FLAT RACKS – AN ECONOMIC SOLUTION FOR CYCLING/PEDESTRIAN BRIDGES

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ABSTRACT

The ever increasing demand to extend and develop new shared use cycleway networks place significant capital and operational costs on to local Councils.

Significant cost savings can be achieved by using refurbished and modified pre-loved shipping container “flat-rack” transportation platforms.

Innovative thinking is needed to achieve the great community outcomes sought within limited Council budgets (and limited ratepayer funding) and growing complexity of planning and building regulations. Ex shipping industry Flat-Racks provide an opportunity to span small water crossings. They are also very strong, accommodating not just cycleway traffic but also contractor maintenance vehicles/machinery. Flat racks may be considered a short-term or temporary solution but they are so affordable that shorter life-span renewal is more cost effective over the long term.

1 INTRODUCTION - NEW CYCLEWAY BUDGET CHALLENGES

Local Council budget allocations to deliver cycleway projects are limited due to infrastructure funding priorities elsewhere. “Nice to have” projects are not as critical as other “must have” infrastructure projects, so budgets for recreation outcomes are nearly always significantly smaller.

Against this landscape, there is a large and growing expectation from ratepayers that Council will provide well constructed, attractive recreation assets AND without a corresponding increase in rates.

There is also a growing burden of bureaucratic process, adding further cost and disincentives to stakeholder groups.

So the challenge for Council is to find other funding sources and innovate with procurement, design and construction to help minimise the complexity and costs of compliance, while achieving affordable successful outcomes for local communities.

1.1 Situation Example 1 – Katikati peninsula coastal trail – length 1.0Km

Trail development at this rural coastal location was limited to $100,000 of Council Community Board (ratepayer) funding. Any extra funds needed over Council’s budget to complete the trail would be up to the local community to raise.

This project needed a bridge to span a shallow tidal wetland drain flowing out into the Tauranga harbor tidal flats. Not just for cyclists and walkers, the bridge would also need to allow for Council and contractor vehicles, small trucks and machinery access for maintenance. A typical “economic” concrete pre-cast bridge design at this location would cost about $50,000 including abutments – absorbing too much of the budget, so another solution was needed.

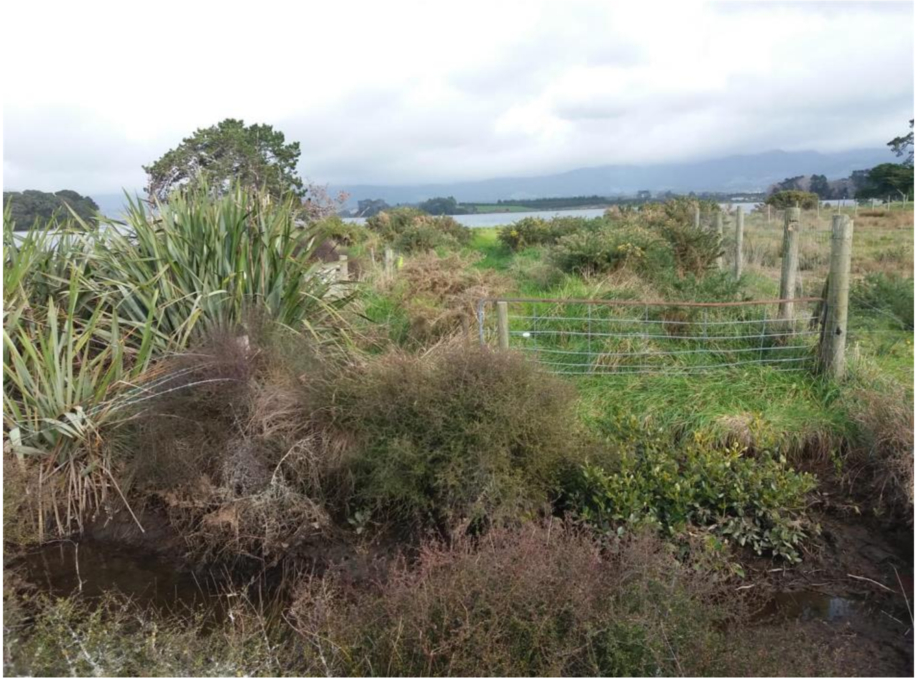
Compliance costs associated with a permanent structure like this also needed to be considered – was there another way to achieve the goal safely without these additional costs?

Would a modified flat rack container be a suitable solution?

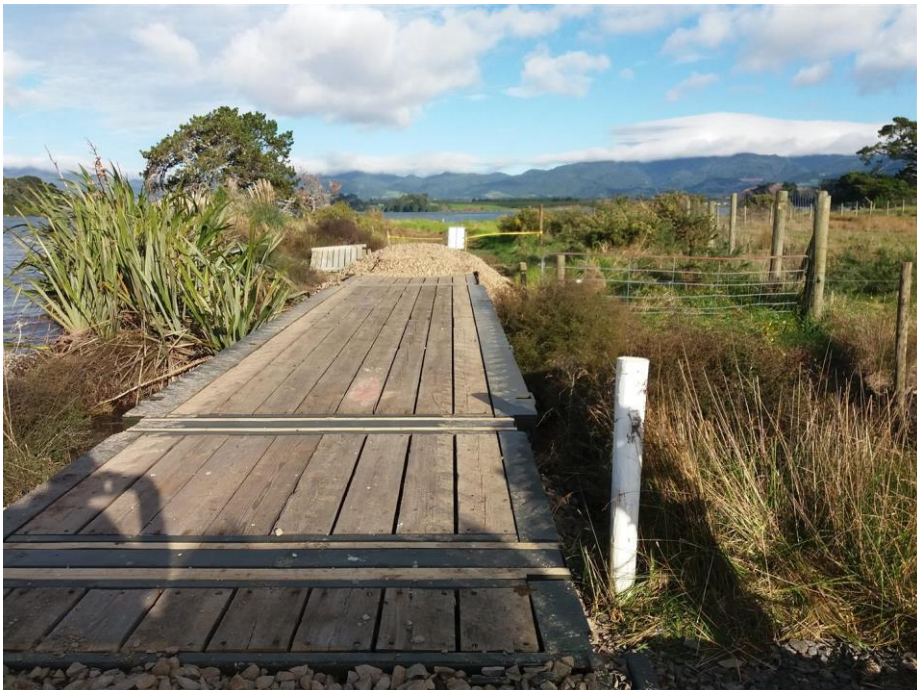
1.2 Example 1 photos

Council’s contractor – Fotheringhame Contractors Ltd (FCL), had the capability in-house to transport, remove/treat any corrosion, repaint, remove the unwanted flat rack end walls, re-clad the timber deck (if required), attach timber handrails and install at the nominated site.

