Recovering the Waiho
Flood Event: 25\textsuperscript{th} - 27\textsuperscript{th} March 2019

- “Atmospheric River (NIWA)” extending over 5000km from the Timor sea to New Zealand.
- Manapouri, Hokitika, Milford Sound and Mount Cook received their highest or second highest extreme one-day rainfall totals since records began.
- Greymouth and Arthurs Pass received their fourth highest one-day rainfall totals since records began in the early 1900’s.
- Haast River recorded at its highest level.
- 1086mm fell in the Hokitika Cropp River Catchment over 48 hours (NZ record).
- Over 500mm in 48 hours fell at Franz Josef (much more in the Waiho catchment).
Flood Event: 25\textsuperscript{th} - 27\textsuperscript{th} March 2019
Outline

1. Site location
2. Waiho Bridge History
3. River Behaviour
4. Flood Event
5. Bridge Damage
6. Emergency Response
7. Design
8. Recovery
9. Summary & Lessons Learnt
Recovering the Waiho

**waiho**

1. *(verb)* (- ngaia, - tia) to let be, leave alone, put, place, ignore

**waiau**

1. River of swirling currents
2. Smoking waters
Site Location

WAIHO RIVER
-43.393047, 170.181159

Image c/o NZ Transport Agency and 41 South
Site Location and River Protection
Waiho River Bridge History

1926-1927

1980
Waiho River Bridge History

- Bailey soffit set around 4m higher than the soffit of the raised suspension bridge
Waiho River Bridge History

- 1996: Northern approach (true right) washed out.
- Bailey bridge extended by one span to 152m.
- Northern approach and stop-bank reinstated and protected with an improved rock revetment.
Waiho River Bridge History

- 2002: Bailey Bridge raised by 1.5m and extended by 3.0m with cantilever end spans.
- 2011: Bailey Bridge raised a further 2.0, with 6.7m hinged simple supported land-span extensions. Total bridge length now 172m.
- Bridge soffit now around 7.5m higher than the original suspension bridge.
River Behaviour – Bed Monitoring

FIGURE 1 – WAIHO RIVER BRIDGE – AGGRAVATION OF RIVERBED

latest level on
June 2018
The river has been assessed as having a 1 in 100 year flood flow in the order of 2,100 – 2,600m$^3$/s.

The Franz Josef glacier has been the scene of ‘jökulhlaup’ or outbreak floods.

Peak flood surface water velocities have been observed as high as 7m/s!

Depth average 1 in 100 year flood velocities are estimated in the order of 6m/s

Standing waves of up to 2m high have been observed during flood flows, along with chunks of ice and snow.
Flood Event - 25th - 27th March 2019

- Massive flood event - some of the highest rainfall ever recorded on the West Coast.
- 506mm rainfall at the bridge site over 48 hours (significantly more in the upper catchment.
- 310mm rainfall in 24 hours at the bridge site
- 114mm in 6 hours
- Flood flow in the order of 1,500 m³/s
- Peak surface river velocities estimated in the order of 5.3m/s
- Bow wave on piers of around 4-5m high!
- Rocks in the order of 1.5m-2m moving down the stream and impacting piers
- Still plenty of freeboard to the bridge (3.6m)
Pier Damage
Emergency Response

Like David, we had taken on similar giants before…

**Massive Earthquakes**
- September 2010 Mag 7.1 Earthquake (PGA − 1.26g)
- February 2011 Mag 6.3 Earthquake (PGA − 2.2g)
- June 2011 Mag 6.4 Earthquake (PGA − 2.13g)
- December 2011 Mag 6.0 Earthquake (PGA 1.0g)
- November 2016 Mag 7.8 Earthquake (PGA 3.0g*)

**Wind Events**
- April 2014 Ex. Tropical cyclone Ita (140km/hr wind)

**Flood Events**
- Numerous events in excess of 50 and 100 year ARI
Emergency Response

- $2-3M cost per day to the West Coast Region
- Key engagement and decisions within the first 24 hours
- Three main work zones
- Everything on the critical path. Contingencies on contingencies
Design – Plans A and B for Nth Abut
Design – Pier C Repairs
Design – Pier B replacement
Design – Bailey Removal
Recovery - Equipment
Challenges – there were many!

- Communications
  - Develop a plan
  - But there is a river in the middle!
  - Nine contractors + NZ defence force + Helicopter operator all thrown together within a few days
- Everyone wanted the river in a different place
- Weather – Two freshes over 18 day recovery
- Equipment breakdowns – Thunderbird didn’t work initially, large crane broke down.
- Significant damage to most piers
- Everything on the critical path!
- People trying to enter the site (media / mayors etc)
Recovery – Further Repairs

Existing pier cap (2 No. 530UB92)

PIER E ELEVATION
SCALE 1:25
Recovery – Improved Resilience
Recovery – Improved Resilience
Summary

- Massive storm event
- 170m long bridge recovered in 18 days
- Around $6.5M recovery and improvement cost
- Significant praise from Waka Kotahi NZ Transport Agency
- Still a lot of recovery and resilience improvement work ahead
Lessons Learnt – Prior to Collapse

– Strong working relationships between all parties – i.e. SMC, NOC (FH led), Bailey Bridge Contractor (Downer) the NZ Defence force and various sub-contractors.
– Experienced consultants and contractors are essential.
– Develop Trigger Action Response Plans (TARPs) for key at-risk infrastructure.
– Underlying vulnerabilities can exist even when a structure is well maintained.
– Critical to have pre-existing contracts in place that cover Emergency Response
Lessons Learnt – Response and Recovery

- Get the right people and parties involved from the start
- Understand the issues and make key decisions early
- Develop a communication plan
- Use the right equipment
- Understand roles and responsibilities
- Prioritise design and undertake in parts as required
- Design with what you have available
- Have a common site office
- Prepare contingency plans
- Maintain a sense of humour (emergency recovery is stressful)
Did we recover the Waiho?

waiho

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waiau

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Acknowledgements

- NZ Transport Agency
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  - Wellington Hydraulics Team
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  - Downer
  - Liddell Contracting
  - Smith Crane and Construction
  - MBD Contracting
- Blakely Construction
- Grey Brothers Engineering
- Westroads
- E-Quip Engineering
- NZ Defence Force (including supply of video)
- Heliservices Franz Josef
- Stuff (drone footage)
- Thunderbirds movie
- Many others…
Questions?

wsp-opus.co.nz