamental assumption is that a bridge site has been selected, with adequate survey, flooding and hydraulic assessment, and geotechnical investigation carried out to assess the bridge span, bridge deck level, clearances and road alignment approaches. The assessment matrix tool only considers the superstructure (deck) and assumes that an appropriate substructure (abutment) is in place.

The technical design criteria listed in Section 4.3 are embedded within the tool, either in the form of baseline assumptions or scenario-based filters. The underpinning key assumptions are as follows:

- Single span range flexibility (10m – 20m);
- Bridges are straight (no skew);
- Compliance with AS/NZS design standards;
- Suitable deck edging and traffic barrier performance; and
- Minimum bridge width to accommodate one lane with provision for a pedestrian walkway or two lanes[9].

The underpinning key assumptions exclude four of the 19 bridge suppliers assessed in the initial qualitative evaluation from the scenario-based assessment matrix. This is due to the fact that three of the bridge suppliers do not comply with AS/NZS design standards or the NZTA Bridge Manual (Acrow Bridge, Kramer Ausenco and Waagner-Biro) while the fourth does not provide a unique modular bridge product (Novare Design).

8.2 Assessment Criteria

The remaining 15 bridges have been assessed in the scenario-based matrix.

Thirteen assessment criteria have been selected, based on the qualitative evaluation presented in Section 4.4. Each criterion falls into one of the following categories:

- Site location;
- Design requirements;

[9] All assessed bridge system can accommodate two lanes, except Hynes, for which the deck is only wide enough for one lane and a pedestrian footpath.

- Site access and constructability; and
- Procurement, maintenance and supplier support.

The criteria act as a series of filters to provide a tailored list of bridge systems, suited to site constraints and client requirements. The following sections explain the criteria within each category.

8.2.1 Site Location

The assessment of site location includes the proximity of the bridge site to the coast and the anticipated bridge span, summarised in Table 4.

Table 4. Site Location Assessment

Criteria	Design feature	Filter
Coastline proximity	Exposure classification	For sites within 1km of the coast, the matrix will filter through bridge systems that have been designed for a minimum B2 exposure classification.
Anticipated span	Maximum span	For spans greater than 15m, the matrix will filter through suitable bridge systems.

8.2.2 Design Requirements

The assessment of design requirements includes the desired design code and design life, as well as anticipated vehicle loading and traffic volume, summarised in Table 5.

Table 5. Design Requirements Assessment

Criteria	Design feature	Filter
Design code	Design code	The matrix will filter through bridge systems designed to AS/NZS 5100 or NZTA SP/M/022.
Design life	Design life	For desired design lives of 100 years, the matrix will filter through suitable bridge systems.
Traffic loading	Traffic loading	For SM1600 or HN-HO-72 traffic loading requirements, the matrix will filter through suitable bridge systems. For T44 and 0.85HN-72 loading requirements, bridge systems design to SM1600 or HN-HO-72 loading are deemed suitable.
Traffic volume	Barrier design	For average traffic volume exceeding 500 vehicles per day, the matrix will filter through bridge systems with superior traffic barrier design.

8.2.3 Site Access and Constructability

The assessment of site access and constructability addresses the adequacy of access roads to support transport of bridge components, the available construction equipment and the suitability of the site to accommodate construction activities. These criteria can be subjective, and dependent upon the judgement of the authority or bridge designer, when assessing the bridge site. In addition, the manufacturer of the modular bridge system may be able to modify their system to accommodate site constraints, once selected. The criteria are summarised in

Table 6.

Table 6. Site Access and Constructability Assessment

Criteria	Design feature	Filter
Site access	Ease of transport of modular bridge components	For sites without access roads designed for long and heavy vehicle transport, the matrix will filter through bridge systems that are designed for ease of transport.
Site equipment	Weight of bridge components	For sites with limited suitability for craneage, the matrix will filter through lightweight componentry bridge systems.
Site activity	Level of activity required to construct bridge	For sites not suited to a high level of construction activity, such as in-situ concrete pouring, the matrix will filter through bridge systems designed for minimal construction activities.

8.2.4 Procurement, Maintenance and Support

Bridge systems have also been assessed to consider the provision for substructure design, construction services, corrosion resistance and maintenance access, as well as the presence of local support offices to assist in the construction and maintenance process. Availability of spare parts may be important for some of the bridge systems in the future, especially if the manufacturer is no longer in business. These criteria are summarised in Table 7.

As noted in the previous section, the assessment should be considered subjectively, as while most bridge suppliers do not specify provision of substructure or installation services, they may help facilitate these aspects of design and construction.

Table 7. Procurement, Maintenance and Support Assessment

Criteria	Design feature	Filter
Provision for substructure	Substructure supply	The matrix can filter through bridge systems which include substructure design.
Installation	Construction services	The matrix can filter through bridge systems which include construction / installation services.

Maintenance	Corrosion resistance / maintenance access	The matrix can filter through bridge systems which require minimal or easy maintenance, through the design of corrosion resistant components or components designed with maintenance access in mind.
Ongoing Support	Local industry setup	The matrix can filter through bridge systems which have local fabrication and supply offices, for ease of ongoing support during the life of the bridge.

8.2.5 User Inputs

The scenario-based assessment matrix prompts the user to respond to a series of questions corresponding to each of the fifteen criteria. The questions and applicable answers are summarised in Table 8.

Table 8. Scenario-based matrix tool user inputs

Category	**Criteria**	**Questions**	**Answers**	
Site Location	Coastline proximity	*Where is the site located, relative to the coastline?*	>1km from coastline	<1km from coastline
	Anticipated span	*What is the anticipated bridge span?*	<15m	15-20m
Design Requirements	Design code	*Which bridge code will the design conform to?*	NZTA SP/M/022	AS5100
	Design life	*What is the desired design life for the bridge?*	<100 years	100 years
	Traffic loading	*What is the anticipated vehicle loading?*	T44 / 0.85HN-72	SM1600 / HN-HO-72
	Traffic volume	*What is the anticipated traffic volume?*	<500 vehicles/day	>500 vehicles/day
Site Access and Constructability	Site access	*Are existing access roads adequate to support heavy vehicles?*	Adequate access	Limited access
	Site equipment	*Is the construction site adequate to accommodate heavy equipment? (e.g. large cranes)*	Adequate equipment	Limited equipment
	Site activity	*What level of on-site activities (e.g. in-situ concrete pouring) can the construction site accommodate?*	Adequate activity	Limited activity

Procurement, Maintenance and Support	Provision for substructure	*Is there a preference for the substructure to be provided by the bridge supplier?*	Superstructure only	Substructure supplied
	Installation	*Is there a preference for construction to be provided by the bridge supplier?*	Design &/ Supply only	Design & Construct
	Maintenance	*Is there a preference to minimise the maintenance regime for the bridge?*	Regular maintenance	Minimal maintenance
	Ongoing Support	*Is there a preference for local industry support within Australia / New Zealand?*	Setup located anywhere	AS/NZS industry setup

Further details of the scenario-based assessment matrix are provided in Appendix A9.

8.2.6 Example Output

An example output from the scenario-based assessment matrix has been assumed and is visually summarised in Figure 2. For the given set of design constraints, the matrix has recommended three bridge suppliers. Humedeck, InQuik and Waeger. This implies that the bridge systems proposed by these suppliers satisfy all design criteria in this example scenario. In addition, Wagners CFT has been provided as a secondary recommendation, as it passes all critical criteria and only fails one suitability criterion.

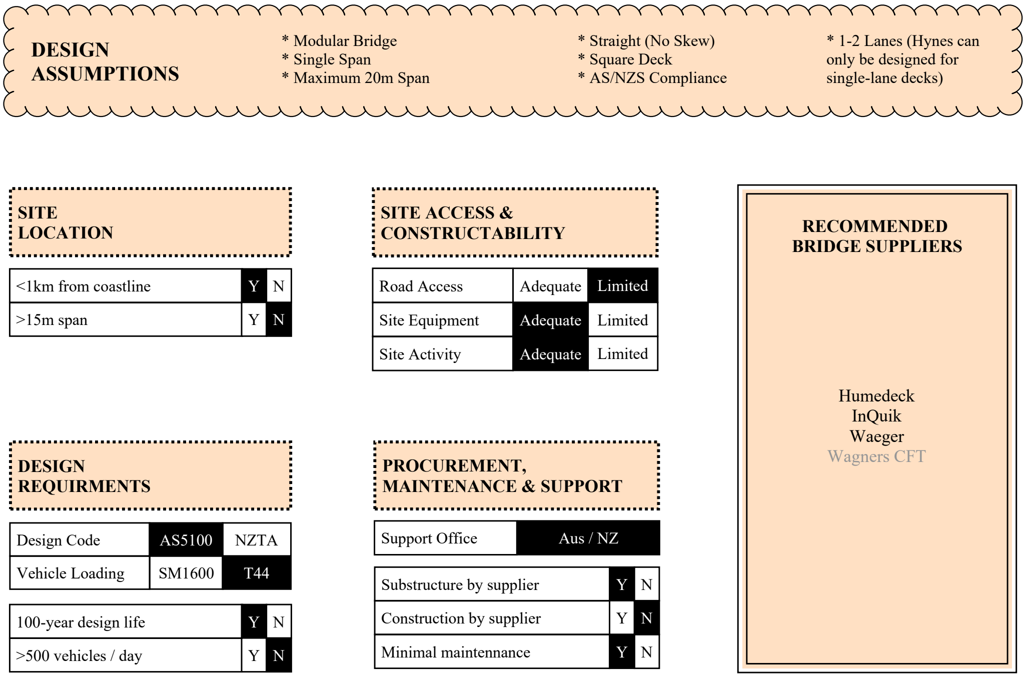


Figure 2. Visual representation of example output from scenario-based assessment matrix

This example and additional output examples are included in Appendix A10.

Appendices

A1 Structural Characteristics Table

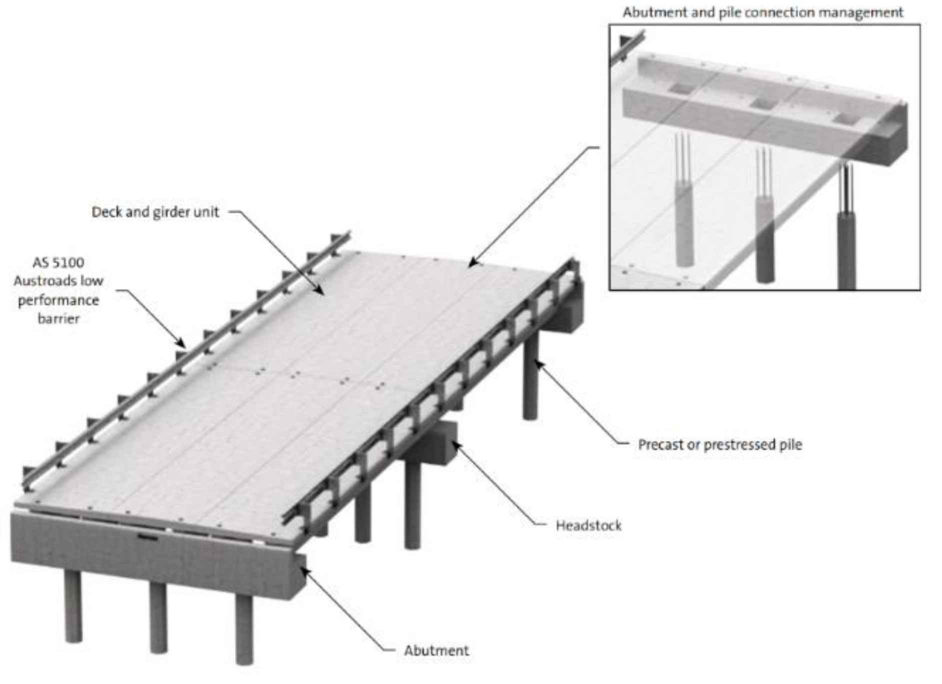
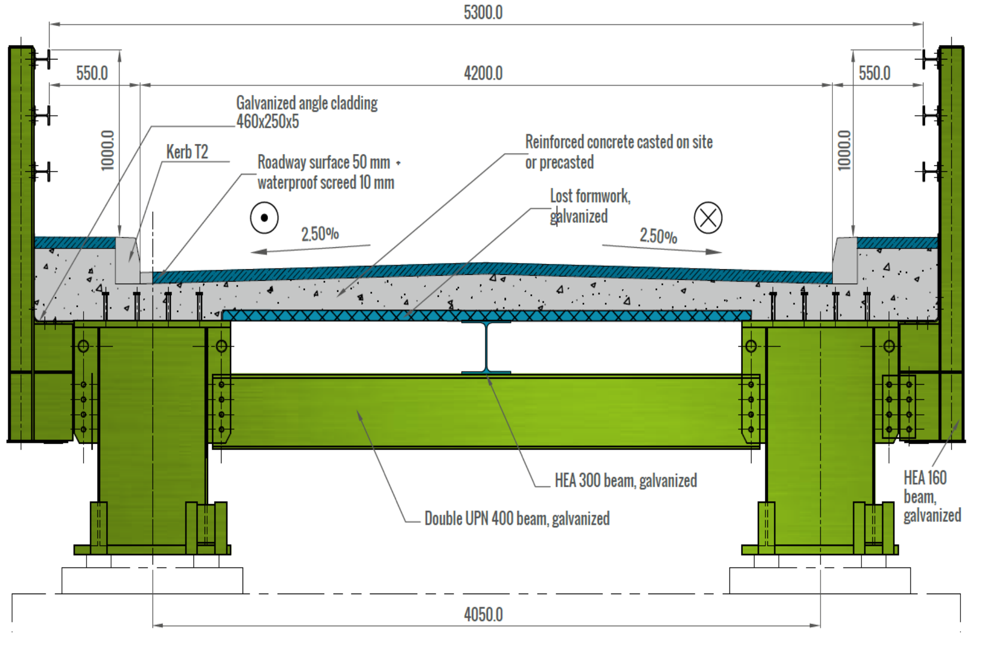
Preliminary Selection	Company	Country	Services	Span Length (m)	Width (m)	Design Criteria			Material		Case Studies
						Design Standard	Design Traffic Load	Design Life (Years)	Girders	Deck	
HumeDeck	Holcim Pty Ltd	Australia	*Design and supply* Foundation Substructure Superstructure Barriers	6.0 to 12.0 max. span	Multi-lane Any width	AS 5100	SM 1600	100	Precast reinforced concrete (included in deck unit)	Precast reinforced concrete deck panels	- Drummond Drive, Gympie, QLD - Koombooloomba Dam, QLD (Over Tully River) - MacArthur Gardens, NSW
SMARTspan	BCP Precast	Australia	*Design and supply* Foundation Substructure Superstructure Barriers	9.0, 10.0, 12.0 standard spans	1 or 2 lanes No specific width	AS 5100	SM 1600	100	Precast concrete (included in deck unit)	Precast concrete deck panel	- N/A
InQuik	InQuik Pty Ltd	Australia	*Design and supply* Substructure (excluding foundation) Superstructure Barriers	6.1, 9.1, 12.1, 13.7, 16.1, 18.5 max. span	Multi-lane 4.8 to 14.4 custom widths	AS 5100 Austroad '92	SM 1600	100	Steel reinforced concrete (included in deck unit)	Fully reinforced cast-in-situ concrete with permanent sacrificial steel formwork	- Horsey Swamp Bridge, Snowy Mountains, NSW - James Road, Dungog Shire, NSW - Reids Creek, Bellingen Shire, NSW - Murrumbidgee River Skew Bridge, Kosciuszko National Park, NSW
Unibridge	Unibridge Australasia Pty Ltd	Australia	*Design and supply* Superstructure only	11.4, 17.4 max. span	Multi-lane Any width	AS 5100	SM 1600 HLP 320	100	2 x prefabricated steel box girders	Steel composite deck with anti-skid system / cast in-situ or precast concrete deck	- Tari Bridge, Papua New Guinea (all steel bridge) - Uamai Bridge, Papua New Guinea (all steel bridge)