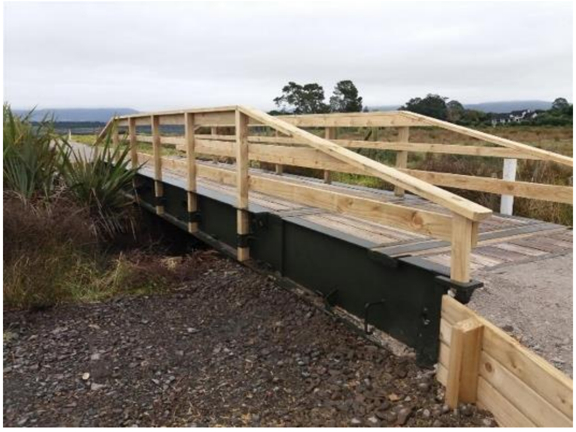
Total cost for a 40’ flat rack at the Katikati location was $13,000 including the purchase price. This is between 20-30% of a traditionally designed and constructed concrete pre-cast, steel/concrete or steel/timber bridge equivalent.

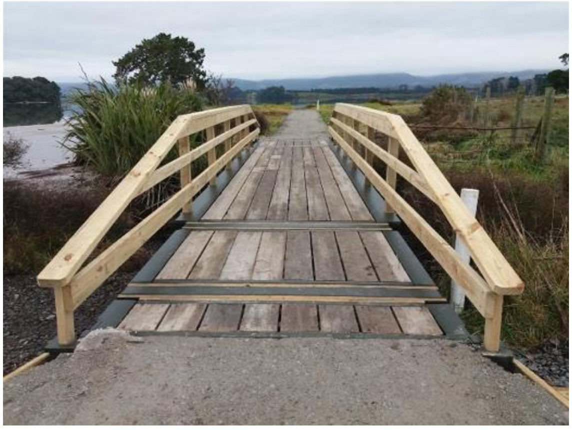


Example 1 – Photo 1 - location of waterway before flat rack bridge installation

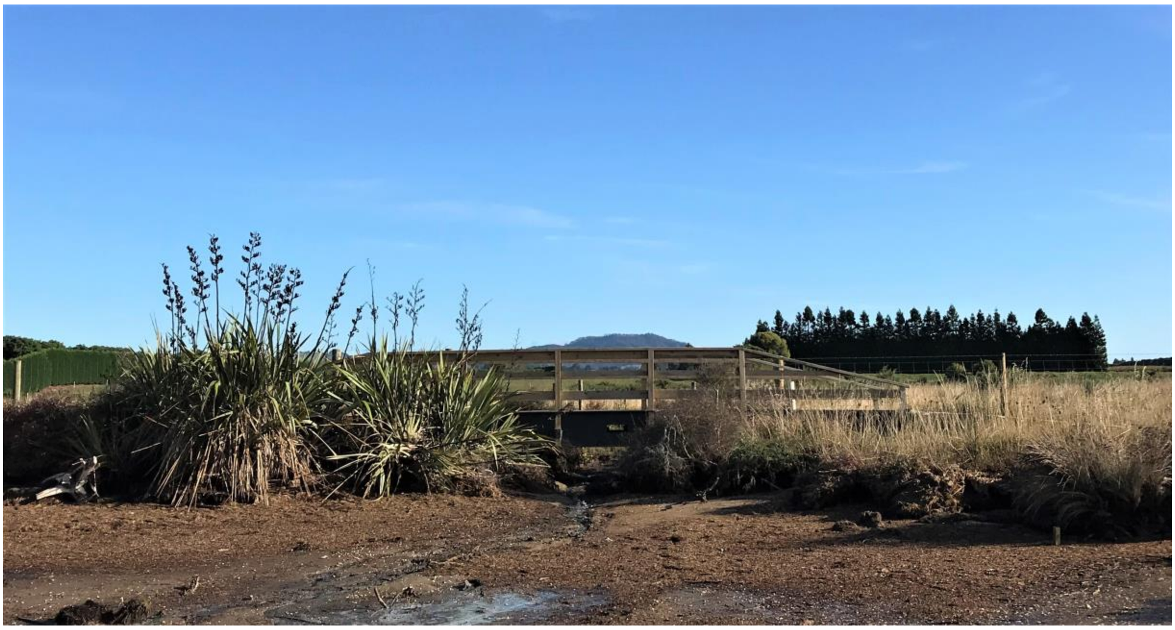


Example 1 – Photo 2 - location after 40’ flat rack placed on site





Example 1 – photos 4, 5 & 6 – 40' flat rack bridge installed, completed with handrails and approaches



1.3 Situation Example 2 – Omokoroa to Tauranga Cycleway (19km)

When complete, this shared path cycleway will connect the rapidly growing Omokoroa community and other smaller communities to Tauranga City. This trail is a significant project for Council, with a total budget of $13.4m, funded with significant grants and subsidies from Central Government via the NZ Transport Agency, external funders and Tauranga City Council ($1m). WBOPDC's commitment is approximately $1.5m of the total.

Approximately 13.6km of the 19km route is on dedicated off-road trails or on formed shared paths within the road berm. The rest of the route is on-road, shared with motor vehicles.

$6.5m of the $13.4m budget will be consumed in the construction of 1 major bridge (a $4.5m clip-on structure to a State Highway road bridge) and three medium sized bridges ($2m). The remaining $6.8m is for the off-road trail construction and some road safety improvements where the route is on road.

Funding for two minor bridges (5m and 12m spans respectively) has had to compete against a lot of other trail priorities – so the pressure was on to find a suitable affordable solution.

