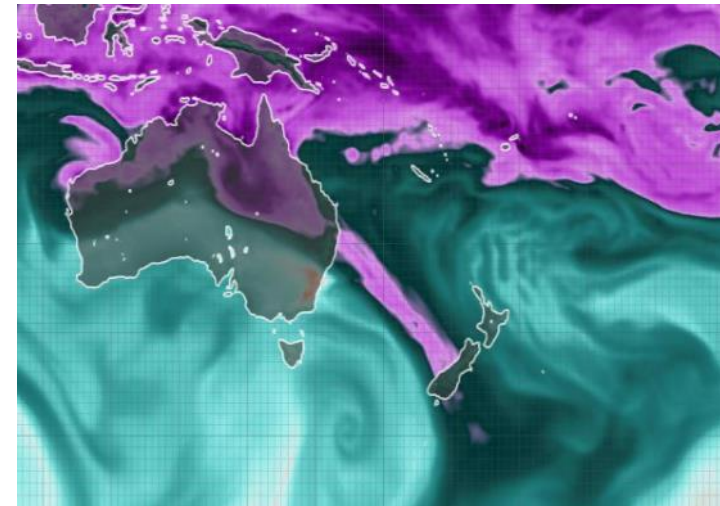


Recovering the Waiho



Flood Event: 25th - 27th 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: 25th - 27th March 2019







30



RIGHT ACCESS
→

No
Camping
Dog
Area
Keep Dogs
Away From
Area

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)** (-ngia, -tia) to let be, leave alone, put, place, ignore