Preliminary Selection	Company	Country	Services	Span Length (m)	Width (m)	Design Criteria			Material		Case Studies
						Design Standard	Design Traffic Load	Design Life (Years)	Girders	Deck	
Rocla M-Lock	Rocla Pty Ltd	Australia	*Design and supply* Foundation Substructure Superstructure Barriers	7.0, 9.0, 10.0, 12.0, 15.0 max. span	Single or multi-lane 4.8, 6.0, 7.2, 8.4, 9.6, 10.8	AS 5100	SM 1600	100	Precast concrete (included in deck unit)	Precast concrete inverted U sections fitted to headstock using bolts	- Humula Bridge, NSW - Mulgoa Rise, NSW - Stanage Bay Road, Central QLD (Over Banwan Creek)
PERMAcast	PERMAcast	Australia	*Design and supply*	6.0 to 48.0 max. span	Multi-lane Any width	AS 5100 WA Main Roads Series 800	SM 1600	100	Prestressed precast concrete	Precast concrete (double T unit)	- Four bridges along Mitchell Freeway extension, WA
Country Bridge Solutions	Roads and Maritime Services	Australia	*Design only*	8.0, 10.0, 12.0 max. span	1 or 2 lanes 4.2, 6.5	AS 5100	SM 1600	100	Precast prestressed concrete (included in deck unit)	Precast prestressed concrete double T deck units + in-situ closure pour	- Trial bridge Bookookoorara Creek, NSW
Wagners CFT	Wagners CFT Pty Ltd	Australia	*Design and supply* Superstructure Substructure Foundation Barriers	11.8 max. span	Multi-lane Varying increment widths	AS 1170 AS 5100 Austroad '92	SM 1600 T44	100	Prefabricated composite fibre technology	Prefabricated concrete deck unit	- Manly Road Bridge, Brisbane, QLD - Baio's Bridge, Cairns, QLD - Angellala Bridge, Charleville, QLD (steel reinforcing)
Stahlton Engineered Concrete	Fulton Hogan Ltd	New Zealand	*Design and supply* Substructure Superstructure Foundation Barriers	12.5, 14.0, 20.0 max. span	Multi-lane 1.8 to 2.2	AS 1170 NZS 3101 NZS 3109	HN-HO72 0.85 HN	50	Precast, pre-existing or cast in-situ concrete	Double T prestressed precast concrete	- Okain's Bay Bridge, Banks Peninsula, New Zealand - Tai Tapu Footbridge, Christchurch, New Zealand

Preliminary Selection	Company	Country	Services	Span Length (m)	Width (m)	Design Criteria: Design Standard	Design Criteria: Design Traffic Load	Design Criteria: Design Life (Years)	Material: Girders	Material: Deck	Case Studies
Humes	Humes	New Zealand	*Design, supply and construction* Superstructure Substructure (foundations*) Barriers	8.0 to 18.0 max. span	1 or 2 lanes	NZTA Bridge Manual SLS AS 5100	0.85 HN	50	Prestressed precast concrete (included in deck unit)	Precast concrete (double T unit)	- Collins Road Bridge, Hamilton, New Zealand
Mabey Compact 200	Mabey Group	Australia (Offices in New Zealand)	*Fabrication and supply* Superstructure only	15.4, 18.2, 21.3, 60.96 max. span (3.048 increments)	1 or 2 lanes 3.15, 4.20, 7.35	AS 5100	SM 1600	100	Steel truss/panel (Bailey) bridging	Steel decking with heavy duty anti-skid surfacing	- Yumi Yet Project, Papua New Guinea - Blades Bridge, Wollondilly Shire, NSW - Galana River Bridge, Kenya
Waagner-Biro	Waagner-Biro AG	Austria (Offices in Indonesia, Philippines and UAE)	*Design, supply and construction* Superstructure Substructure Installation (supervisor only)	Any span Normal span between 25.0 to 60.0 120 max. span	1 or 2 lanes 4.0, 7.0	AASHTO	AASHTO LRFD	100	High-strength steel field cross and end cross girders	Corrugated steel decking with concrete infilling	- Five bridges in over the Gongonwu, Kudage, Gyanwali and Kulpawn rivers, Ghana - Philippines (selection of bridges) - Indonesia (selection of bridges)
Waeger	Waeger Constructions Pty Ltd	Australia	*Design, supply and construction* Superstructure Substructure Foundation Barrier	6.0 to 15.0 max. span	Multi-lane Any width	AS 5100	SM 1600 HLP 321 HLP 400	100	Prestressed concrete (included in deck unit)	Precast Waeger concrete (double T unit)	- Woy Woy Pedestrian Bridge, Woy Woy, NSW - Devonshire Pedestrian Bridge, Maitland, NSW
Eastbridge	Markham Culverts / Eastbridge Ltd	Papua New Guinea / New Zealand	*Design and construction*	Normal span between 30.0 to 80.0 88.0 max. span	Multi-lane Up to 9.0	AS 5100	SM 1600 T44	100	Steel truss / steel plate girder	Steel / precast concrete / timber decked	- Bukit Fraser Bridge, Pahang, Malaysia - KM 39 Bridge, Santa Rosa, Philippines

Preliminary Selection	Company	Country	Services	Span Length (m)	Width (m)	Design Criteria			Material		Case Studies
						Design Standard	Design Traffic Load	Design Life (Years)	Girders	Deck	
											- Whangamoa Bridge, New Zealand
Kramer Ausenco	Kramer Ausenco PNG Ltd	Papua New Guinea (Offices in Australia, Vanuatu, Solomon Islands)	*Design and construction*	Normal span between 30.0 to 90.0	Multi-lane Any width	PNG DoW R&B Specifications	N/A	100	Steel girder composite / Steel truss	Reinforced concrete deck	- Pual River Bridge, Vanimo, West Sepik, Papua New Guinea - Nine bridges along the Hiritano Highway, Port Moresby, Papua New Guinea - Boroko Creek Bridge, Boroko, Port Moresby, Papua New Guinea
Novare Design	Novare Design Limited Wellington	New Zealand	*Design and construction*	12.0, 17.0, 21.0, 24.0, 33.0, 35.0, 36.0, Up to 76.0	Multi-lane 3.0, 3.5, Up to 14.0	NZTA Bridge Manual	0.85 HN	100	Precast prestressed concrete girders (super T)	Concrete stitched precast / in-situ concrete deck panels	- The Arahura Bridge, - Awaruku Bridge, Long Bay, North Auckland, NZ - Makira Bridges, Solomon Islands
Hynds	Hynds Rural Ltd	New Zealand	*Design and supply*	10.0, 12.0, 14.0, 16.0 max. span	1 lane 1.05 wide increments Up to 5.0	NZTA Bridge Manual	0.85 HN	50	Precast, prestressed concrete girders (single T)	Precast concrete deck with broom-finish for non-slip surface	- Various rural bridges in East Tamaki, Auckland, NZ
Acrow Bridge	Acrow Corporation of America	America	*Design and supply*	Custom spans up to 80.0 max.	Multi-lane Custom width	AASHTO	CL625 ONT, CHBDC, HL93	75-100	Prefabricated steel panel truss	Prefabricated steel deck with asphalt surface or epoxy aggregate	- Ganaraska River Bridge, Port Hope, Ontario, Canada - Keahua Arboretum Bridge, Kauai, Hawaii - Bridge at Kedgewick, New Brunswick, Canada
PNG FP NiuBridge System	PNG Forest Products	Papua New Guinea	*Design and supply*	10.0 max. span	Single or double lane	AS5100	T44	50	Plywood girder modules (included in deck unit)	Plywood decking with asphaltic cement deck wearing surface	- Reynolds Creek Bridge, PNG - Elaman Creek Bridge, PNG - Mill Bridge, PNG

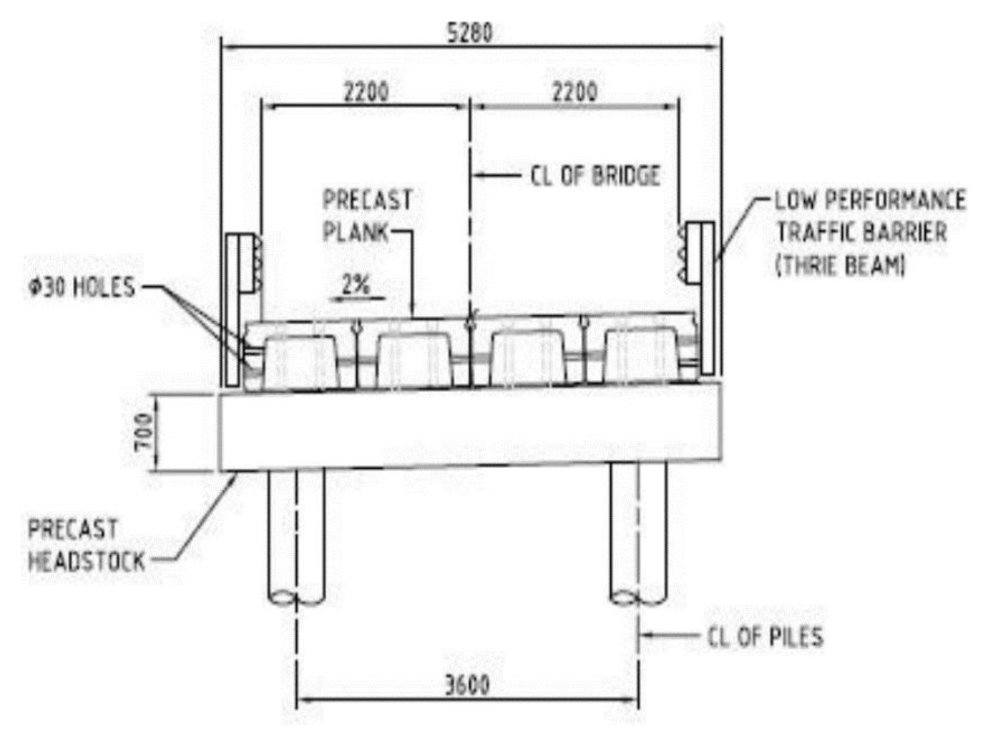
A2 Preliminary selection – images

Preliminary Selection			
HumeDeck (Source – Holcim Pty Ltd, ***HumeDeck bridge system***, April 2014, Australia).		SMARTspan (Source – BCP Precast, *SMARTspan Modular*, 2019, Australia)	
InQuik (Source – InQuik Pty Ltd, ***InQuik Bridging Systems – Catalogue***, 2018, Australia)		Unibridge (Source – Matiere, *Unibridge Prefabricated Modular Bridge*, France, 2019).	

Preliminary Selection

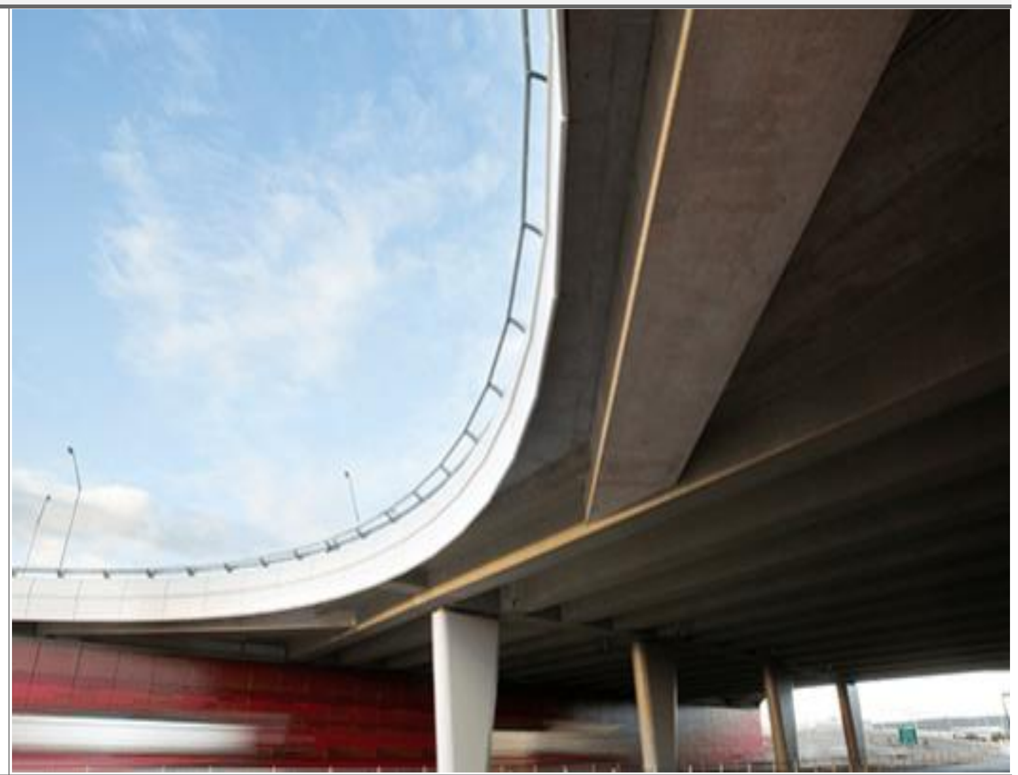
Rocla M-Lock

(Source – Rocla Pty Ltd, ***M-Lock Precast Bridge***, 2010, Australia)