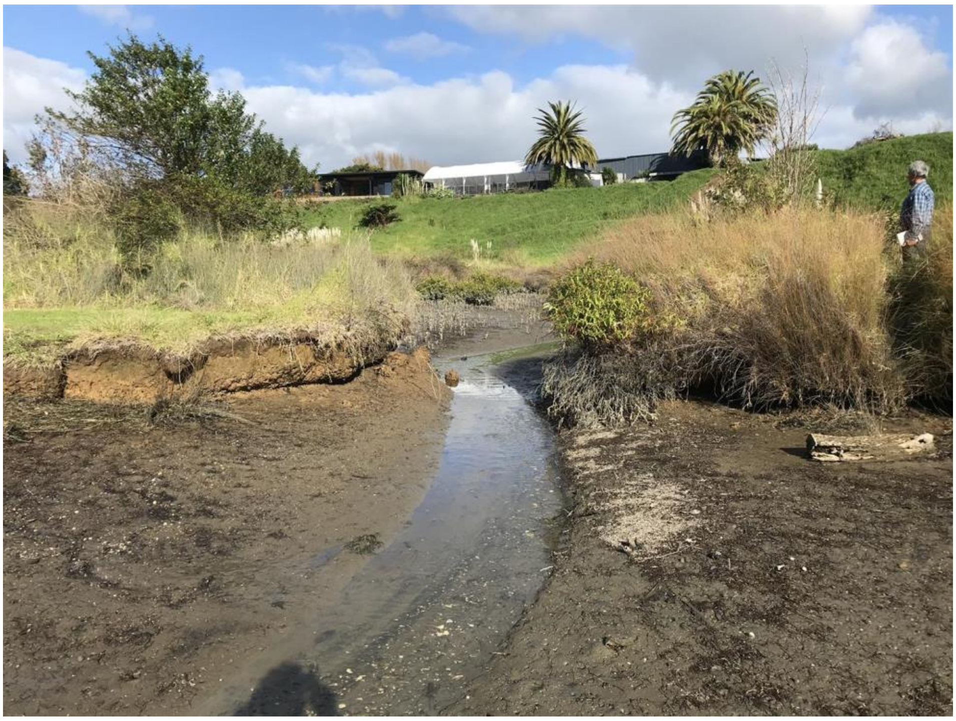
Traditional bridge design & build price estimates at both minor bridge locations was $45,000 for the 5m span crossing and $100,000 at the 12m span crossing.

The Katikati coastal trail flat rack bridge was a big economic success so it made sense to consider these as an option on the Omokoroa to Tauranga trail.

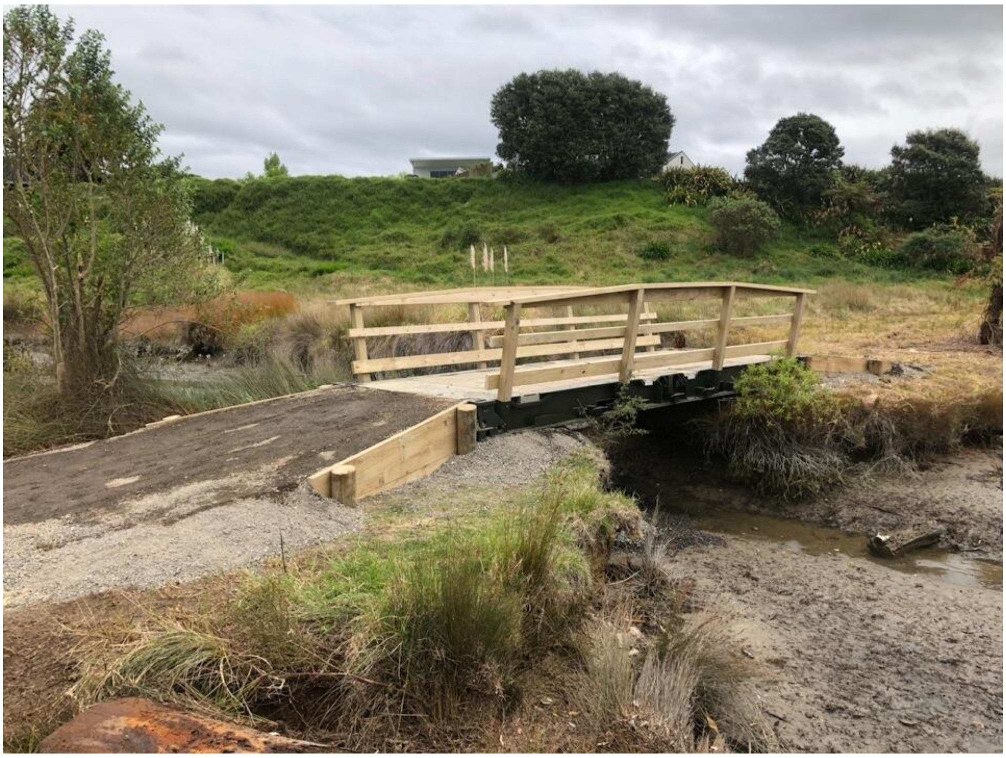
Flat rack supply and install costs at both Omokoroa trail locations was $16,000 (20’ flat rack) and $22,000 (40’ flat rack). The reason for the price increases compared to Katikati was because ground conditions required driven piles to support flat rack loads. Also, handrails were modified to rake outwards, adding extra fabrication costs.

For more information about this cycle trail project, go here: https://www.westernbay.govt.nz/our-facilities/cycleways/Pages/Omokoroa-to-Tauranga-Cycleway.aspx