waiiau

1. River of swirling currents
2. Smoking waters



Site Location



Image c/o NZ Transport Agency and 41 South

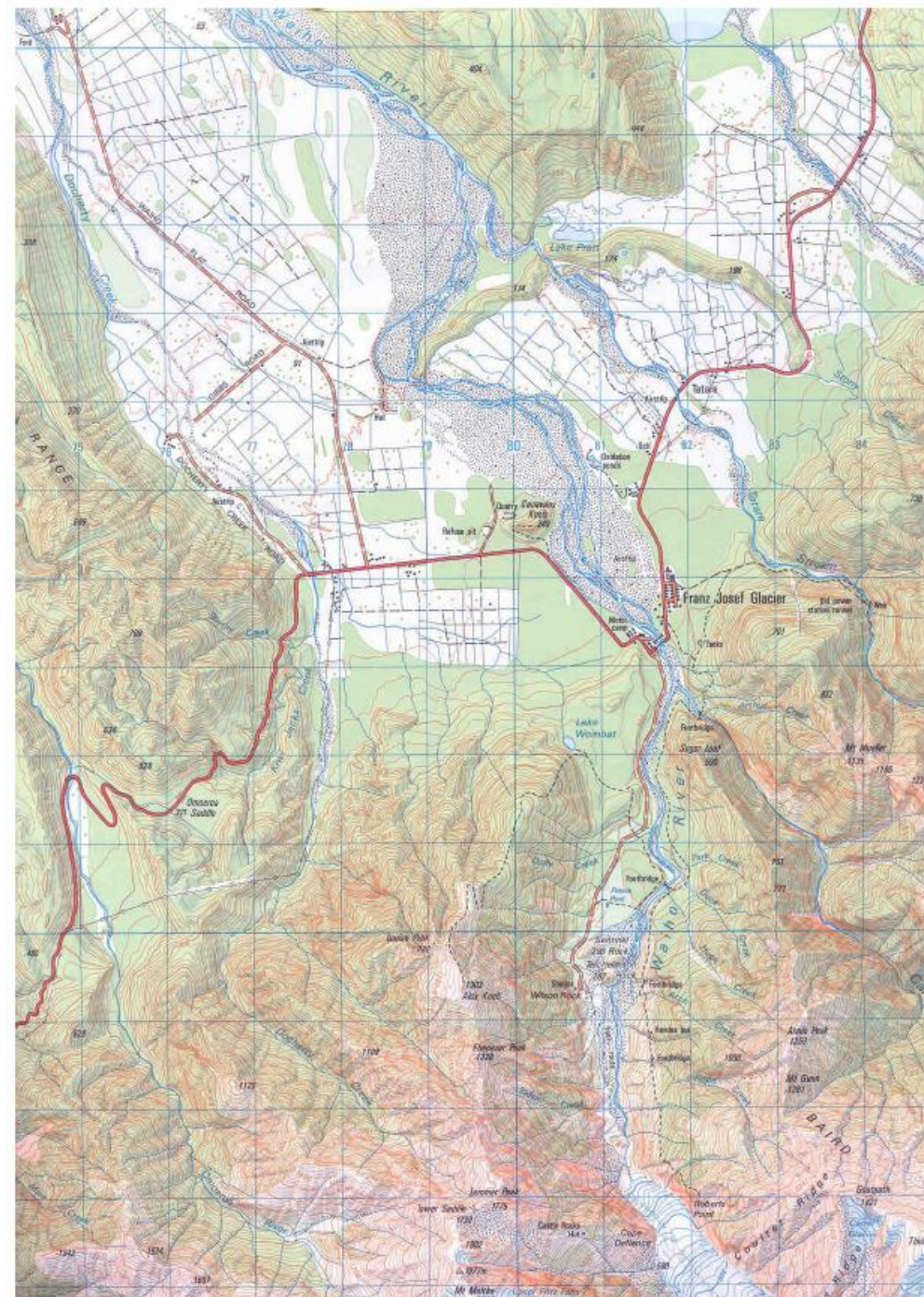
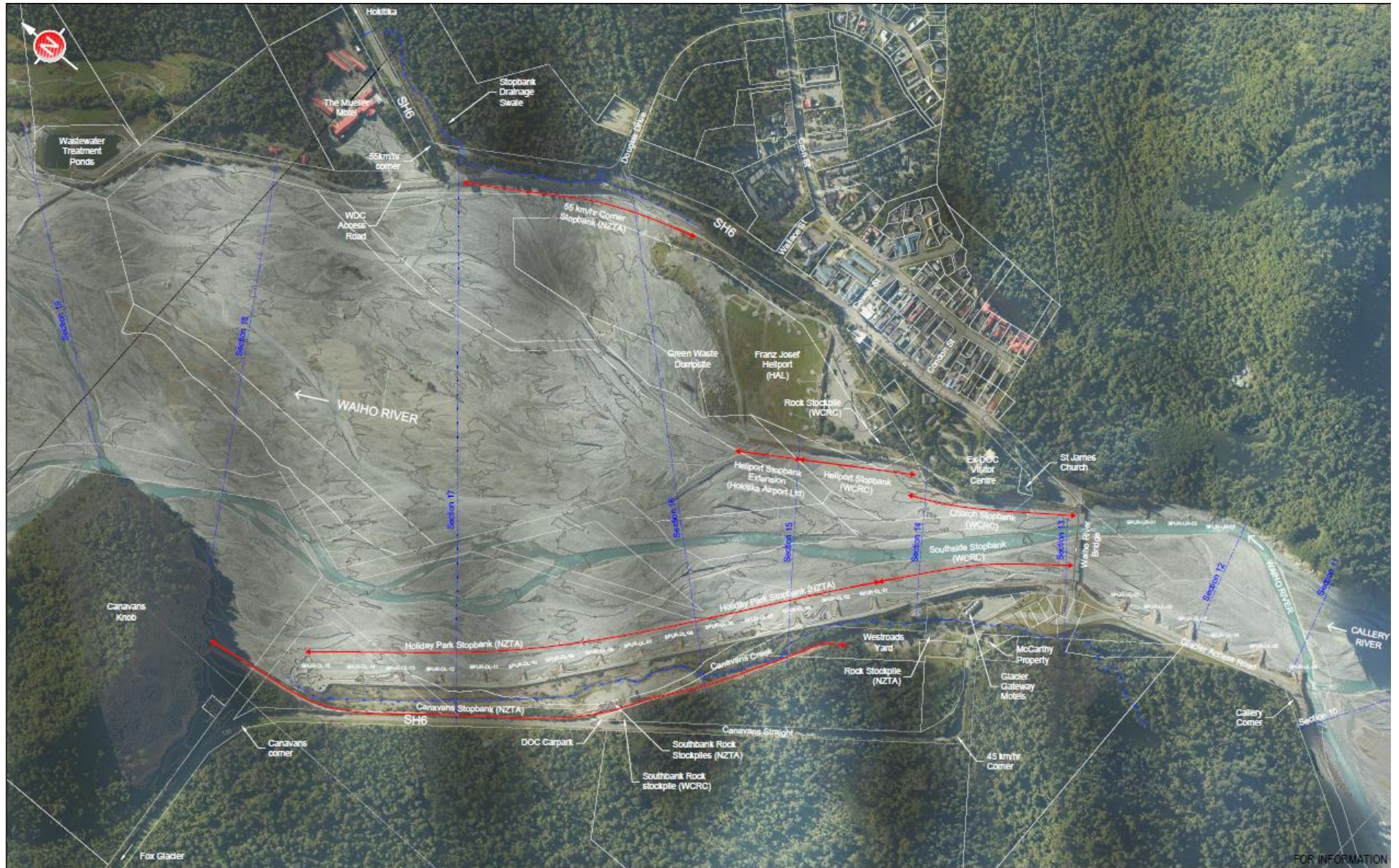