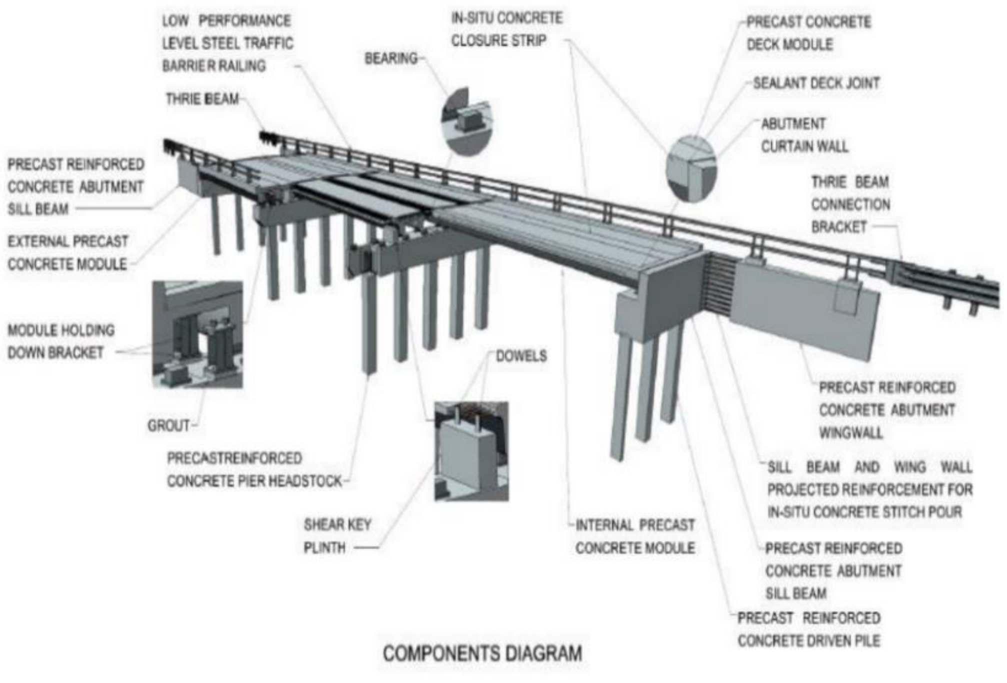
PERMAcast

(Source – PERMAcast, *PERMAcast Bridges*, 2019, Australia)



Country Bridge Solutions

(Source – Roads and Maritime Services, ***Country Bridge Solutions – Design Guide, Edition 1, Version 1.0,*** October 2016, Australia)



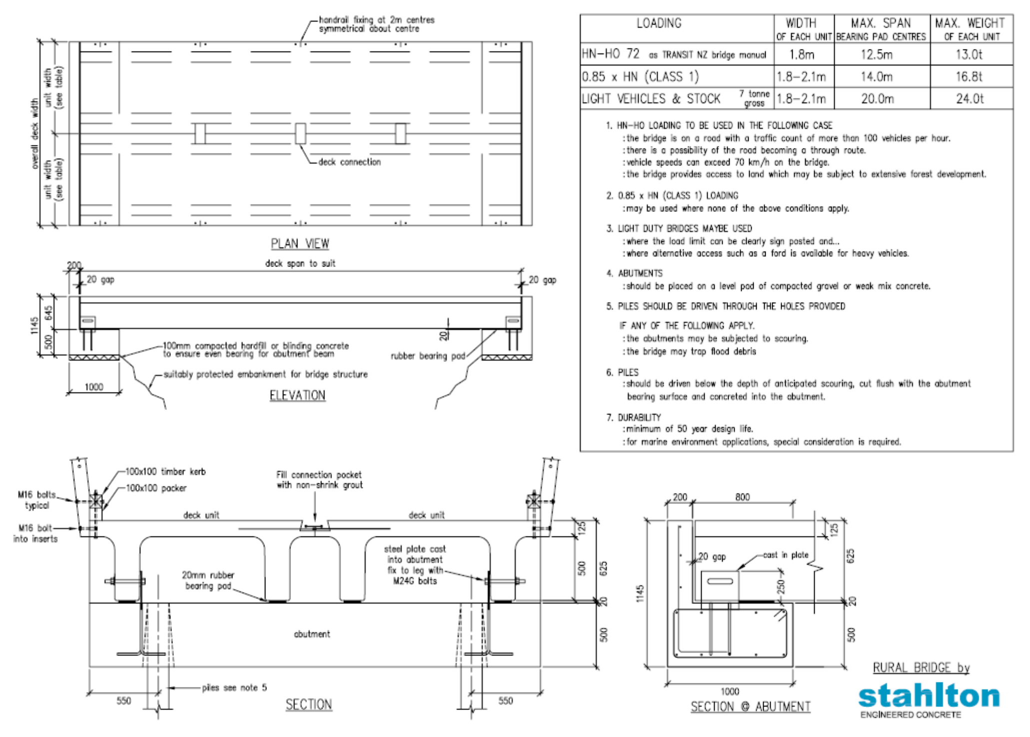
Wagners CFT

(Source – Wagners CFT Pty Ltd, *Wagners CFT Road Bridge Brochure*, March 2016, Australia)

Preliminary Selection

Stahlton Engineered Concrete

(Source – Stahlton Engineered Concrete, Fulton Hogan Ltd, ***Stahlton Double Tee Bridge Balclutha Bridge***, 2019, New Zealand)



Humes

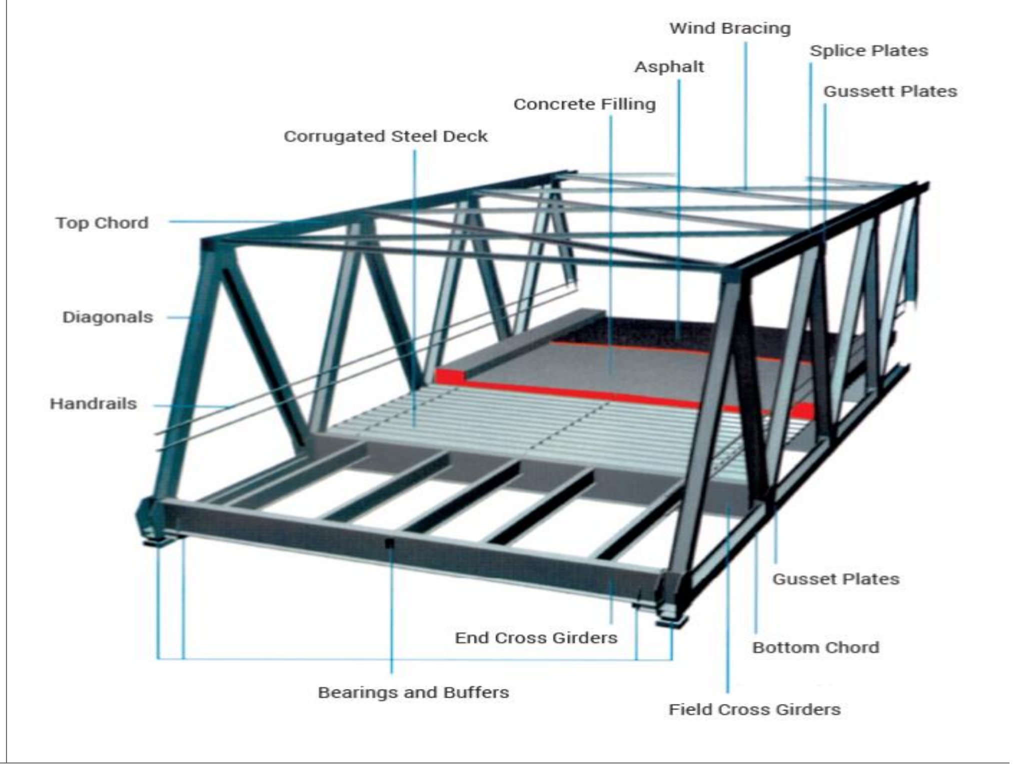
(Source – Humes NZ, *Humes Bridges Brochure WEB*, 2018, Australia)

Mabey Compact 200

(Source – Mabey Group, ***Mabey Bridging Brochure***, October 2016, Australia)

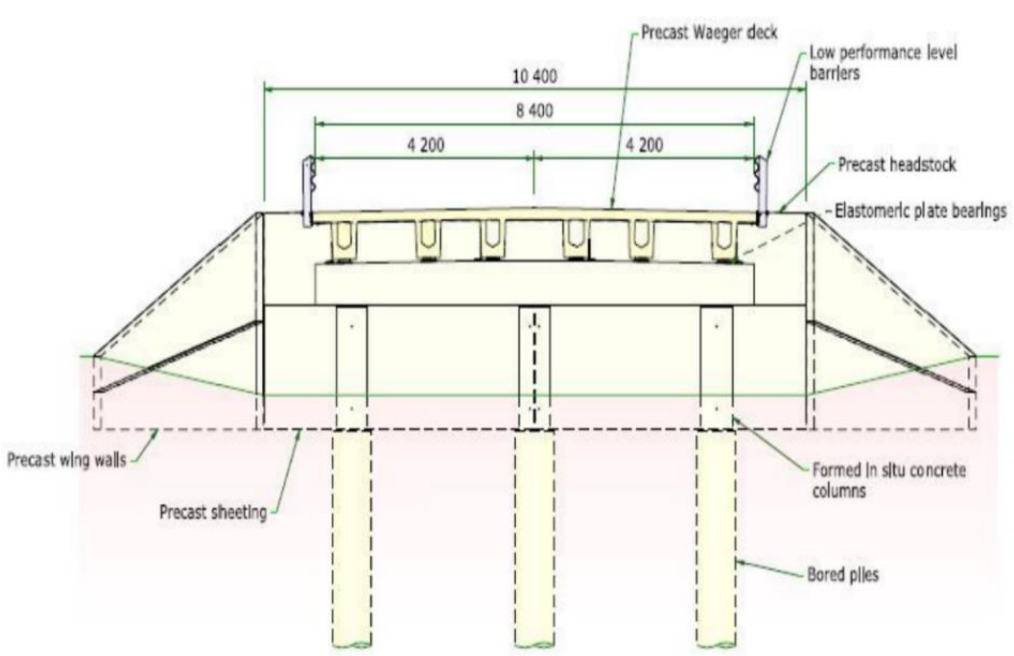
Waagner-Biro

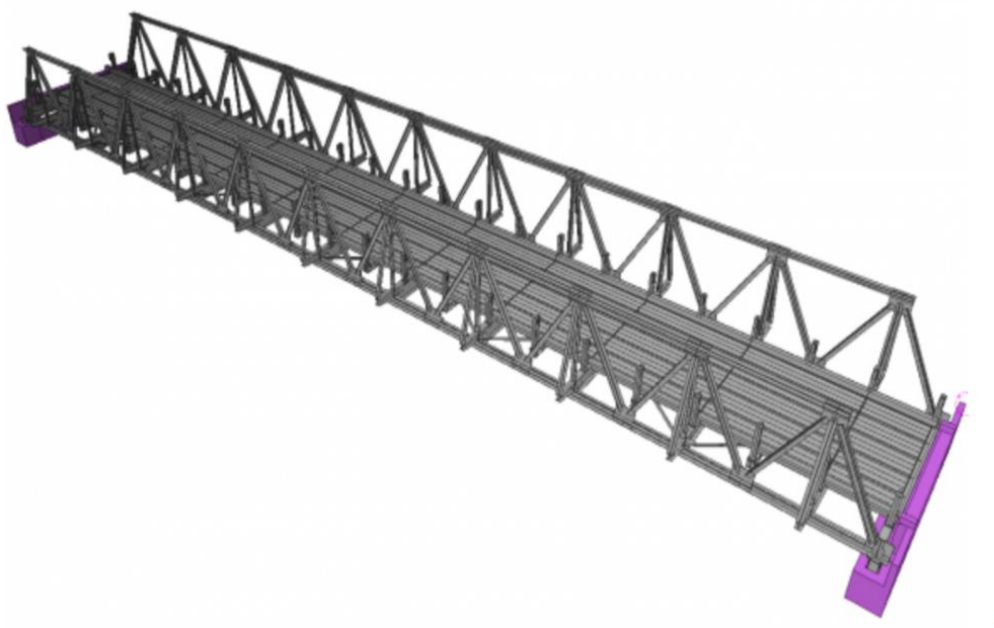
(Source – Waagner-Biro AG, *Bridge Construction – Modular Bridges*, 2012, Austria)