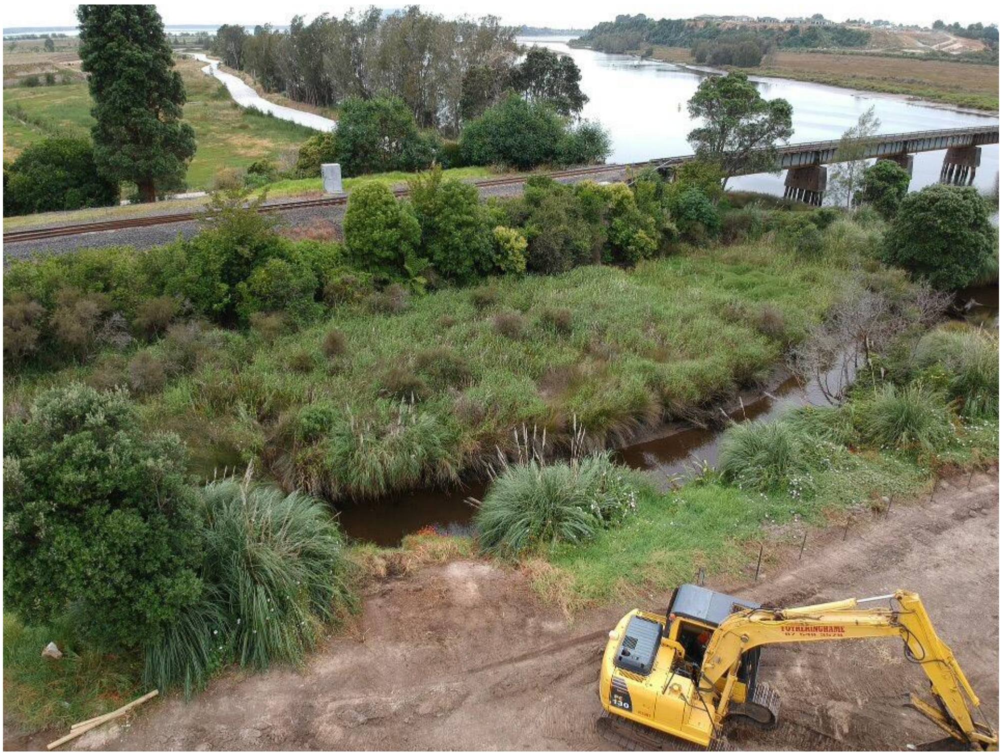
1.4 Example 2 Photos



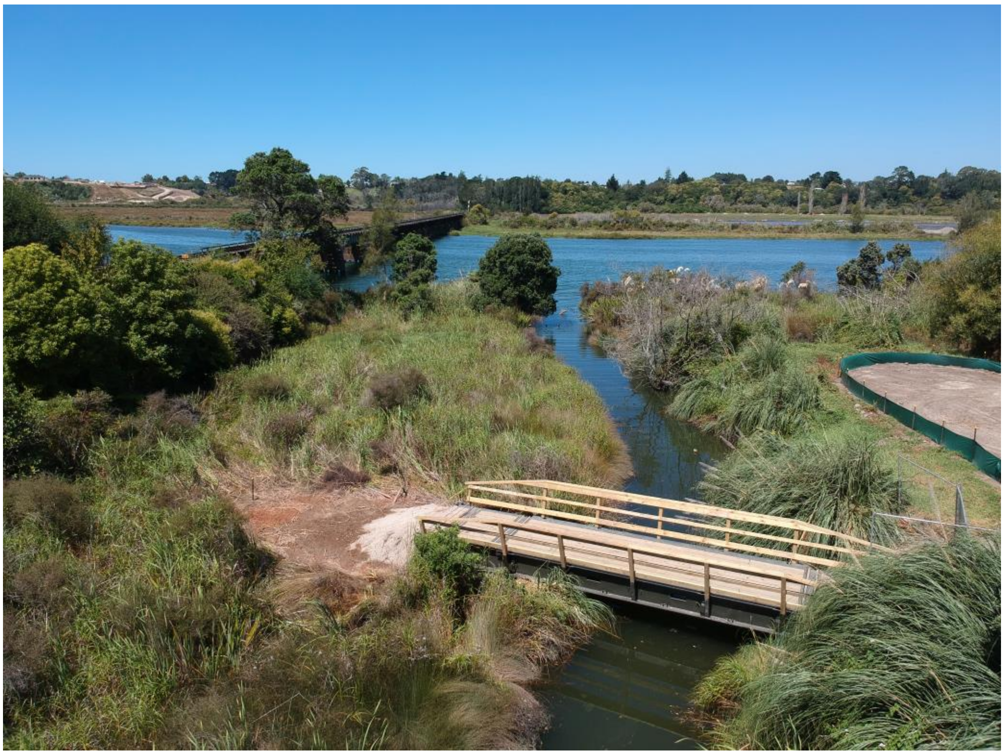
Example 2 – Photo 7 cycle-trail 20’ flat rack location (6m span required)



Example 2 – Photo 8 cycle-trail 20’ flat rack installed



Example 2 – Photo 9 cycle-trail 40’ flat rack location (12m span required)



Example 2 – Photo 10 cycle-trail 40’ flat rack installed

2 SHIPPING INDUSTRY SOLUTION

2.1 Flat Rack containers

Flat rack containers are a shipping industry solution for oversized loads that will not fit within an enclosed shipping container. Consequently, their deck superstructure is constructed to withstand significant load.

The flat rack idea for small water crossings originated when staff discussions with the local Katikati trails community project group and local contractor Fotheringhame Contractors Ltd (FCL), raised the idea of a Flat-Rack shipping container as a potential economic solution. The theory was that they are very strong, easily replaced and very affordable.

It was also a great opportunity to recycle – recycling is an easy sell to community and environmental care groups because it makes sense.

Flat-Rack Containers have no roof or sides and are generally made in two lengths – “40 feet“ and “20 feet“. Dimensional and load capacities of these are described in Table 1.

Table 1 - flat rack container specifications (Ref1)

Specifications	20 ft Flat Rack		40 ft Flat Rack	
Weight	2360 kg	5200 lb	5000 kg	8880 lb
Max Payload	30140 kg	66750 lb	40000 kg	90300 lb
Max Gross Weight	32500 kg	71950 lb	45000 kg	99180 lb
Length (internal)	5940 mm	19’6”	12123 mm	39’9”
Width (internal)	2345 mm	7’8”	2400 mm	7’10”
Height (internal)	2346 mm	7’8”	2135 mm	7’

Local shipping container companies confirmed availability of second-hand flat racks in both sizes. Purchase costs “as-is” with 12 months of load certification for a 20’ or 40’ flat rack is approximately $3,500 and $5,500 respectively.