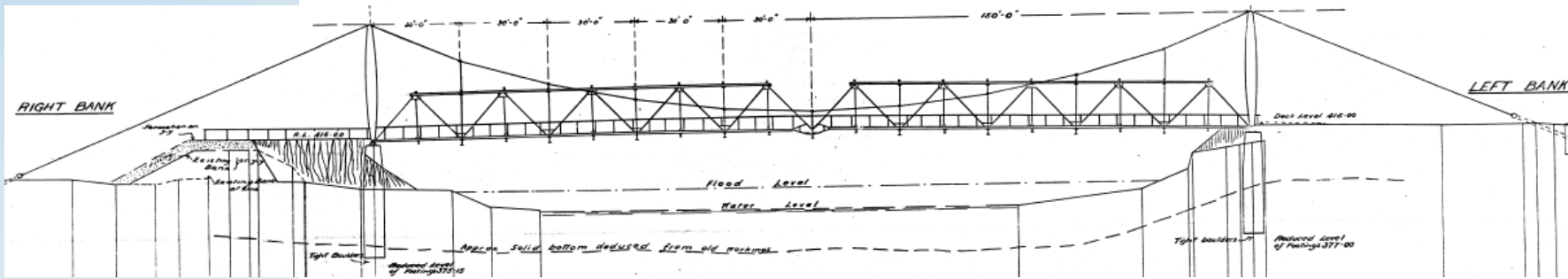
Figure 1 Location of SH6 Crossing of Waiho River at Franz Josef