Preliminary Selection

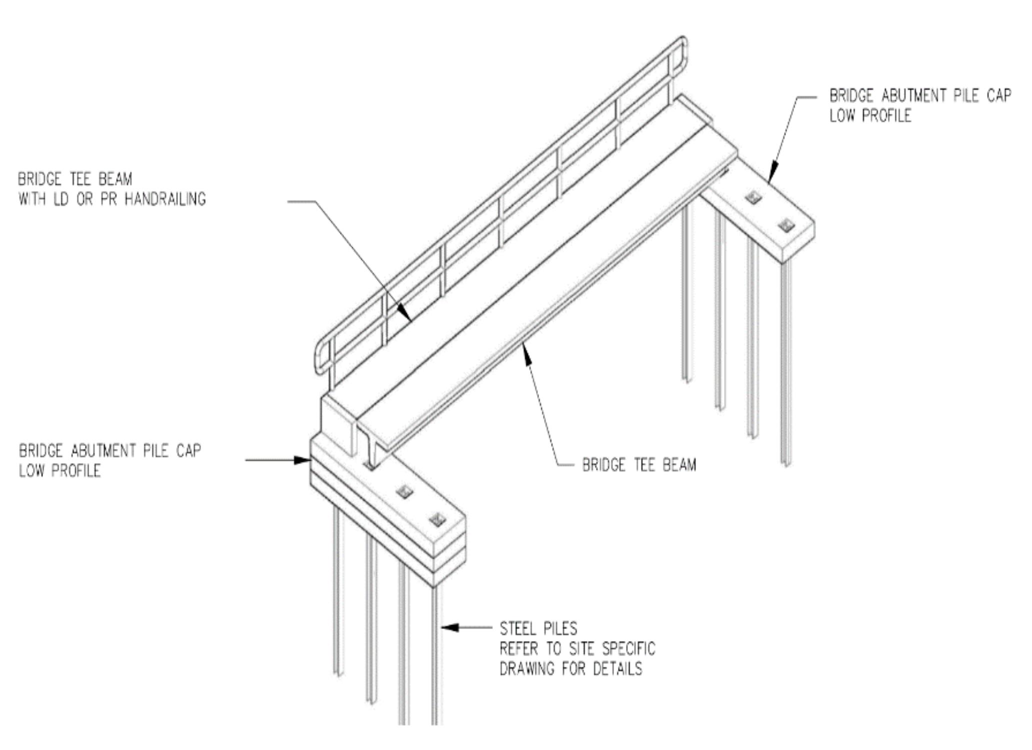
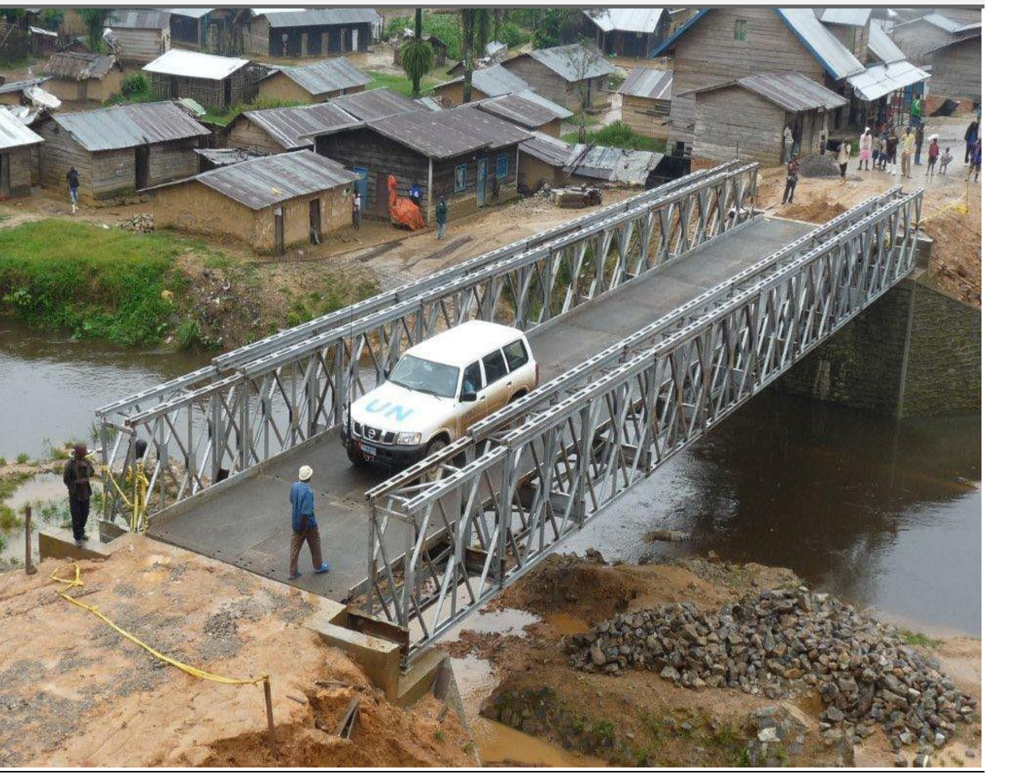
<table>
<tr>
<td>Waeger

(Source – Waeger Constriction Pty Ltd, Bridges, 2019, Australia)</td>
<td>
</td>
<td>Eastbridge

(Source – Eastbridge Ltd, Thru Truss Bridge, 2010, New Zealand)</td>
<td></td>
</tr>
<tr>
<td>Kramer Ausenco

(Source - Kramer Ausenco PNG Ltd, Modular Bridges, 2019, Papua New Guinea)</td>
<td></td>
<td>Novare Design

(Source – Novare Design, Road Bridges, 2017, New Zealand)</td>
<td></td>
</tr>
</table>

Preliminary Selection			
Hynds (Source – Hynds Rural, ***Hynds Landscape Bridge System – Technical Guide R4.1***, 2019, New Zealand)		Acrow Bridge (Source – Acrow Corporation of America, *Permanent Bridges*, 2019, America)	
PNG Forest Products NiuBridge System (Source – PNG Forest Products Engineered Wood Products, ***NiuBridge Modular Bridges***, 2019, Papua New Guinea)			

A3 List of Advantages & Limitations

Preliminary Selection	Advantages	Limitations
HumeDeck	• Fast installation – deck and girders are combined into one unit • Complete precast bridge solution • Reduced site work as post tensioning of units is not required • Headstock and abutments can be joined to piles or bolted to existing piers • Top surface of deck has course broom finish which can be used as the road surface without additional concrete topping or asphalt surfacing	• Maximum span of 12 metres • In-situ stitch joints require on-site concreting and formwork • Inability to replace bearing pads as hold down bolts pass through pads • Butt joints leave 10 mm gap between slab units – no structural connection or lateral load distribution between panels
SMARTspan	• Durable shear key design results in less construction damage, low maintenance and greater long-term durability • High plank stiffness • Superior moulding techniques • Easy bridge assembly	• Maximum span of 12 metres • No existing examples/cast studies of this modular bridge
InQuik	• No onsite welding required for InQuik bridge components • No temporary formwork/supports needed • Deck can be integrated into the abutment and/or approach slab to form a solid mass of concrete • Lightweight prefabricated components • No specialised skills are required, other than concreting • No specialised machinery required • Permanent steel formwork provides additional protection and durability to concrete	• Potential for galvanised steel to leach into the environment • Requires large volume of in-situ concrete • Deck needs concreting in two states • For bridges greater than 12 metres in length, deck beams need to be cast first and given sufficient time to gain strength before continuing the concreting, which increases construction time • No bearing replacement schedule
Unibridge	• Can be completed without extensive construction equipment • Easy expandability • Can be launched using a crane or launching nose (temporary supports not required) • Specialist tools or on-site welding not required	• Standard design fails to consider submergence or scour • Design fails to consider earthquake design • Low performance barrier
Rocla M-Lock	• No large in-situ concrete • No ready-mix concrete required • Fewer on-site skilled labour required • Span over span construction (can be constructed by reaching out) • Minimal construction impact on waterways	• Maximum span of 15 metres • Standard design fails to consider submergence or scour • B1 exposure classification
PERMAcast	• Easy installation of bridge components • Utilise advanced concrete mixes and curing methods	• Escort required for larger bridge components • Bridge components subject to strict quality testing regimes that may prolong construction or installation processes • Manufactured by skilled staff
Country Bridge Solutions	• Ease of transportability of precast components using standard trucks • Reduced maintenance requirements • Lightweight components	• Design only • Not appropriate for use within 1 kilometre of the shoreline of saltwater • Maximum deck height of 10 metres above riverbed level/ground • Equal spans only • Maximum annual average daily traffic of 1000 • B1 exposure classification
Wagners CFT	• Subject to inspection, utilisation of existing timber and concrete bridge abutments can reduce time and cost • Composite products will not rot, rust, corrode or decay • Reduced installation time through prefabrication • Termite proof • Lightweight – allows for simple and quick installation and transport	• Maximum span of 11.8 metres • Wing walls should not be poured prior to installing the decks as it leaves finite space for fitting the units (design dependent) • Extensive testing required, which may prolong time frame

Preliminary Selection	Advantages	Limitations
Stahlton Engineered Concrete	• Large unit size results in faster construction processes • Bridge deck units provide an immediate working platform once in place • No temporary propping or works required • High-strength concrete results in accelerated curing times • Bridges can be used within days of completion • Pre-cast systems eliminate need for ready-mix concrete to delivered to remote sites, which eliminates potential environmental hazards	• Large unit size results in potentially difficult transportability • 50-year design life
Humes	• Built-in continuous kerbing on either side or design to contain effluent and run off • Can be specially designed to any length • All components are manufactured within the factory for easy assembly on site • Quick installation and minimal disruption	• 50-year design life • 0.85 HN loading only
Mabey Compact 200	• Can be used as an emergency, temporary or permanent structure • Quick installation and assembly • Cantilever launch or crane installation • Long unsupported spans • Easy transportability	• Typically, no barriers, however, can be attached if required • Carriageway is narrow • Maximum of two lanes • B1 exposure classification
Waagner-Biro	• Maintenance-free bridge designs • Modular bridge components are deliverable within a short time frame • Scope of supply includes delivery of launching equipment, walkways, construction and site vehicles • Practical training provided for local engineers and workers • Supervision provided during installation process	• Heavy trucks are required for transportation of structural parts • Utilised AASHTO standards, instead of local AS / NZS and codes
Waeger	• Basic precast solutions • Quick construction time on site	• Maximum span of 15 metres • Larger decks are quite heavy • Modified with some cast in-situ elements, including pier columns • Requires in-situ concrete works
Eastbridge	• Componentised supply for ease of transport, assembly and installation • Highly efficient design with no traffic obstruction	• Low performance traffic barrier • Steel truss bridge componentry may result in excessive maintenance regimes and potential for corrosion • Low performance traffic barrier • Normal span range is quite large
Kramer Ausenco	• Provision of construction supervision during bridge construction • Prefabrication results in fast construction time	• Low performance traffic barrier • Large span range and bridge componentry may result in difficulties experienced during transport • 0.85 HN loading only
Novare Design	• Cost effective designs with improved aesthetic appearance • Design solutions can be tailored to suit the preferred construction methodology • Suitable span range flexibility	• 0.85 HN loading only • Low performance traffic barrier
Hynds	• Low cost and quick installation, allowing for rapid completion of works • Simplified preparation and consent of site plans • Precast and pre-stressed components	• 50-year design life • Differential camber between the pre-stressed beams and manufacturing and installation tolerances may result in a small step varying between 5 and 15 mm between the precast concrete beams • Single T beams • 0.85 HN loading only • Single lane only • Maximum span of 16 metres
Acrow Bridge	• Modular design allows for easy customisation of bridge to meet specific requirements • Fast installation in one to four weeks using local labour and minimal heavy equipment • Galvanised steel components • Withstands heavy loads, helpful in unsupervised rural environments	• Steel componentry may require regular maintenance regimes • 75-100-year design life • Utilised AASHTO standards, instead of local AS / NZS and codes
PNG Forest Products NiuBridge System	• Fast installation significantly reduces on-site labour costs and road closure times • Lightweight flexible system is suited to remote areas • Able to be containerised	• 50-year design life • Inadequate marine exposure conditions • Low span range flexibility with 10 m maximum span for NiuBridge system

Preliminary Selection	Advantages	Limitations
	• Environmental credentials of timber results in highly green solution	

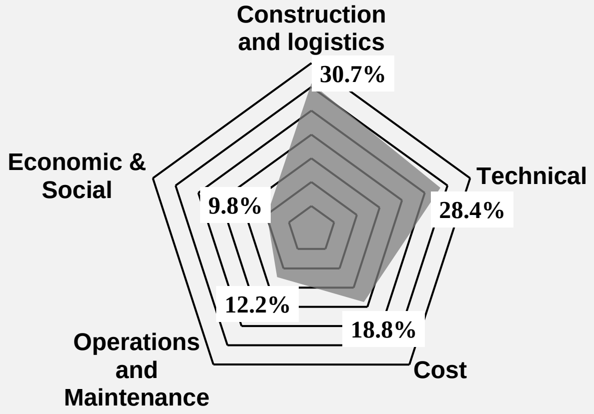
A4 Option Selection Matrix

Preliminary Selection	Span Range Flexibility	Local Design Standards AS / NZS	T44 Vehicle Design Loading	Two Lane Deck	Deck Edge / Traffic Barrier	Design Life	Marine Exposure Conditions (B2)	Corrosion Resistance / Maintenance Access	Local Industry Setup AUS / NZ	Supply and Installation	Constructability			Total
											Onsite Activities	Ease of Transport	Lightweight Components	
InQuik	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓✓	**24**
Unibridge	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓✓	**24**
Wagners CFT	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	**24**
Stahlton Engineered	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓✓	✓	✓✓	**23**
Waeger	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓	**23**
HumeDeck	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓	22
PERMAcast	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓	✓	22
Humes	✓✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	22
Eastbridge	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓	✓	✓✓	✓✓	✓✓	21
SMARTspan	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓	✓	21
Hynds	✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓	20
Novare Design	✓✓	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓	✓	✓	✓	19
Mabey Compact 200	✓✓	✓✓	✓✓	✓✓	✓	✓✓	X	✓	✓✓	✓✓	✓✓	✓✓	✓✓	22*
Rocla M-Lock	✓✓	✓✓	✓✓	✓✓	✓	✓✓	X	✓✓	✓✓	✓	✓✓	✓	✓	20*
Acrow Bridge	✓✓	X	✓✓	✓✓	✓✓	✓	✓✓	✓	✓	✓✓	✓	✓✓	✓✓	20*
PNG FP NiuBridge	✓	✓✓	✓✓	✓✓	✓	✓	X	✓	✓✓	✓✓	✓	✓✓	✓✓	19*
Waagner-Biro	✓	X	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓	19*
Kramer Ausenco	✓	X	✓	✓✓	✓	✓✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	17*
CountryBridge	✓	✓✓	✓✓	✓✓	✓	✓✓	X	✓✓	X	X	✓	✓✓	✓	16*

* these modular bridge systems portray a "not suitable" rating for one or more of the assessment criteria and at this stage will not be considered.