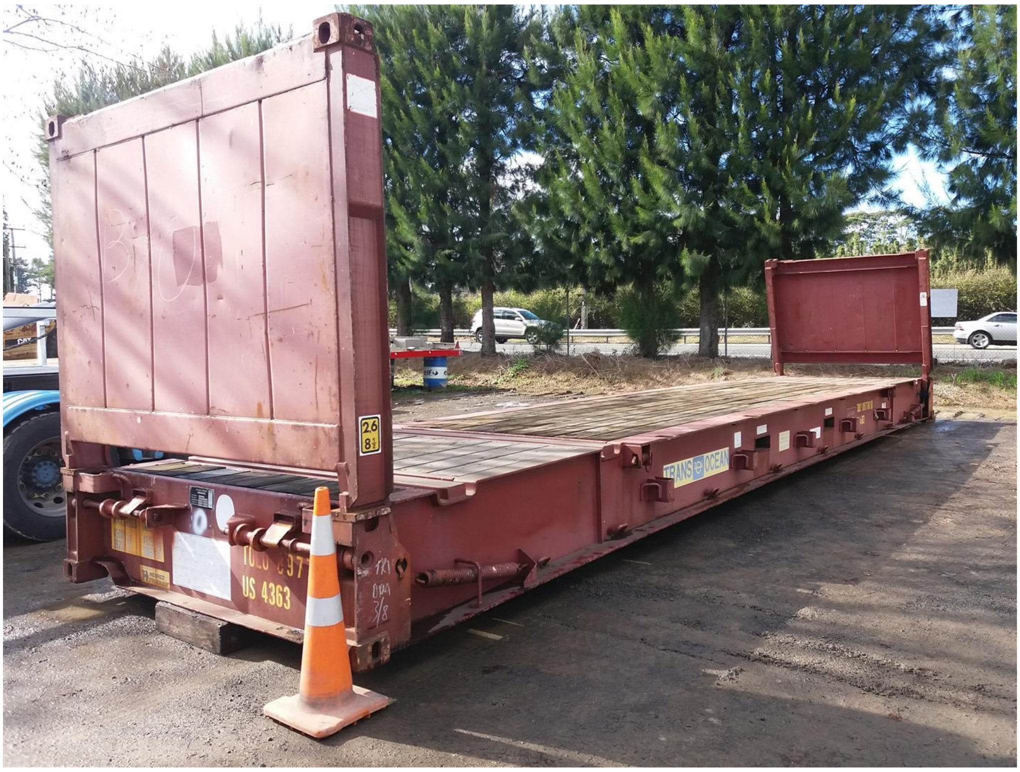


Photo 11- 40' flat rack prior to refurbishment

The flat rack is massively over engineered for cycleway loads, given what it was originally design for. A conventional cycleway bridge would normally be designed to at least 4KPa (UDL) – which is also sufficient for light maintenance vehicle axle loads. The 40' flat rack offers a theoretical 13.5KPa UDL (40,000/(12.123x2.4x101.97)) and the 20' flat rack offers 21.2KPa UDL (30,140/(5.94x2.345x101.97)), which is a huge increase in structural capacity.

No structural analysis has been undertaken to confirm potential lifespan of the flat rack for cycleway use. However, with such a large structural redundancy for the 40' flat rack at over 3 x the normal design requirements (13.5 KPa vs 4.0 KPa), it is anticipated that a lifespan of at least 20 years will be achieved. There is an even greater "5 x redundancy" with the 20' flat rack (21.2 Kpa vs 4.0 KPa). This assumes that regular condition inspections, periodic maintenance to spot treat corrosion, restore paint or timber will be sufficient to achieve that lifespan. It is assumed that cyclic maintenance costs will be in the order of $1,500 every two years and a $5,000 restoration/repaint at 10 years.

2.2 Bridge design options to consider

Several design solution considerations needed to be responded to, not just cost:

Table 2 – Design considerations & response

Considerations	Response
Location and environment – was this an urban or rural setting?	*Both project locations are within very scenic inner-harbour partial wetland and partial farmland rural environments, on the fringes of small urban communities.*
Is an artistic or aesthetically attractive design needed?	*Both project locations need a relatively low profile style that will blend in with the natural environment. High cost, artistic or iconic designs are desirable but not essential. The modified flat rack offers a quirky character not found in conventional bridges.*
What is the level of service expected from the community for each bridge?	• *Sustainable* • *Affordable*

	• *suit the natural environment / landscape* • *Fit for purpose and safe to use - be sufficiently wide for shared use while strong and durable enough for maintenance vehicles*
Did the solution need a bridge – for example, could a ford crossing or a culvert provide a better solution?	*In both examples, a bridge provided the better option. There were also more complex regulatory requirements with culverts and fords*
Could external community funding be obtained to supplement Council's budget if the cost of the bridge was too much?	*Not easily due to limited ability of small user groups to manage and be successful with funding applications*
What are the risks?	• *Expensive bridge resulting in insufficient funds to complete the trail.* • *Raising local and visitor expectations and managing local interest groups.* • *Regulatory compliance requirements.*
What is the economic justification? (whole of life cost considerations)	*The non-cost considerations above could be mitigated by good management process and regulatory discretion. So that just leaves cost as the predominant consideration.*

If the outcome was to be achieved, an economically viable solution was needed. This could only be answered with an understanding of asset lifecycle / whole of life costs.

2.3 Lifecycle cost comparison

Whole of life asset costs calculated for different bridge design options as follows:

Table 3 – Design options – lifecycle comparison

Bridge design type	Characteristics and design assumptions
Modified Flat rack container bridge	• 20 year life expectancy • Supply and Installation - $13,000 installation • Routine maintenance - $15,000 ($1,500/2 x 20). This would include inspections, corrosion spot treatment and minor repairs. • Mid-life restoration - $5,000. This would include a repaint. TOTAL lifecycle cost = **$33,000 or $1,650 / year.**
typical concrete pre-cast bridge 4.5m (example – Hynds Landspan Deck slab bridge)	• 20 year design life • Supply and Installation - $50,000 • Routine maintenance - $10,000 ($1,000/2 x 20). This would include bi-annual inspection, minor repairs and/or abutment erosion/scour treatment. • Mid-life restoration – probably not required • TOTAL lifecycle cost = **$60,000 or $3,000 / year.**
custom designed single span truss bridge 2.5m wide with 50 year design certification	• 50 year design life • Supply and Installation - $100,000 • Routine maintenance - $25,000 ($1,000/2 x 50). This would include bi-annual inspection, minor component repairs and/or abutment erosion/scour treatment. • Mid-life restoration - $40,000. This would include a detailed structural inspection, repairs and a repaint. • TOTAL lifecycle cost = **$165,000 or $3,300 / year.**

Given the very simplistic comparison above, and if the cost assumptions are accurate, a traditional bridge over a small waterway is still more expensive over its lifecycle than the “temporary” flat-rack bridge. “Temporary” in this context means the ability to easily uplift and relocate the “bridge” to another location or replace it entirely with a new one if required. The flat-rack‘s twist-lock sockets enable easy lifting and transportation and there are no abutment connections to consider with the bridge sitting freely under its own weight - either directly on the ground or slightly raised on a simple support. Relocation (if feasible) of a conventional bridge is a lot more difficult and costly.