Site Location and River Protection

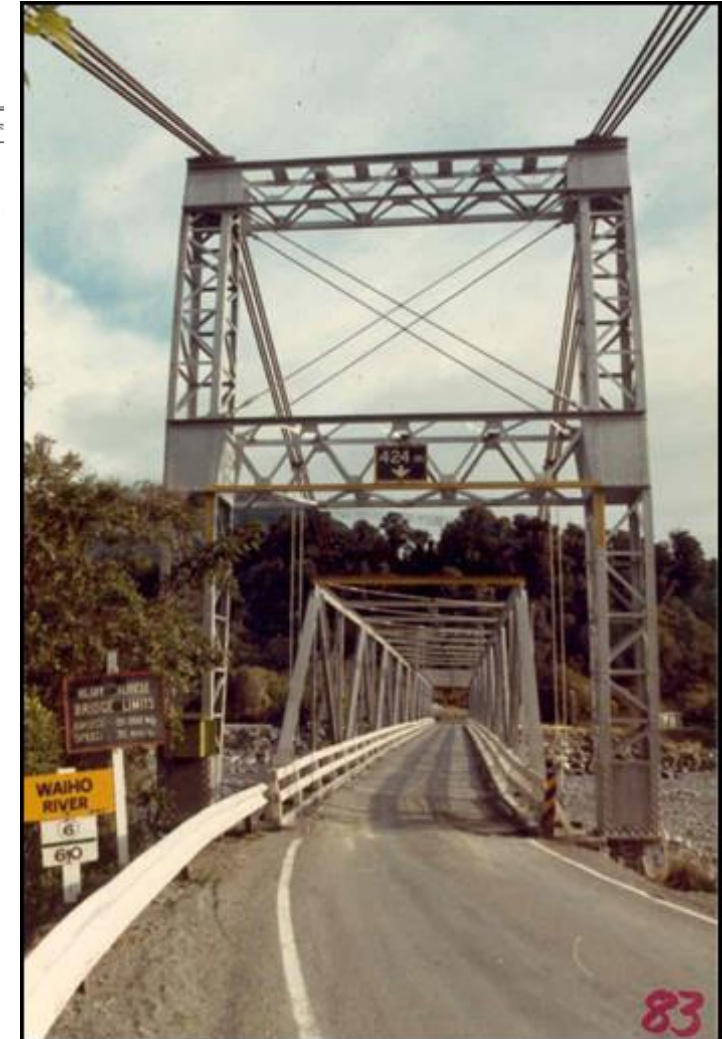


Waiho River Bridge History

1926-1927

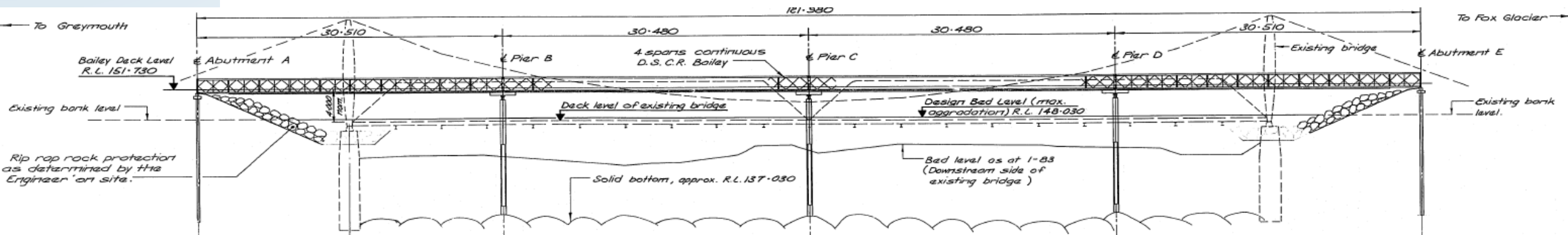


1980



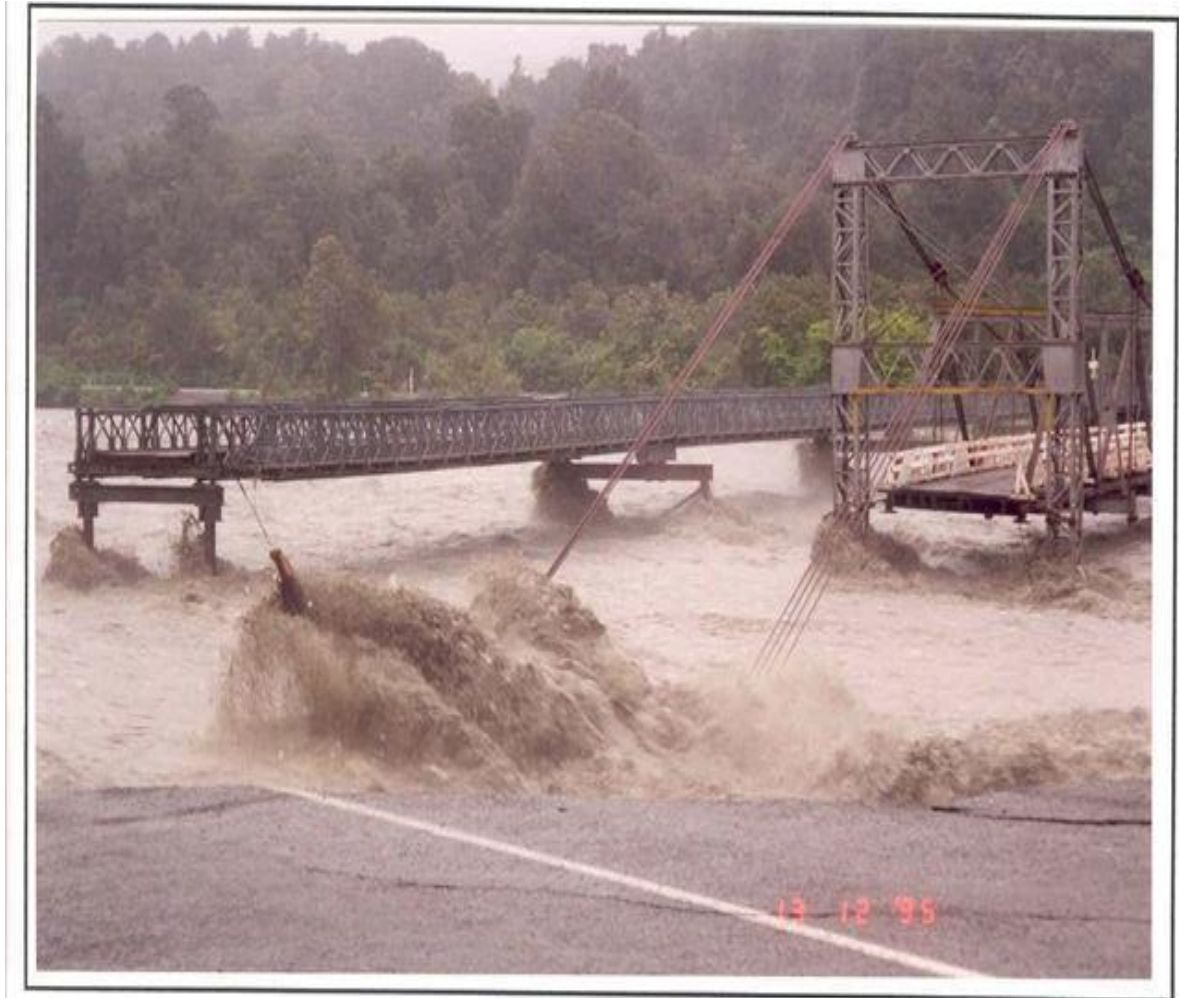
Waiho River Bridge History

- 1990 – 1991: New Four span Bailey Bridge constructed
- Bailey soffit set around 4m higher than the soffit of the raised suspension bridge