✓✓ - highly suitable | ✓ - suitable | X – not suitable

A5 MCA Matched Pairs Analysis Matrix



Criteria you are comparing against	Criteria you are comparing the performance of																												
	Span Range Flexibility	Local Design Standards AS/NZS	T44 Vehicle Design Loading	Deck Edge / Traffic Barrier	Number of Lanes (1 or 2)	Design Life	Marine Exposure Conditions (B2)	Corrosion Resistance / Maintenance Access	Maintenance Requirements	Warranty Provisions	Storage Requirements	Relevant Track Record	Supplier Annual Turnover	Years of Operation	Local job creation (procurement, construction, service life)	Local materials requirement	Local equipment requirement	Environmental impact	Build cost	Maintenance cost	Whole-of-life cost	Level of on-site activities required	Ease of (Ground) Transport	Lightweight Components	Construction plant and equipment requirements	Fabrication time	Shipment time	Installation time	Weighting
Span Range Flexibility	1	2	2	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	**3.4%**
Local Design Standards AS/NZS		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6.9%**
T44 Vehicle Design Loading			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6.9%**
Deck Edge / Traffic Barrier				1	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**0.3%**
Number of Lanes (1 or 2)					1	2	2	2	2	0	2	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	**2.4%**
Design Life						1	1	1	1	0	0	0	0	0	0	0	0	0	2	2	2	1	1	1	1	1	1	1	**4.3%**
Marine Exposure Conditions (B2)							1	1	1	0	1	0	0	0	0	0	0	0	2	2	2	1	1	1	1	1	1	1	**4.2%**
Corrosion Resistance / Maintenance Access								1	1	0	0	0	0	0	0	0	0	0	2	2	2	1	1	1	1	1	1	1	**4.3%**
Maintenance Requirements									1	0	1	0	0	0	0	0	0	0	2	2	2	1	1	1	1	1	1	1	**4.2%**
Warranty Provisions										1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**0.3%**
Storage Requirements											1	0	0	0	0	0	0	0	2	2	2	1	1	1	1	2	2	2	**3.4%**
Relevant Track Record												1	0	1	0	0	0	0	2	2	2	2	2	2	2	2	2	2	**2.0%**
Supplier Annual Turnover													1	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	**1.1%**
Years of Operation														1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	**1.5%**
Local job creation (procurement, construction, service life)															1	1	1	1	2	2	2	2	2	2	2	2	2	2	**1.3%**
Local materials requirement																1	1	1	2	2	2	2	2	2	2	2	2	2	**1.3%**
Local equipment requirement																	1	1	2	2	2	2	2	2	2	2	2	2	**1.3%**
Environmental impact																		1	2	2	2	2	2	2	2	2	2	2	**1.3%**
Build cost																			1	2	2	0	0	0	0	0	0	0	**6.0%**
Maintenance cost																				1	2	0	0	0	0	0	0	0	**6.3%**
Whole-of-life cost																					1	0	0	0	0	0	0	0	**6.5%**
Level of on-site activities required																						1	1	1	1	2	2	2	**4.0%**
Ease of (Ground) Transport																							1	1	1	2	2	2	**4.0%**
Lightweight Components																								1	1	2	2	2	**4.0%**
Construction plant and equipment requirements																									1	2	2	2	**4.0%**
Fabrication time																										1	1	2	**4.8%**
Shipment time																											1	2	**4.8%**
Installation time																												1	**5.2%**

A6 MCA Basis of Assessment

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
1	**Span Range Flexibility**	Technical	Ability of bridge girders to be extended/adjusted to meet specific site requirements. Are there limiting increments/standard spans? Is the maximum single span less than the upper bound of the defined range of interest i.e. 20m	**InQuik modular bridging system** Currently, max span is 18.5m, though they have preliminary designs for longer spans. Incremental standard spans apply: 6.1m, 9.1m, 12.1m, 13.7m, 16.1m, 18.5m They offer a multi-span option with headstocks between deck span.	1 - the option does not provide a span length within the defined range of interest 2 - the option does provide span lengths within the defined range of interest, however the options are limited to a few fixed increments 3 - the option does provide span lengths within the defined range of interest, with a few fixed increments. 4 - the option does provide span lengths within the defined range of interest, at a number of fixed increments, however girders can be easily extended/adjusted to meet the exact site specific requirements 5 - the option does provide span lengths within the defined range of interest, at a number of fixed increments, however girders can be easily extended/adjusted to meet the exact site specific requirements, and can also provide a single span solution beyond 20m.	It is important to understand how flexible and responsive the technology can be in relation to the site-specific characteristics including typology and required span lengths. Consideration must be given as to how the technology can accommodate typical spans (10m - 20m) based on knowledge of the existing bridge infrastructure asset bases, avoiding the need for pier supports which add cost.	Yes
2	**Local Design Standards AS/NZS**	Technical	Has the technology been designed and certified to an appropriate design standard that is likely to meet expected local standards in the South Pacific, specifically those standards applicable in Melanesian islands?	**Unibridge modular bridge system** Designed to AS 5100	1 - The option does not comply with appropriate AS/NZS or other local design standards within the South Pacific. 2 - The option complies with some appropriate AS/NZS and local design standards within the South Pacific to a lesser degree, with large unknowns/ambiguity. 3 - The option complies with appropriate AS/NZS and is likely to meet expected local standards in the South Pacific. 4 - The option complies with appropriate AS/NZS and local design standards within the South Pacific. 5 - The option clearly complies with all appropriate AS/NZS and all local design standards within the South Pacific, exceeding all necessary requirements and certifications.	The importance of having sufficient design provisions, detailing and capacity cannot be understated. The technology simply cannot be adopted unless it meets the requirements of local standards and codes.	Yes
3	**T44 Vehicle Design Loading**	Technical	Has the technology been designed to accommodate anticipated vehicle loading that is reasonably likely to apply in the South Pacific, specifically transport infrastructure in Melanesian Islands?	**Wagner's CFT modular road bridge** Vehicle Design Loading: SM 1600 | T44	1 - The option does not accommodate T44 vehicle loading, or any other loading likely to apply in the South Pacific. 2 - The option does not accommodate T44 vehicle loading, however does comply with alternative loading requirements that may be suitable in the South Pacific (0.85HN). 3 - The option accommodates T44 vehicle loading (or an alternate equivalent loading HN/OH-75), and meets any other local loading requirements in the South Pacific. 4 - The option exceeds the anticipated T44 vehicle loading, or any other local loading requirements in the South Pacific. 5 - The option satisfies minimum AS5100 loading (SM1600), and any other local loading requirements in the South Pacific.	As with design standards criteria, the ability to meet anticipated local vehicle loading requirements is a fundamental requirement. The technology cannot be adopted unless it meets the requirements of local standards and codes.	Yes

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
4	**Deck Edge / Traffic Barrier**	Technical	Does the technology come with, or support the installation of, suitable deck edging and traffic barrier performance.?	**Mabey Compact 200** Standard arrangement does not come with traffic barriers, however, can be attached if required. *Note, this technology was not shortlisted following the stage 1 evaluation and therefore not included in MCA.*	1 - The option does not accommodate nor support the installation of suitable deck edging or traffic barriers within the design. 2 - The option accommodates the use of deck edging and traffic barriers, however may not meet AS/NZS standards and necessary local safety requirements. 3 - The option accommodates and supports the installation of deck edging and allows for the use of low performance traffic barriers within the design. 4 - The option accommodates and supports the installation of deck edging and allows for the use of regular/medium performance traffic barriers within the design. 5 - The option accommodates and supports the installation of deck edging and allows for the use of high performance traffic barriers within the design.	Subject to anticipated traffic characteristics, design speed, road geometry and volumes (including forecasted future demand), and the number of lanes to accommodate this, there may be a safety requirement imposed necessitating the installation of suitable deck edging and traffic barrier to a specified performance level.	Yes
5	**Number of Lanes (1 or 2)**	Technical	As a minimum one (1) lane plus pedestrian walkway is required; however, depending on anticipated traffic volumes (with consideration for future demand) is there inherent flexibility to allow for a two (2) lane option.	**Waeger precast modular bridging system** Can accommodate multiple lanes at any width	1 - The option accommodates a maximum one (1) lane design, however, does not allow for the addition of a pedestrian walkway if required. 2 - The option accommodates a multi-lane configurated design, however, does not allow for the addition of a pedestrian walkway if required. 3 - The option accommodates a maximum one (1) lane design, with addition of pedestrian walkway if required. 4 - The option accommodates a maximum two (2) lane design, with addition of pedestrian walkway if required 5 - The option accommodates a multi-lane configurated design at any width, with the addition of a pedestrian walkway if required.	Subject to anticipated traffic characteristics, design speed, road geometry and volumes (including forecasted future demand), there may be need for more than one lane. It would be more cost effective to implement as part of the original technology solution than to retrofit or replace later.	Yes
6	**Design Life**	Technical	Has the technology been designed to a 100-year design life in terms of its standard arrangement/specification? If not standard, can a 100-year design life be achieved economically.	**Stahlton Engineered Concrete precast modular bridge system** 50-year design life	1 - The option provides a lesser than 100 year design life, with very frequent maintenance, and/or replacement in the short-term. 2 - The option provides a lesser than 100 year design life with regular maintenance. 3 - The option achieves a 100 year design life with regular maintenance. 4 - The option provides a 100 year design life with irregular maintenance. 5 - The option exceeds a 100 year design life with irregular maintenance.	The durability of infrastructure is a key consideration set out in the World Bank Terms of Reference (ToR) document. **Disaster response implications.**	Yes

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
7	**Marine Exposure Conditions (B2 or C4)**	Technical	Marine exposure conditions - minimum B2 classification required for concrete structures, as per AS5100.5 Table 4.3, or minimum C4 corrosion category for steel structures as per AS5100.6 Table G1.	**InQuik modular bridging system** The current standard InQuik products have been designed with a min. 55mm concrete cover, for a 100-year design life. Consistent with AS5100, B1 classification is achieved using min. 40MPa concrete. B2 classification is achieved using 50MPa concrete. Depending on design life, concrete grade used, or if higher classification is required, the designs can be modified to increase the concrete cover.	1 - The option does not provide any suitable exposure or corrosivity conditions within the design. The design cannot be modified to increase classification level. 2 - The option accommodates for maximum B1 exposure conditions and low corrosivity requirements (C2) within the design. 3 - The option typically accommodates for less than B2 or C4 exposure/corrosivity conditions (B1/C3), however, the design can be modified to increase classification level to minimum B2 and corrosivity category C4. 4 - The option accommodates for minimum B2 exposure conditions, or minimum C4 corrosivity. The design can be modified to increase classification level, if required. 5 - The option accommodates for extreme marine conditions (C1/C2) and high levels of corrosivity (C5). The design can be modified to account for any level of exposure/corrosion.	The durability of infrastructure is a key consideration set out in the World Bank Terms of Reference (ToR) document.	Yes
8	**Corrosion Resistance / Maintenance Access**	Operations and Maintenance	How resistant is the technology to corrosion during its service life and what are the corrosion treatment requirements (are there likely to be maintenance access issues?)	**InQuik modular bridging system** The Magnelis-coated material used by InQuik is more resistant to corrosion than galvanised steel. In high salinity coastal environments, the material has an expected lifetime before first maintenance (steel perforation) of > 50 years.	1 - The option does not provide any suitable exposure or corrosivity conditions within the design. The option is likely to require first corrosion treatment within 10 years of operation, with expected maintenance access issues. 2 - The option accommodates for maximum B1 exposure conditions and low corrosivity requirements (C2) within the design. The option is likely to require first corrosion treatment within 20 years of operation, with expected maintenance access issues. 3 - The option typically accommodates for less than B2 or C4 exposure/corrosivity conditions (B1/C3), however, the design can be modified to increase classification level to minimum B2 and corrosivity category C4. The option is only likely to require treatment for corrosion once during its design life. 4 - The option accommodates for minimum B2 exposure conditions, or minimum C4 corrosivity. The design can be modified to increase classification level, if required. The option is only likely to require treatment for corrosion once during its design life. 5 - The option accommodates for extreme marine conditions (C1/C2) and high levels of corrosivity (C5). The design can be modified to account for any level of exposure/corrosion and is unlikely to require treatment for corrosion during design life.	The durability of infrastructure is a key consideration set out in the World Bank Terms of Reference (ToR) document.	Yes

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
9	**Maintenance Requirements**	Operations and Maintenance	The scope and frequency of maintenance and inspection activities in order to realise intended design life i.e. engineering useful life = theoretical design life.	**Waeger precast modular bridging system** Cleaning of bridge deck and substructure required (prevent build-up of debris). Bearings to be checked / replaced at approximately 50 years life. Steel components to be monitored / inspected for deterioration and replaced as required (typically 50-year life expected).	1 - The option prescribes extensive maintenance and inspection activities, bi-annually or less in frequency, requiring the efforts of experienced asset management/engineering professionals and proprietary knowledge the option technology 2 - The option prescribes extensive maintenance and inspection activities, bi-annually or less in frequency, requiring the efforts of asset management/engineering professionals 3 - The option prescribes maintenance and inspection activities that are comparable to traditional construction methods, bi-annually or less in frequency, requiring the efforts of asset management/engineering professionals 4 - The option prescribes minimal maintenance and inspection activities, bi-annually or less in frequency, requiring the efforts of asset management/engineering professionals 5 - The option requires little to no maintenance in order to achieve the specified design life for the given operating environment and applied load conditions, and can be planned and performed by skill labour with little to no guidance	It is well understood that even a moderately sophisticated approach to the maintenance of transport infrastructure, in-keeping with the likely supplier requirements, in the South Pacific is not realistic; therefore, any solutions which require little to no maintenance without significantly impacting upon the remaining useful life would be considered favourably.	No
10	**Warranty Provisions**	Operations and Maintenance	Does the technology supplier provide a suitable warranty against defective products?	**Unibridge modular bridge system** Warranty against any manufacturing defect for three (3) years.	1 - No warranty for defective products provided 2 - Warranty for defective products 1yrs 3 - 2-year warranty provided for manufacturing defects 4 - 3-year warranty provided for manufacturing defects 5 - 5-year warranty provided for manufacturing defects including corrosive defects	Resources are very limited in the South Pacific (including Melanesia), so understanding any warranty provisions that can help provide surety that there is contractual coverage for defective products for a certain amount of time will be considered favourably.	No
11	**Storage Requirements**	Operations and Maintenance	Are there onerous storage requirements? Can the bridge components be stacked easily?	**Unibridge modular bridge system** Components can be stacked. Decks are prestressed, so should be supported no more than 0.6m from the end of each beam. Timber dunnage should be supported on stable, level ground.	1 - Components cannot be stacked during storage 2 - Components can be stacked during storage however specialised equipment (racking) or skilled labour required 3 - Components can be stacked during storage 4 - Components can be stacked during storage with minimal support requirements 5 - Components can be stacked during storage with no additional support requirements	The ability for bridge components to be stored easily, without overly onerous environmental conditions, will help with the initial construction planning, but perhaps more importantly will help support the development of any disaster response strategy or asset management strategy (with respect to corrective maintenance) which looks to utilise in-country storage. **Disaster response implications.**	No
12	**Relevant Track Record**	Economic & Social	Track record of supplier, including relevant project experience.	**InQuik modular bridging system** InQuik have not yet exported to the South Pacific but have undertaken market expeditions and quoted projects in Fiji, Vanuatu, New Zealand and	1 - The option has no relevant track record 2 - The option has minimal project experience in Australia and New Zealand, no project experience in the south pacific 3 - The option has project experience in corrosive environments in Australia and New Zealand, understands export requirements to the South Pacific	With any proprietary product fabricated off-site, it is important to understand whether the supplier has an appreciation for local context, and whether there is existing evidence that the associated technology has, and will, perform as intended within this local context.	No