2.4 Compliance and Risk

There was no engineering consultancy or “professional engineer” involvement – given the view that the bridge is temporary and can be easily repaired or replaced at relatively low cost. Similarly, no permits were considered necessary by regulatory authorities (who can exercise this discretion) because the risk of structural failure or risk to public safety is very low. Bridge deck surfacing with its rough sawn timber deck provides slip resistance and the timber handrails provide fall protection.

The flat-rack solution will not suit every application. But it is ideally suited to rural areas outside of city limits where the bulk and appearance of the structure can be easily absorbed within a natural environment. It will cope with the relatively light traffic counts (traffic which it was never designed for) but probably not so well in a busy urban environment where a higher level of service (performance and aesthetic design/appearance) is demanded. The flat rack allows Council to progress and respond quickly to community involved projects where budgets are tight. And it also gives Council sufficient time to plan and budget for permanent structures if a higher level of service is needed long term.

2.5 Flat rack modification & refurbishment

The modification / refurbishment process involved the following:

- Removal of the end walls and mechanical components
- Timber deck assessed for replacement (if required)
- Sand blasting to remove corrosion – note intention is not to remove paint from non-rusty areas
- Steel fabrication/welding repairs and handrail post pockets
- Timber handrails constructed and deck replaced if required
- Paint priming and finishing (VALSPAR paint system) (ref2)

2.5.1 Modification / refurbishment

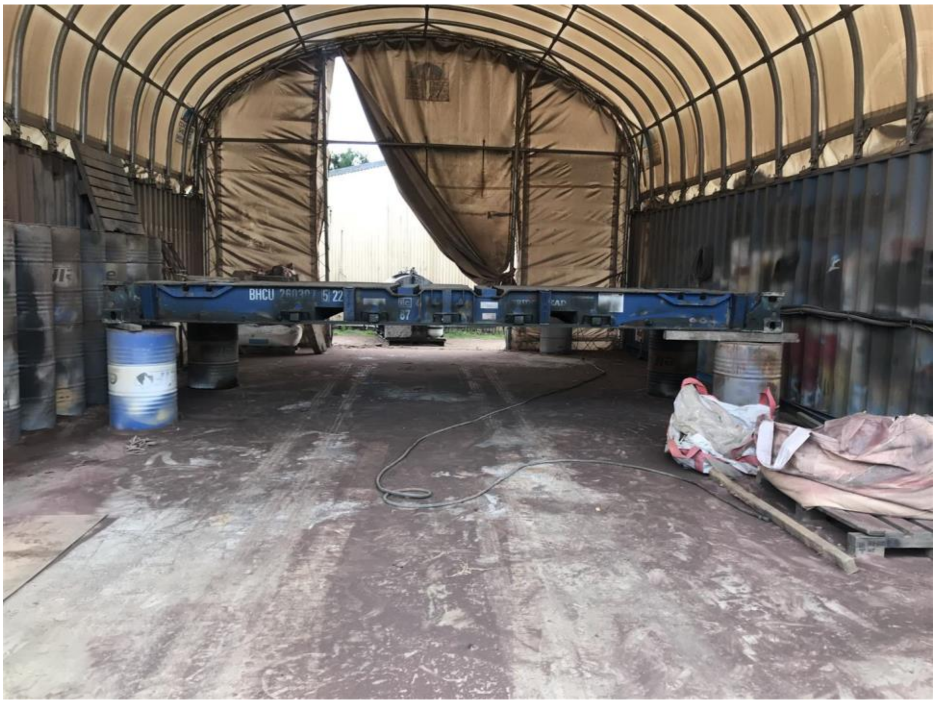
- 

Photo 12 – 20' flat rack in paint/blasting bay – note end walls have already been removed

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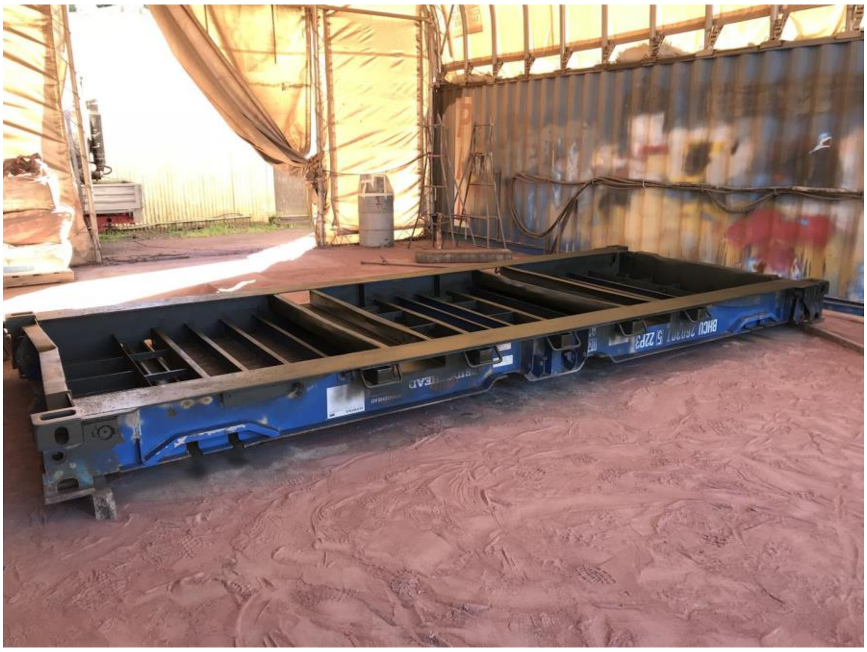
- 

Photo 13 – 20' flat rack underside primed ready for flipping

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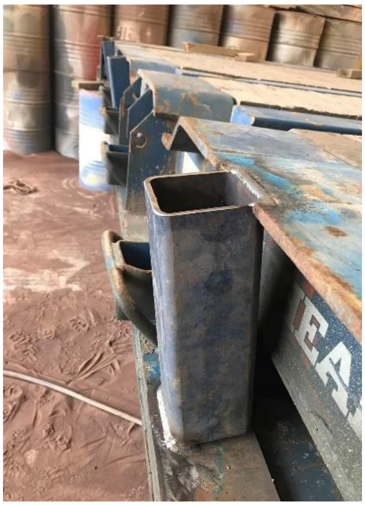