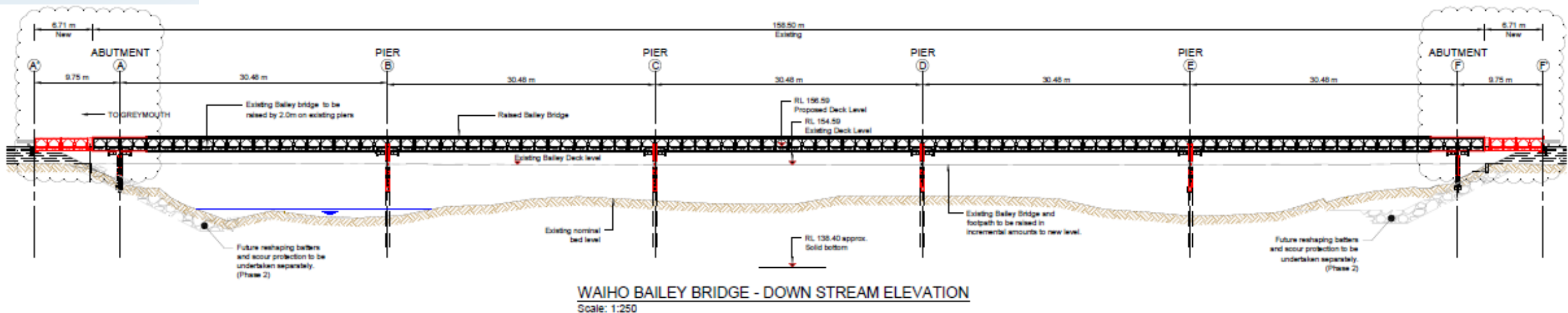
Waiho River Bridge History

- 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

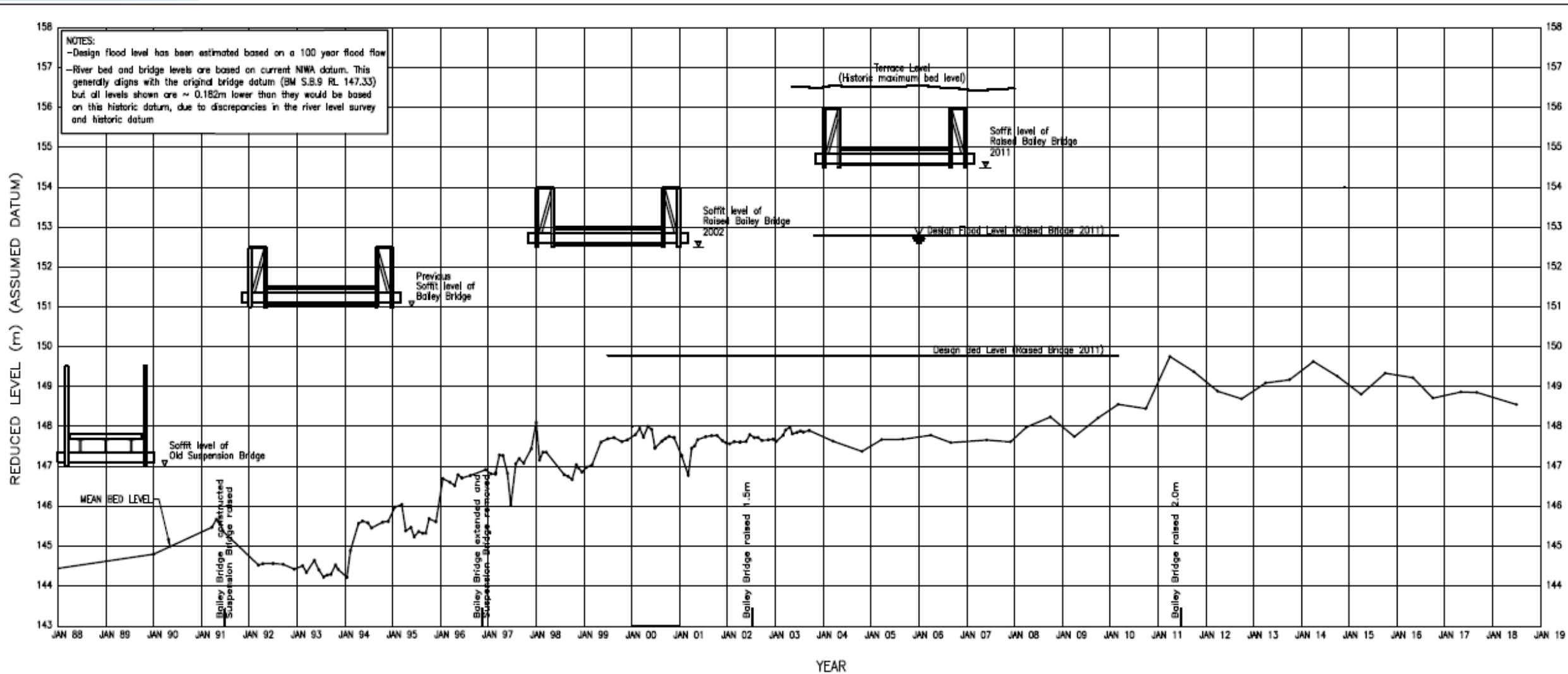


FIGURE 1 – WAIHO RIVER BRIDGE – AGGRADATION OF RIVERBED

latest level on
June 2018

River Behaviour – Hydraulics

- The river has been assessed as have a 1 in 100 year flood flow in the order of 2,100 – 2,600m³/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)



stuff

Pier Damage



Emergency Response

Like David, we had taken on similar giants before...