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				Papua New Guinea. The Unibridge modular bridging system has been formally approved as a bridge system by the PNG Department of Works. They had been designed into a project for Vanuatu, but the winning contractor changed the design.	4 - The option has relevant project experience in the South Pacific region 5 - The option has extensive project experience in the South Pacific with performance meeting or exceeding expectations		
13	**Supplier Annual Turnover**	Economic & Social	Average annual turnover over the past five (5) years	**Waeger precast modular bridging system** Average turnover of AUD$14M per year	1 - Average turnover < AUD $10M 2 - Average turnover < AUD $50M 3 - Average turnover > AUD $50M 4 - Average turnover > AUD $100M 5 - Average turnover > AUD $200M	The size of the supplier (in terms of annual turnover) can give an indication as to how likely the supplier is to sustain itself during short term economic stresses and strains and provide for longevity of service. This can have implications on the any cash flow requirements of the supplier as part of commercial negotiations as well as providing surety that the supplier will be able to service maintenance and replacement works (as required) over the useful life of the asset; particularly important with proprietary technologies.	No
14	**Years of Operation**	Economic & Social	The amount of years the supplier has been operation.	**Stahlton Engineered Concrete precast modular bridge system** Fulton Hogan (parent company) has been in operation 86 years and completed its first project in the Pacific in 1983 with the overlay of Nadi airport.	1 - Supplier has been in operation for < 5years, technology deployed for < 1year 2 - Supplier has been in operation for < 10years, OR technology deployed for < 2years 3 - The supplier has been in operation for >10 years, OR technology deployed for >2 years 4 - The supplier has been in operation for >25 years, OR technology deployed for >5 years 5 - Supplier has been in operation for >25 years, OR technology deployed for >10 years	The amount of years a supplier has been operating provides inference of both experience and ongoing longevity, supporting the overall supplier assessment. An established organisation provides a greater level of comfort that it will be able to service the ongoing needs of their clients, as well as potentially having a product that has been tested over a longer period of time.	No
15	**Local job creation (procurement, construction, service life)**	Economic & Social	Does the technology provide employment opportunities for local labour during procurement, construction and/or its service life?	**Stahlton Engineered Concrete precast modular bridge system** For a one-off small bridge, 3 - 5 FTE job creation during construction, where the skill level required relates to the following roles: - crane operator - dogman - supervisor - general labourers	1 - The option produces nil local employment opportunities 2 - The option produces local employment opportunities less than that of traditional construction methods across procurement, construction and service life 3 - The option produces local employment opportunities on par with traditional construction methods across procurement, construction and service life. 4 - The option produces local employment opportunities exceeding traditional construction methods across procurement, construction and service life 5 - The option produces local employment opportunities significantly	Understanding any local job creation opportunities during procurement, construction and the service life, that supports local communities (and their micro economy) should be considered favourable.	No

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
					exceeding (50% increase) traditional construction methods across procurement, construction and service life		
16	**Local materials requirement**	Economic & Social	Will the technology use locally produced materials during construction and maintenance of the modular bridge?	**Unibridge modular bridge system** Concrete supply	1 - The solution uses nil locally sourced materials during construction and maintenance 2 - The solution uses materials sourced locally (including the South Pacific) during construction and maintenance 3 - Over 50% of materials used during construction and maintenance are sourced locally (including the South Pacific) 4 - Over 50% of materials used during construction and maintenance are sourced locally (region bridge installed) 5 - Over 75% of materials used during construction and maintenance are sourced locally (region bridge installed)	Understanding any demand and resulting consumption of local materials during construction and service life, that supports local communities (and their micro economy) should be considered favourable.	No
17	**Local equipment requirement**	Economic & Social	Will the technology use locally sourced equipment during construction and maintenance of the modular bridge?	**Unibridge modular bridge system** The main local equipment and materials are: - concrete - crane and plant hire - concreting equipment (screeds, etc) - hand tools and hand power tools	1 - The solution uses nil locally sourced equipment during construction and maintenance 2 - The solution uses equipment sourced locally (including the South Pacific) during construction and maintenance 3 - Major equipment (crane, earthmoving) used during construction and maintenance are sourced locally (including the South Pacific) 4 - Major equipment (crane, earthmoving) used during construction and maintenance are sourced locally (region bridge installed) 5 - All equipment (crane, earthmoving) used during construction and maintenance are sourced locally (region bridge installed)	Understanding any demand and resulting consumption of local equipment during construction and service life, that supports local communities (and their micro economy) should be considered favourable.	No
18	**Environmental impact**	Economic & Social	Are any sustainability principles adopted throughout the asset lifecycle (asset creation, maintenance and disposal)?	**InQuik modular bridging system** InQuik' s reinforcing steel manufacturer, ARC, is part of the Liberty group, which uses recycled steel in its processes as part of their policy is to promote and expand the use of 'Green steel'.	1 - There is evidence to suggest the option presents additional adverse effects on the environment during the asset lifecycle than that associated with traditional construction methods 2 - The option is reasonably likely to present additional adverse effects on the environment during the asset lifecycle than that associated with traditional construction methods 3 - There is no evidence of sustainability principles being adopted, however the option does not present any additional adverse effects on the environment during the asset lifecycle than that associated with traditional construction methods 4 - There is evidence of sustainability principles being adopted such that there is a reduction in the environmental impact compared to traditional construction methods 5 - The option pioneers the use of sustainable practices in bridge construction and asset management such that there is a significant reduction in the environmental impact compared to traditional construction methods	Understanding any contribution towards sustainability goals should be considered favourable.	No

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
19	**Build cost**	Cost	Direct costs of supply only based on indicative (non-binding) supplier quotes.	**InQuik modular bridging system** Single-lane (4.8m-wide), 13.7m-span bridge deck with Magnelis formwork, T44 load rating, flat side, integral = $77,000 ($5,620 per linear meter, between $2,500 - $3,500 per SQM) All figures AUD, exclusive of tax (as of 2019)	1 - The option direct build costs significantly exceed (50% increase) traditional construction methods 2 - The option direct build costs exceed (25% increase) traditional construction methods 3 - The option direct build costs are on par with traditional construction methods 4 - The option direct build costs are lower (25% decrease) than traditional construction methods 5 - The option direct build costs are significantly lower (50% decrease) than traditional construction methods	The ability to construct and maintain bridge infrastructure at a Whole of Life Cost less than that incurred from traditional construction methods is a key success measure set out in the World Bank Terms of Reference (ToR) document.	No
20	**Maintenance cost**	Cost	Qualitative comparative assessment of maintenance costs based on the scope and frequency of the required maintenance and inspection activities.	**InQuik modular bridging system** The InQuik integral bridge is very low maintenance. Periodic inspections should still be carried out (according to site conditions/extreme events), but the structure does not have bearings or tie-downs (which eventually wear out and require replacement). The main parts that may require regular maintenance are the barriers. **Provides inference of maintenance costs*	1 - The option prescribes extensive maintenance and inspection activities, bi-annually or less in frequency, and requires the replacement of major parts or components such as the bearings and tie downs within specified design life, for a given operating environment and applied load conditions 2 - The option prescribes extensive maintenance and inspection activities, bi-annually or less in frequency, and may require the replacement of major parts or components such as the bearings and tie downs within specified design life, for a given operating environment and applied load conditions 3 - The option prescribes maintenance and inspection activities that are comparable to traditional construction methods, bi-annually or less in frequency, and may require the replacement of bearings and tie downs within the specified design life, for a given operating environment and applied load conditions 4 - The option prescribes minimal maintenance and inspection activities, bi-annually or less in frequency, and unlikely to require the replacement of major parts or components such as the bearings and tie downs within the specified design life, for a given operating environment and applied load conditions 5 - The option requires little to no maintenance in order to achieve the specified design life for the given operating environment and applied load conditions	The ability to construct and maintain bridge infrastructure at a Whole of Life Cost less than that incurred from traditional construction methods is a key success measure set out in the World Bank Terms of Reference (ToR) document.	No
21	**Whole-of-life cost**	Cost	Qualitative comparative assessment of Whole-of-Life costs based on expected construction and O&M costs.		1 - Over a 100-year useful life, both the initial build cost and inferred maintenance costs are significantly greater than traditional construction methods. 2 - Over a 100-year useful life, the option expected whole of life cost is greater than traditional construction methods 3 - Over a 100-year useful life, the option whole of life costs is on comparable to traditional construction methods	The ability to construct and maintain bridge infrastructure at a Whole of Life Cost less than that incurred from traditional construction methods is a key success measure set out in the World Bank Terms of Reference (ToR) document.	No

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
					4 - Over a 100-year useful life, he options expected whole of life cost is less than traditional construction methods 5 - Over a 100-year useful life, the initial build cost and inferred maintenance costs are significantly less than traditional construction methods		
22	**Level of on-site activities required**	Construction and logistics	The level of onsite activity required during the construction of the modular bridge solution.	**Stahlton Engineered Concrete precast modular bridge system** Requires some grouting to be completed for precast abutment to pile connection, shear connection between units, and concrete topping to bridge deck.	1 - The option requires a very high level of onsite activity during the construction of the modular bridge solution. 2 - The option requires a high level of onsite activity during the construction of the modular bridge solution. 3 - The option requires a standard level of onsite activity during the construction of the modular bridge solution. 4 - The option requires nominal onsite activity during the construction of the modular bridge solution. 5 - The option requires minimal onsite activities during the construction of the modular bridge solution.	It is important to understand the level of on-site activities required to complete construction as per the supplier's requirements, as this will inform the skills and expertise requirements that need to be met by locally available resources. **Disaster response implications.**	Yes
23	**Ease of (Ground) Transport**	Construction and logistics	Ground transport requirements to move the bridge components to the construction site.	**Stahlton Engineered Concrete precast modular bridge system** Large unit sizes may make it difficult to transport to site. Flat deck truck required as a minimum.	1 - The option does not allow for easy ground transportation, and requires heavy, specialised/oversized vehicles with escort. 2 - The option allows for standard industry ground transportation, and requires extensive, heavy, specialised/oversized vehicles with escort. 3 - The option allows for standard industry ground transportation, however, some specialised/oversized vehicles may be required. 4 - The option allows for standard industry ground transportation, and no specialised/oversized vehicles may be required. 5 - The option allows for easy ground transportation, and no specialised/oversized vehicles are required.	It is important to understand what the ground transport requirements will be to move bridge components to site as this will inform the required vehicle and equipment, but also the required transport infrastructure to/from site. It is not uncommon for remote sites to have insufficient road infrastructure to support heavy vehicle movements as well as having challenging typology. **Disaster response implications.**	Yes
24	**Lightweight Components**	Construction and logistics	Weight of the bridge components and the implications on plant and equipment usage including cranage requirements during construction.	**Unibridge modular bridge system** Unibridge beams are typically 1T per linear meter. The Unibridge system can be craned into place or launched if there is not sufficient crane capacity on site.	1 - The option includes heavy bridge components that require specialised cranage and are difficult to transport (>50t). 2 - The option includes moderately heavy bridge components (20-50t). 3 - The option includes moderately weighted bridge components (15-20t). 4 - The option includes lightweight bridge components (10-15t). 5 - The option includes considerably lightweight bridge components (<10t).	The weight of the bridge components helps understand and predict any challenges in terms of both transport (shipping and ground transport) as well as during construction in terms of plant & equipment needs. **Disaster response implications.**	Yes

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
25	**Construction plant and equipment requirements**	Construction and logistics	Plant and equipment requirements to support installation.	**Waeger precast modular bridging system** Depending on site constraints, the units could typically be installed using either a single 160t crane, or a dual crane lift if access permits.	1 - The option requires a substantially high level of construction plant and equipment, including the use of extremely heavy cranage. 2 - The option requires a standard industry level construction plant and equipment, including the use of heavy cranage. 3 - The option requires a standard industry level of construction plant and equipment, including the use of moderate cranage. 4 - The option requires a low level of standard industry construction plant and equipment, including the use of standard to lightweight cranage. 5 - The option requires minimal construction plant and equipment, including the use of lightweight cranage.	It is understood the availability of specialist plant and equipment in the South Pacific, specifically Melanesia, may be limited, so understanding the specific plant and equipment requirements as they pertain to a particular technology will help with construction planning and understanding any potential constructability issues. **Disaster response implications.**	No
26	**Fabrication time**	Construction and logistics	The time associated with off-site fabrication.	**Wagner's CFT modular road bridge** Circa. 20 working days fabrication time	1 - The option requires a substantially long off-site fabrication time for modular bridge components (>12 weeks). 2 - The option requires a moderately long off-site fabrication time for modular bridge components (9-12 weeks). 3 - The option requires an average off-site fabrication time for modular bridge components (6-9 weeks). 4 - The option requires a shorter off-site fabrication time for modular bridge components (4-6 weeks). 5 - The option requires an significantly short off-site fabrication time for modular bridge components (<4 weeks).	Impacts on lead time from placing order to receiving bridge components at the site ready for installation. **Disaster response implications.**	No
27	**Shipment time**	Construction and logistics	The time associated with shipping bridge components to islands in the South Pacific, specifically those islands in Melanesia.	**Unibridge modular bridge system** Circa. 45 working days shipping time.	1 - The option is being shipped from a location that requires a substantially long shipment time of bridge components to islands in the South Pacific (>12 weeks). 2 - The option is being shipped from a location that requires a moderately long shipment time of bridge components to islands in the South Pacific (9-12 weeks). 3 - The option is being shipped from a location that requires an average shipment time for bridge components (6-9 weeks). 4 - The option is being shipped from a location that requires a shorter shipment time for bridge components (4-6 weeks). 5 - The option is being shipped from a location that requires a shorter shipment time for brideg components (<4 weeks).	Impacts on lead time from placing order to receiving bridge components at the site ready for installation. **Disaster response implications.**	No