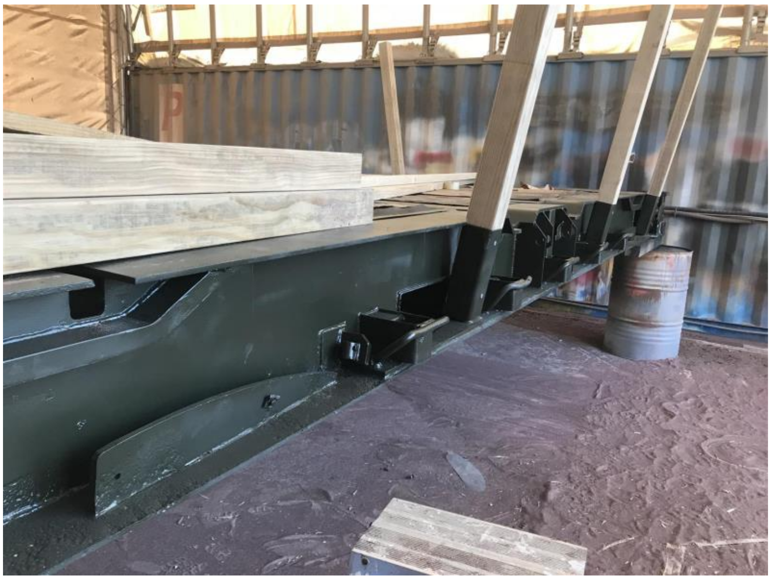

Photos 14 & 15 – hand-rail post pockets fabrication

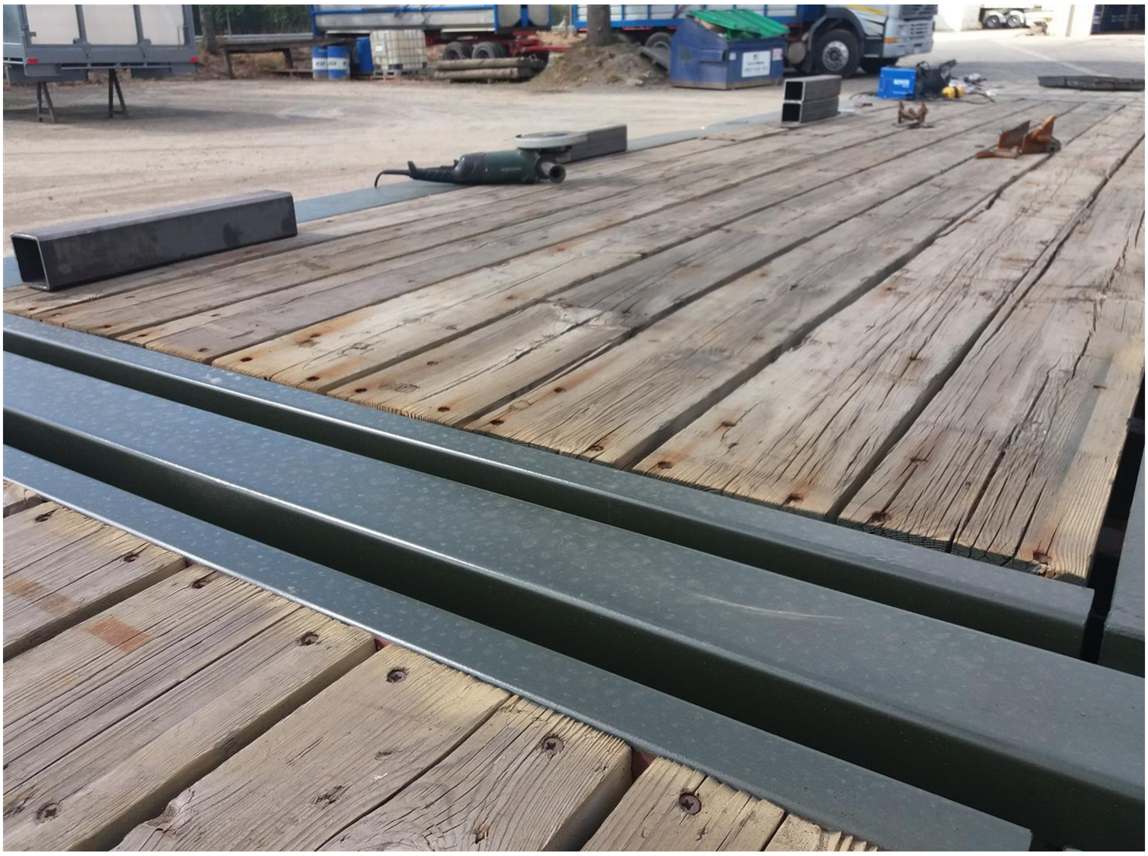

Photo 16 – 40’ flat rack – timber deck needs replacement (refer 2.6 lessons learned)

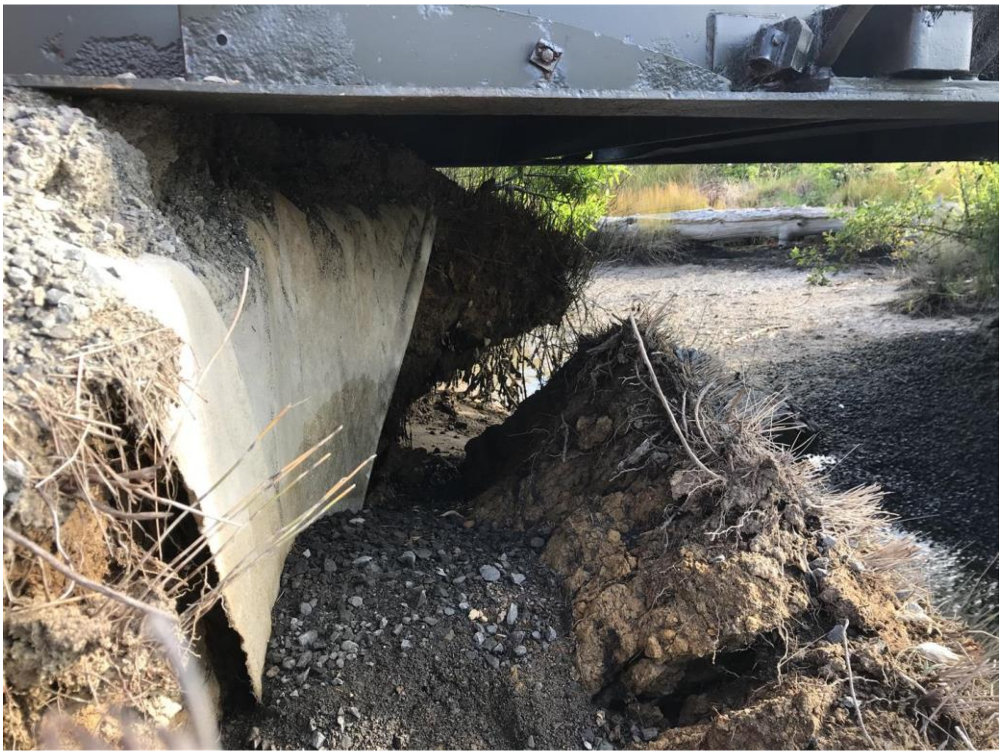

Photo 17 - 20’ flat rack location – abutment erosion (refer 2.6 lessons learned)