Criteria Definitions

Ref	Criteria	Category	What is being considered	Example information/data	Basis of Assessment (1 to 5)	Justification	Threshold Criteria
28	**Installation time**	Construction and logistics	The installation time of the superstructure decking, assuming all planning and consents are in place, sub-structure is complete, minimum labour requirements met, and all plant and equipment are available and on-site	**Waeger precast modular bridging system** For a Waeger Deck type modular bridge, the superstructure construction can be done in a single day (typically 2 to 3 days until trafficable).	1 - The option requires an installation time for the superstructure decking that is greater than 3 weeks in duration. 2 - The option requires an installation time for the superstructure decking that is between 2-3 weeks in duration. 3 - The option requires an installation time for the superstructure decking that is approximately 1 week in duration 4 - The option requires an installation time for the superstructure decking that is between 2-5 days in duration. 5 - The option requires an installation time for the superstructure decking that is less than 1 day.	The ability to construct bridge infrastructure quicker than traditional construction methods is a key success measure set out in the World Bank Terms of Reference (ToR) document. **Disaster response Implications.**	No

A7 MCA Scoring

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	Category	Criteria	Evidence Provided (summarised)	Score	Evidence Provided (summarised)	Score	Evidence Provided (summarised)	Score	Evidence Provided (summarised)	Score	Evidence Provided (summarised)	Score
1	Technical	Span Range Flexibility	Current maximum span of 18.5m, with preliminary designs available for longer spans. Multi-span options available.	4	57m maximum clear girder span, with the option to extend or modify these spans with the use of piers.	5	15m maximum girder spans, with potential to modify or extend the bridge if required.	3	Maximum girder span of 15.5m. Potential to modify or extend. Beyond 15.5m Stahlton can work with Hollowcore bridge beams.	3	For Waeger decks, maximum overall length of bridge is 15.5m (clear span of 14m). Decks can be made to any length up to 15.5m.	3
2	Technical	Local Design Standards AS/NZS	InQuik complies with AS5100 (2017) bridge design code (certified by SMEC Australia).	5	Unibridge complies with AS5100 (2017) bridge design code.	5	Wagners CFT complies with AS5100 bridge design code.	5	Stahlton complies with NZTA bridge manual (NZS3101).	3	Waeger complies with AS5100 (2017) bridge design code.	5
3	Technical	T44 Vehicle Design Loading	Satisfies minimum AS5100 loading (SM1600) and can also provide lower rated loadings at T44.	5	Satisfies minimum AS5100 loading (SM1600). If exceptional loads need to pass, Unibridge are able to review the specific vehicle and determine if it can pass over the bridge.	5	Satisfies AS5100 loading (SM1600).	5	Maximum vehicle loading of HO or 0.85HN.	2	Satisfies AS5100 loading (SM1600).	5
4	Technical	Deck Edge / Traffic Barrier	InQuik accommodates for the use of regular/medium performance traffic barriers, with low performance barriers also available.	4	Unibridge accommodates for the use of regular/medium traffic barriers, however, normally supply low level barriers to prevent impact loads being transferred to the Unibridge beams underneath.	4	Wagners CFT will accommodate traffic barriers depending on client requirements.	3	Stahlton accommodates for low performance traffic barriers within the design (in the form of kerb/bump stop).	3	Typically, a low performance barrier, but can accommodate up to a regular/medium performance level barrier.	4

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
5	Technical	Number of Lanes (1 or 2)	There is no maximum width for the bridge. InQuik bridges can be multi-lane and have been designed between 3.2m and 13.3m wide. A walkway can be provided alongside the deck.	5	There is no maximum number of lanes as the Unibridge system can be designed to be as wide as required. Walkways can be attached to either side of the Unibridge and can be added at any time.	5	Wagners CFT solution accommodates a maximum two (2) lane design. A pedestrian walkway can be added.	4	Typically, single lane, but can be multi-lane. A pedestrian walkway can be added.	5	No limit to lane numbers. A walkway can be added with extra deck units (widths can vary accordingly).	5
6	Technical	Design Life	100-year design life with minimal long-term maintenance requirements.	4	100-year design life with regular maintenance due to steel componentry, including checking of bolts after one month and then six months.	3	75-year design life	2	50-year design life	2	100-year design life with irregular maintenance.	4
7	Technical	Marine Exposure Conditions (B2 or C4)	Typically accommodates for B1 exposure conditions, to achieve a 100-year design life. However, utilising alternative concrete strengths can achieve B2 classification, however, reduces design life to 50-60 years.	3	Unibridge modular bridge solutions accommodate for minimum C4 corrosivity category.	4	Resistant to corrosion – ideal for application in coastal environments.	4	Can be designed for coastal conditions	3	Typically accommodates for B1 but can be customised for more aggressive environments where needed.	3
8	Operations and Maintenance	Corrosion Resistance / Maintenance Access	100-year design life (B1 classification) is achieved by using 40MPa concrete or 50MPa in a coastal environment (B2 classification) using 25MPa concrete would reduce the design life to 50-60 years. The Magnelis-coated material used by InQuik is more resistant to corrosion than galvanised steel. In high salinity coastal environments, the material has an expected lifetime before first maintenance (steel perforation) of >50 years.	3	C4 (High corrosion risk - Urban and industrial atmospheres with moderate sulphur dioxide pollution and/or coastal areas with low salinity.)	4	Composite fibre components not subject to corrosion.	4	Can be designed for coastal conditions	3	Typically, B1, but can be customized for more aggressive environments where needed	3

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
9	Operations and Maintenance	Maintenance Requirements	The InQuik integral bridge is very low maintenance. Periodic inspections should still be carried out (according to site conditions/extreme events), but the structure does not have bearings or tie-downs (which eventually wear out and require replacement). The main parts that may require regular maintenance are the barriers. Maintenance can be performed directly by the asset owner/operator	4	A check of the bolts after one month and then six months is recommended. We also suggest using lock tight or some similar product to endure that there is no loosening. No spare parts required Maintenance can be performed directly by the asset owner/operator	3	Minimal inspection/maintenance required: possible 20 years to the first inspection	5	It is expected that an annual inspection (possibly even bi-yearly) would be required. Maintenance activities would typically primarily be patching any damage to concrete elements. Depending on the barrier system etc this will have its own requirements but could be selected to align with the Stahlton precast modular bridge maintenance cycle.	3	Cleaning of bridge deck and substructure required (prevent build-up of debris). Bearings to be checked / replaced at approximately 50 years life. Steel components to me monitored / inspected for deterioration and replaced as required (typically 50-year life expected) All maintenance could be completed by asset owners with experience in bridge maintenance/construction	3
10	Operations and Maintenance	Warranty Provisions	Will repair/replace goods that have a structurally significant defect if notified within 15 months of delivery (or 12 months of installation).	2	Provides three (3) year warranty against manufacturing defects.	4	7 years materials only	5	No warranty is offered	1	Do not have a standard warranty, and this could be negotiated if needed.	1
11	Operations and Maintenance	Storage Requirements	Before installation, InQuik parts should be stored under cover, protected from the elements. The modular units can be easily stacked. The InQuik system is designed for ease of transport and can be supplied in shipping container or transported by break bulk. Standard panels will fit on a regular semitrailer, with no need for wide/long load escort requirements.	5	Only requirements are to respect the protected surfaces during storage. All Unibridge parts can be easily stacked.	5	Can be stacked	5	units can be stacked on dunnage over the lifting points	5	Items can be stacked. Decks are prestressed, so should be supported no more than 0.6m from the end of each beam. Timber dunnage should be supported on stable, level ground.	5

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
12	Economic & Social	Relevant Track Record	We have not yet exported to the South Pacific, but we have undertaken market expeditions and quoted projects in Fiji, Vanuatu, New Zealand and Papua New Guinea. We have been formally approved as a bridge system by the PNG Department of Works. We were also designed into a project for Vanuatu, but the winning contractor (from China) changed the design. 2 years' experience in Australia with experience in remote areas including Far North Queensland (tropics). inquik.com.au/projects/	2	We have installed over 550 Unibridge bridges of all types in the Philippines. Depending on the sites location and accessibility determined installation times.	5	Minimal experience in South Pacific	3	Have shipped 2 bridge units from Christchurch to Fiji to be installed by Fulton Hogan Fiji Civil in recent years. One of these bridges has since been relocated from its temporary location to a new location, which is easily done due to the modular nature of the system. FRA was the customer - both bridges (and both installations of the first bridge) was a great outcome for them we understand	4	Strong experience in NSW. No experience outside Australia	3
13	Economic & Social	Supplier Annual Turnover	InQuik was founded in April 2017. Turnover figures: 2016-17: AUD$232,360 (approx. USD$164,000) 2017-18: AUD$600,200 (approx. USD$424,000) 2018-19: AUD$951,700 (approx. USD$672,000)	1	€100M plus (approx. AUD$162.5m + or USD$115m +)	4	No information made available	1	NZD 3 - 4b (approx AUD$2.8 - 3.8b or USD$2.0 - 2.7b)	5	Average turnover of AUD$14M per year (approx USD9.9M per year)	2
14	Economic & Social	Years of Operation	InQuik was founded in April 2017.	3	87 years	5	15years	3	86 years No comment on bridge solution	5	25+ years.	5

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
15	Economic & Social	Local job creation (procurement, construction, service life)	Typically, with a small crew of 3–5 people, two preassembled abutment/wing wall sets could be installed, and the concrete poured and finished in about 6 hours on- site.	2	5-man team, crane operator and rigger will completely install composite model Unibridge in 6 hours. with one of our Technical Assistance operators on site. Local untrained labour can easily and effectively be utilised.	2	3 hours minimum	2	For a one-off small bridge, 3 - 5 Crane operator, dogman, supervisor, labourers We use local labour in Fiji	2	For a Waeger Deck type modular bridge, the superstructure construction can be done in a single day. Typically, 3-4 persons for the duration of the construction period. Local labour can be used to supplement experienced supervisors.	2
16	Economic & Social	Local materials requirement	The main local materials are: - concrete (can also be imported if necessary) Refer InQuik Installation guide page 22 - 24 supplied	5	Concrete deck can be prefabricated or cast on site	1	no cast in situ requirements.	1	All materials could potentially be imported	1	non-shrink grout	2
17	Economic & Social	Local equipment requirement	The main local equipment includes: - crane and plant hire - concreting equipment (screeds, etc) - hand tools and hand power tools	5	Minimal lifting capacity and standard tools are fine transported in Standard 40’ and 20’ shipping containers Unibridge beams are typically 1T per linear meter. The Unibridge system can be craned into place or launched so if there is not sufficient crane capacity on site it is not an issue for us.	4	Flatbed trailer and small crane to lift off into position.	4	Flat deck truck 17 - 20 tonne max, cranage is required, FH have cranes in Fiji	3	Flatbed semi-trailer or extensible trailer. 15m long deck units can be up to 28t which may require extendable low loaders or jinker trailers depending on local road conditions. 26-30t for 15m Waeger Decks (depending on widths). Cranage is needed to loading/unload and installation. Cranes, steelwork / barriers	4
18	Economic & Social	Environmental impact	InQuik's reinforcing steel manufacturer, ARC, is part of the Liberty group, which uses recycled steel in its processes as part of their policy is to promote and expand the use of 'green steel'.	4	The entire Unibridge can be recycled at the end of the bridge’s lifespan.	4	Use of "Green" concrete when requested	3	No evidence of sustainability principles adoption.	3	No evidence of sustainability principles adoption.	3

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
19	Cost	Build cost	For 13.7x4.8m, deck cost is AUD$1,170 per SQM (approx USD $826 per SQM) Superstructure: 13.7x4.8m integral bridge deck, Magnelis formwork, T44 load rating, flat side, integral = AUD $77,000 (approx USD $54,500) **Excludes GST**	4	Unibridge Composite model 17.5m long 5m wide concrete deck, and two lines of beams 1.0m for launch installation: AUD$131,816 (approx USD$93,500) Cost to Port of Melbourne. **Excludes GST**	3	AUD$2300 per SQM (approx USD$1,623 per SQM) Cost for bridge decking, before traffic barriers **Excludes GST**	3	AUD$34,000 (approxUSD$24,000) for bridge decking or AUD$630 per SQM (approx USD$445 per SQM) **Excludes GST**	5	Ranges between AUD$23,000 to AUD$27,000 per deck unit (approx USD$16,500 to USD$19,500 per deck unit). 2 required for a single lane bridge (AUD54,000 or USD38,500). Costs can be reduced for larger production runs. **Excludes GST**	5
20	Cost	Maintenance cost	The InQuik integral bridge is very low maintenance. Periodic inspections should still be carried out (according to site conditions/extreme events), but the structure does not have bearings or tie-downs (which eventually wear out and require replacement). The main parts that may require regular maintenance are the barriers.	4	The bolts need to be checked after one month and then six months. Annual maintenance and inspection activities are recommended.	3	Minimal inspection/maintenance required: possible 20 years to the first inspection	5	Annual inspections recommended Maintenance expected to be condition based, with principal activity being concrete patching (due to an impact event or general deterioration).	3	Bi-annual inspections recommended Cleaning Checking of bolts Bearings expected to be replaced 40 to 60 years	3
21	Cost	Whole-of-life cost	This option is expected to be cheaper to build and maintain and has a 100-year design life. Therefore, it is expected to be more economical than traditional construction methods in terms of Whole of Life cost.	4	This option has a 100-year design life and is comparable in initial build costs and maintenance costs and is therefore expected to have a similar Whole of Life cost to traditional construction methods.	3	The initial build cost is comparable to traditional construction methods. Given this option has a 75-year design life, there is a reasonable probability that replacement or additional condition-based maintenance (life extension) is required to achieve a 100-year useful life. Overall, the expectation is that this option is comparable in Whole of Life cost	3	This option has a low initial cost outlay. Given the option only has a 50-year design life, it is expected to be replaced at least once to achieve a 100-year useful life. Despite replacement costs, it is still expected to be more economical than traditional construction methods in terms of Whole of Life cost.	4	This option has a low initial cost outlay, but requires regular maintenance and inspection activities, as well as expecting the replacement of bearings and steel components at approximately 50 years. Overall, the Whole of Life costs are still expected to be less than traditional construction methods.	4

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
							with traditional construction methods.					
22	Construction and logistics	Level of on-site activities required	The InQuik system is fully cast onsite to create an incredibly robust monolithic bridge structure, hence, requires a standard level of onsite activity during the construction process.	3	The Unibridge system requires minimal onsite activities during construction. The concrete deck option can be either cast-in-situ or precast.	5	Minimal onsite activities are required during construction of the modular bridge solution.	5	Minimal onsite activities. Only requires grouting.	5	Minimal onsite activies. Grouted shear key joints required.	5
23	Construction and logistics	Ease of (Ground) Transport	InQuik modular bridge solutions do not require specialised/oversized vehicles for transportation. Standard panels will fit on a regular semi-trailer, with no need for wide/long load escort requirements.	4	Unibridge modular bridge systems required some specialised transportation including 40' to 20' shipping containers	3	Wagners CFT do not require specialised/oversized vehicles for transportation. A flatbed trailer is typically required for transportation.	4	Stahlton do not require specialised/oversized vehicles for transportation. A flatbed trailer is typically required for transportation.	4	Flatbed semi-trailer or extensible trailer. 15m long deck units can be up to 28t which may require extendable low loaders or jinker trailers depending on local road conditions.	3
24	Construction and logistics	Lightweight Components	The InQuik modular bridge solution includes considerably lightweight components, with a 16.1m deck panel having a weight of approx. 8.5-9.5t.	5	Unibridge beams are typically 1T per linear metre (15-20T for a 15m to 20m bridge).	3	Typical bridge components are lighter than timber or steel.	3	17-20 tonne maximum	3	26-30t for 15m Waeger decks (depending on widths).	2

MCA Scoring			InQuik modular bridge		Unibridge modular bridge		Wagners CFT modular bridge		Stahlton precast modular bridge		Waeger precast modular bridge	
Ref	**Category**	**Criteria**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**	**Evidence Provided (summarised)**	**Score**
25	Construction and logistics	Construction plant and equipment requirements	InQuik modular bridge solutions can be installed using HIAB and Franna cranes due to the lightweight components. Lightweight crane is required to lift the bridge panels in place.	4	Unibridge system can be craned into place or launched, so if there is not sufficient cranage capacity onsite, it is not an issue. Minimal lifting capacity is required.	4	Small cranes are required to lift off into position.	4	Cranage is required. FH has cranes in Fiji.	4	Cranage is required for loading/unloading and installation.	3
26	Construction and logistics	Fabrication time	After the bridge designs are finalised and the supply agreement is in place, standard componentry can be provided ex-factory in 4-5 weeks. If orders are expected, this lead time can be significantly reduced.	4	A small single span bridge (approximately 15m) takes 45 days to fabricate (9 weeks).	2	A small single span bridge (approximately 15m) takes circa 4 weeks to fabricate.	4	6-8 weeks depending on shop drawing approval.	3	4 weeks fabrication time	4
27	Construction and logistics	Shipment time	InQuik components are currently fabricated in Newcastle, NSW and Eagle Farm, QLD - which are both near major shipping ports. Standard componentry can be provided ex-factory in 4-5 weeks.	4	All factories are located in France, with the utilisation of major French shipping ports. The shipment time would take 45 days from France (9 weeks).	2	Wagners CFT components are fabricated in Toowoomba Queensland and can be shipped from Brisbane Port and can be provided in 4 weeks.	4	Stahlton bridge components are fabricated in Christchurch and Auckland, NZ. With ports in these locations as well as Suva, Fiji. Shipment time of 6-8 weeks.	4	Manufacturing facility is in Rutherford, NSW. Items would need to be shipped from Sydney, NSW (6 weeks).	4
28	Construction and logistics	Installation time	The InQuik "place and pour" methodology means that the InQuik Integral Bridge can be installed by semi-skilled labour over 2-3 days over a total project timeline of 1-2 weeks. Refer to InQuik Installation Guide for full breakdown of the process.	4	Using a 5-man team, crane operator and rigger, a Class All Steel bridge can be installed in 8 hours or less. For the composite model Unibridge all supplied components can be installed in 6 hours.	5	3 hours minimum installation time	5	2 days installation time	4	Curing/installation 1 week	3

A8 MCA Results

MCA Results & Ranking

Ref	Criteria	Weighting	InQuik modular bridge	Unibridge modular bridge	Wagners CFT modular bridge	Stahlton precast modular bridge	Waeger precast modular bridge
1	Span Range Flexibility	3.4%	4	5	3	3	3
2	Local Design Standards AS/NZS	6.9%	5	5	5	3	5
3	T44 Vehicle Design Loading	6.9%	5	5	5	2	5
4	Deck Edge / Traffic Barrier	0.3%	4	4	3	3	4
5	Number of Lanes (1 or 2)	2.4%	5	5	4	5	5
6	Design Life	4.3%	4	3	2	2	4
7	Marine Exposure Conditions (B2)	4.2%	3	4	4	3	3
8	Corrosion Resistance / Maintenance Access	4.3%	3	4	4	3	3
9	Maintenance Requirements	4.2%	4	3	5	3	3
10	Warranty Provisions	0.3%	2	4	5	1	1
11	Storage Requirements	3.4%	5	5	5	5	5
12	Relevant Track Record	2.0%	2	5	3	4	3
13	Supplier Annual Turnover	1.1%	1	4	1	5	2
14	Years of Operation	1.5%	3	5	3	5	5
15	Local job creation (procurement, construction, service life)	1.3%	2	2	2	2	2

MCA Results & Ranking

Ref	Criteria	Weighting	InQuik modular bridge	Unibridge modular bridge	Wagners CFT modular bridge	Stahlton precast modular bridge	Waeger precast modular bridge
16	Local materials requirement	1.3%	5	1	1	1	2
17	Local equipment requirement	1.3%	5	4	4	3	4
18	Environmental impact	1.3%	4	4	3	3	3
19	Build cost	6.0%	4	3	3	5	5
20	Maintenance cost	6.3%	4	3	5	3	3
21	Whole-of-life cost	6.5%	4	3	3	4	4
22	Level of on-site activities required	4.0%	3	5	5	5	5
23	Ease of (Ground) Transport	4.0%	4	3	4	4	3
24	Lightweight Components	4.0%	5	3	3	3	2
25	Construction plant and equipment requirements	4.0%	4	4	4	4	3
26	Fabrication time	4.8%	4	2	4	3	4
27	Shipment time	4.8%	4	2	4	4	4
28	Installation time	5.2%	4	5	5	4	3
		Total	**4.015**	**3.749**	**3.936**	**3.480**	**3.761**
		%	**80.3%**	**75.0%**	**78.7%**	**69.6%**	**75.2%**
		Rank	**1**	**4**	**2**	**5**	**3**

A9 Scenario-Based Assessment Matrix

Assumptions	Site Location		Design Requirements				Site Access and Constructability			Procurement, Maintenance and Support			
Design Assumptions	**Coastline Proximity**	**Bridge Span**	**Design Code**	**Design Life**	**Vehicle Loading**	**Traffic Volume**	**Site Access**	**Site Equipment**	**Site Activity**	**Substructure**	**Installation**	**Maintenance**	**Ongoing Support**
* Modular Bridge * Superstructure * Single Span * 20m Max Span * Straight (No Skew) * Square Deck * AS/NZS Compliance * 1-2 Lanes (Hynes can only be designed for single-lane decks)	*Where is the site located, relative to the coastline?*	*What is the anticipated bridge span?*	*Which bridge code will the design conform to?*	*What is the desired design life for the bridge?*	*What is the anticipated vehicle loading?*	*What is the anticipated traffic volume?*	*Are existing access roads adequate to support heavy vehicles?*	*Is the construction site adequate to accommodate heavy equipment? (e.g. large cranes)*	*What level of on-site activities (e.g. concrete pouring) can the construction site accommodate?*	*Is there a preference for the substructure to be provided by the bridge supplier?*	*Is there a preference for construction to be provided by the bridge supplier?*	*Is there a preference to minimise the maintenance regime for the bridge?*	*Is there a preference for local industry support within Australia / New Zealand?*
	>1km from coastline	*<15m*	*NZTA SP/M/022*	*<100 years*	*T44*	*<500 vehicles/day*	*Adequate access*	*Adequate equipment*	*Adequate activity*	*Superstructure only*	*Design &/ Supply only*	*Regular maintenance*	*Setup located anywhere*
	<1km from coastline	*15-20m*	*AS5100*	*100 years*	*SM1600*	*>500 vehicles/day*	*Limited access*	*Limited equipment*	*Limited activity*	*Substructure supplied*	*Design & Construct*	*Minimal maintenance*	*AS/NZS industry setup*
Design inputs ⇨	**<1km from coastline**	**15-20m**	**AS5100**	**100 years**	**SM1600**	**<500 vehicles/day**	**Limited access**	**Limited equipment**	**Adequate activity**	**Superstructure only**	**Design &/ Supply only**	**Minimal maintenance**	**Setup located anywhere**
Bridge Products / Characteristics	Exposure Design	Maximum Span	Design Code	Design Life	Design Loading	Barrier Design	Ease of Transport	Lightweight components	Required Level of Site Activity	Substructure Design	Services Provided	Corrosion Resistance Maintenance	Setup Location
Country Bridge	B1	12	AS5100	100	SM1600	Medium	Highly transportable	Regular weight	Regular activity	Superstructure only	Design Only	Regular maintenance	Aus / NZ
Eastbridge	B2	80	AS5100	100	SM1600	Low	Highly transportable	Lightweight	Minimal activity	Superstructure only	Design & Supply	Minimal maintenance	Aus / NZ
HumeDeck	B2	12	AS5100	100	SM1600	Medium	Highly transportable	Regular weight	Minimal activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
Humes	B2	18	NZTA SP/M/022	50	0.85HN-72	Low	Highly transportable	Lightweight	Minimal activity	Superstructure only	Design & Supply	Minimal maintenance	Aus / NZ
Hynds	B2	16	NZTA SP/M/022	50	0.85HN-72	Low	Highly transportable	Regular weight	Regular activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
InQuik	B2	18.5	AS5100 / NZTA	100	SM1600 / HN-HO-72	Medium	Highly transportable	Lightweight	Regular activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
Mabey Compact 200	B1	60.96	AS5100	100	SM1600	Low	Highly transportable	Lightweight	Minimal activity	Superstructure only	Design & Supply	Regular maintenance	Aus / NZ
PERMAcast	B2	48	AS5100	100	SM1600	Medium	Transportable	Regular weight	Minimal activity	Superstructure only	Design & Supply	Minimal maintenance	Aus / NZ
PNG FP NiuBridge	B2	10	AS5100	50	T44	Low	Highly transportable	Lightweight	Regular activity	Superstructure only	Design & Supply	Regular maintenance	PNG
Rocla M-Lock	B1	15	AS5100	100	SM1600	Low	Transportable	Regular weight	Minimal activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
SMARTspan	B2	12	AS5100	100	SM1600	Low	Transportable	Regular weight	Minimal activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
Stahlton Engineered	B2	20	NZTA SP/M/022	100	HN-HO-72	Medium	Transportable	Lightweight	Minimal activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ
Unibridge	B2	17.4	AS5100 / NZTA	100	SM1600 / HN-HO-72	Low	Highly transportable	Lightweight	Regular activity	Superstructure only	Design & Supply	Minimal maintenance	France
Waeger	B2	15	AS5100 / NZTA	100	SM1600 / HN-HO-72	Medium	Highly transportable	Regular weight	Regular activity	Substructure supplied	Design & Construct	Minimal maintenance	Aus / NZ
Wagners CFT	B2	11.8	AS5100 / NZTA	100	SM1600 / HN-HO-72	Low	Highly transportable	Lightweight	Minimal activity	Substructure supplied	Design & Supply	Minimal maintenance	Aus / NZ

Legend			
Legend	Recommended	Less suitable	Not suitable

A10 Example Scenarios from Assessment Matrix

DESIGN ASSUMPTIONS

* Modular Bridge
* Single Span
* Maximum 20m Span
* Straight (No Skew)
* Square Deck
* AS/NZS Compliance
* 1-2 Lanes (Hynes can only be designed for single-lane decks)

SITE LOCATION

<1km from coastline	Y	N
>15m span	Y	N

SITE ACCESS & CONSTRUCTABILITY

Road Access	Adequate	Limited
Site Equipment	Adequate	Limited
Site Activity	Adequate	Limited

RECOMMENDED BRIDGE SUPPLIERS

Humedeck
InQuik
Waeger
Wagners CFT

DESIGN REQUIRMENTS

Design Code	AS5100	NZTA
Vehicle Loading	SM1600	T44

100-year design life	Y	N
>500 vehicles / day	Y	N

PROCUREMENT, MAINTENANCE & SUPPORT

Support Office	Aus / NZ

Substructure by supplier	Y	N
Construction by supplier	Y	N
Minimal maintennance	Y	N

DESIGN ASSUMPTIONS

* Modular Bridge
* Single Span
* Maximum 20m Span

* Straight (No Skew)
* Square Deck
* AS/NZS Compliance

* 1-2 Lanes (Hynes can only be designed for single-lane decks)

SITE LOCATION

<1km from coastline	Y	N
>15m span	Y	N

SITE ACCESS & CONSTRUCTABILITY

Road Access	Adequate	Limited
Site Equipment	Adequate	Limited
Site Activity	Adequate	Limited

DESIGN REQUIRMENTS

Design Code	AS5100	NZTA
Vehicle Loading	HN-HO	0.85HN

100-year design life	Y	N
>500 vehicles / day	Y	N

PROCUREMENT, MAINTENANCE & SUPPORT

Support Office	Aus / NZ

Substructure by supplier	Y	N
Construction by supplier	Y	N
Minimal maintennance	Y	N

RECOMMENDED BRIDGE SUPPLIERS

Stahlton Engineered
Humes
InQuik
Wagners CFT

DESIGN ASSUMPTIONS

* Modular Bridge
* Single Span
* Maximum 20m Span

* Straight (No Skew)
* Square Deck
* AS/NZS Compliance

* 1-2 Lanes (Hynes can only be designed for single-lane decks)

SITE LOCATION

<1km from coastline	**Y**	N
>15m span	**Y**	N

SITE ACCESS & CONSTRUCTABILITY

Road Access	Adequate	**Limited**
Site Equipment	Adequate	**Limited**
Site Activity	**Adequate**	Limited

DESIGN REQUIRMENTS

Design Code	**AS5100**	NZTA
Vehicle Loading	**SM1600**	T44

100-year design life	**Y**	N
>500 vehicles / day	Y	**N**

PROCUREMENT, MAINTENANCE & SUPPORT

Support Office	**Aus / France**

Substructure by supplier	Y	**N**
Construction by supplier	Y	**N**
Minimal maintennance	**Y**	N

RECOMMENDED BRIDGE SUPPLIERS

Eastbridge
InQuik
Unibridge
Waeger
Wagners CFT