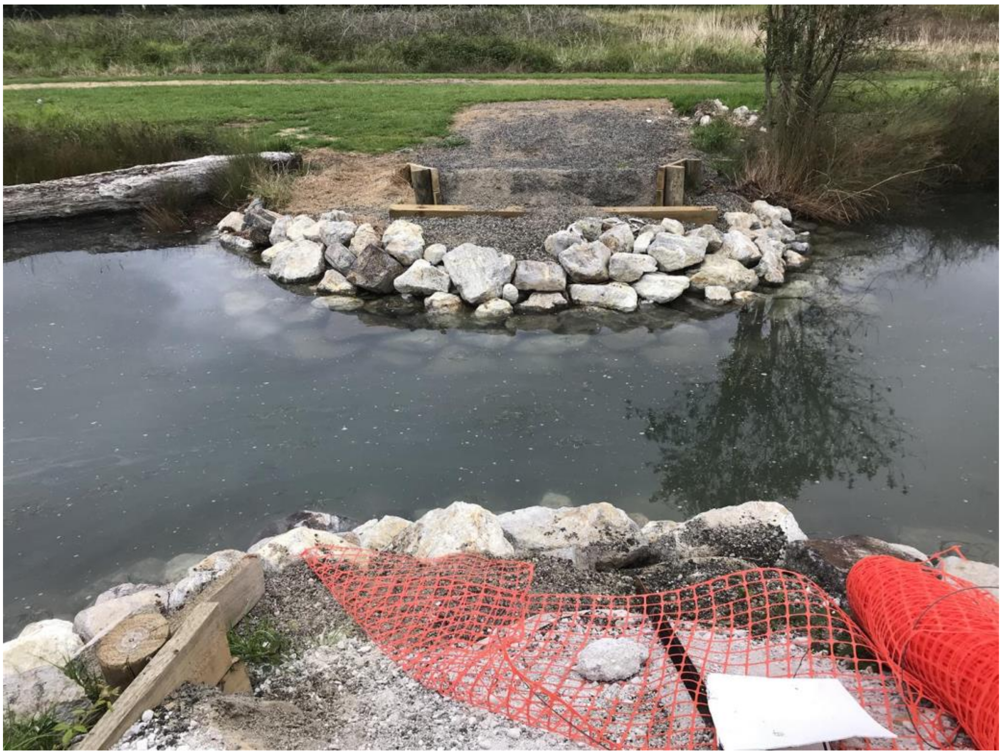

Photo 18 – 20’ flat rack location – rock revetment treatment and driven abutment piles added

2.6 Lessons learned

- When purchasing, make sure to visit storage site to select the best condition flat rack
- Assess the timber deck for possible replacement before sand-blasting/corrosion removal process
- Although there is more cost involved, raked handrails provide more room and a smarter appearance. Very desirable for any service/maintenance vehicles crossing the bridge (for example, large mower-tractors, where clearance becomes tight.
- Take time to properly assess ground conditions – a geotechnical investigation may be necessary if unsure.
- Wet conditions and erosion prone areas are likely to need piles to support flat-rack loads. Rock revetments to protect these abutment areas may also be required – however, it's very easy to address that later if it becomes an issue given the portability of the flat rack.
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3 CONCLUSION

For small water crossings, re-purposed flat rack containers make an innovative and ideal bridge solution where:

- Rural shared-path cycleways are being constructed
- budgets are limited
- A temporary solution will do until a more permanent solution is needed
- A high load capacity bridge across a short span is needed at short notice
- Sustainability, innovation and recycling is important
- Something different and quirky without high cost is wanted and appreciated by local communities

Modified Flat rack bridges will not suit busy urban environments where a higher level of service (performance and aesthetic design/appearance) is demanded.

4 REFERENCES

- **Ref1** Table 1 - flat rack container specifications. Retrieved from https://www.ifl.co.nz/resources/container-shipping
- **Ref2** Paint priming and finishing – epoxy primer and sealer paint system TB543 from VALSPAR. Technical data sheet retrieved from https://www.valsparindustrialmix.com/americas/en/products/topcoatbinders

5 ACKNOWLEDGEMENTS

- **Fotheringhame Contractors Ltd (FCL), Katikati, NZ**. FCL took the idea and developed it with Council to provide the outcome sought. Their multi-talented civil works team carried out the Flat Rack refurbishment, modifications and site installation.
- **Wayne Allchorne – Reserves & Facilities Officer, Western Bay of Plenty District Council**. It was Wayne who came up with the flat rack idea in discussion with FCL and a local community user group

6 AUTHOR BIOGRAPHY

Scott Parker – Reserves & facilities Projects and Assets Manager / Western Bay of Plenty District Council / New Zealand.

In his current role, Scott has over 12 years experience of recreation open space and coastal structure projects for the Western Bay of Plenty District Council. For the last three years he has become heavily involved in the project management of Western Bay of Plenty District's cycleway projects.

Scott's primary responsibilities include delivery of recreation / open space projects (approximately $4m annually excluding cycleway projects) and the asset management of parks, coastal structures & public swimming pool assets. Achievements over the years include delivery of many parks recreation facilities, new and renewed coastal structures (jetties, seawalls, boat ramps) and some small bridge projects.

The key to success has been his ability to develop great working relationships with community stakeholders, Tangata whenua, contractors and consultants. And a strong reliance on experts!

In his previous life Scott trained and served for twenty years as an aircraft engineer (airframe/mechanical & propulsion systems) with the Royal NZ Airforce. This background has given him a thorough grounding in the lifecycle management of critical assets.