Massive Earthquakes

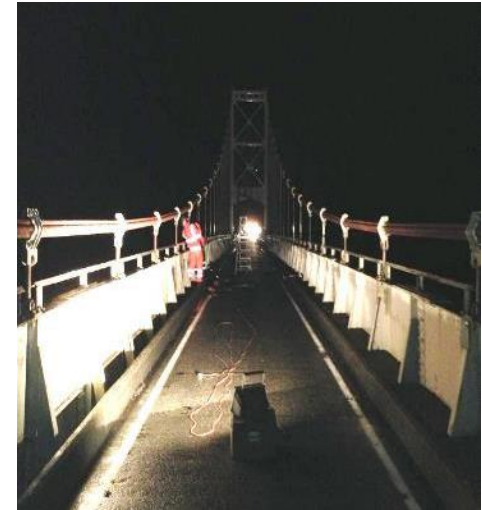
- September 2010 Mag 7.1 Earthquake (PGA - 1.26g)
- February 2011 Mag 6.3 Earthquake (PGA - 2.2g)
- June 2011 Mag 6.4 Earthquake (PGA - 2.13g)
- December 2011 Mag 6.0 Earthquake (PGA 1.0g)
- November 2016 Mag 7.8 Earthquake (PGA 3.0g*)

Wind Events

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

Flood Events

- Numerous events in excess of 50 and 100 year ARI

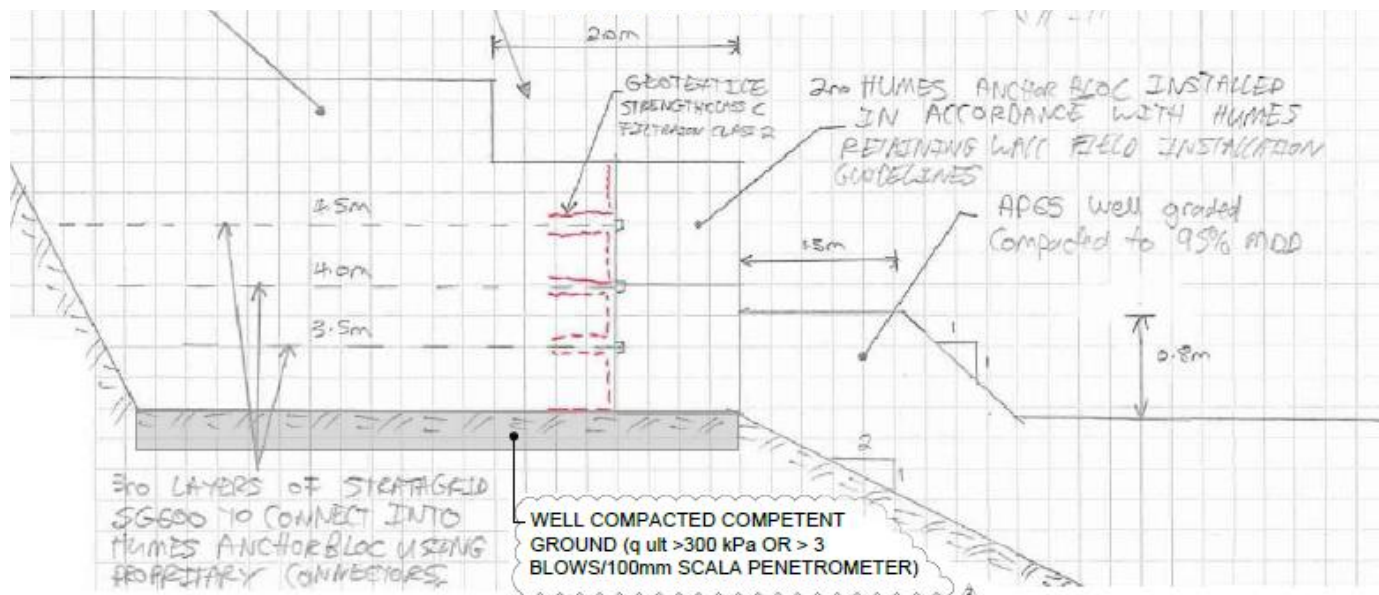
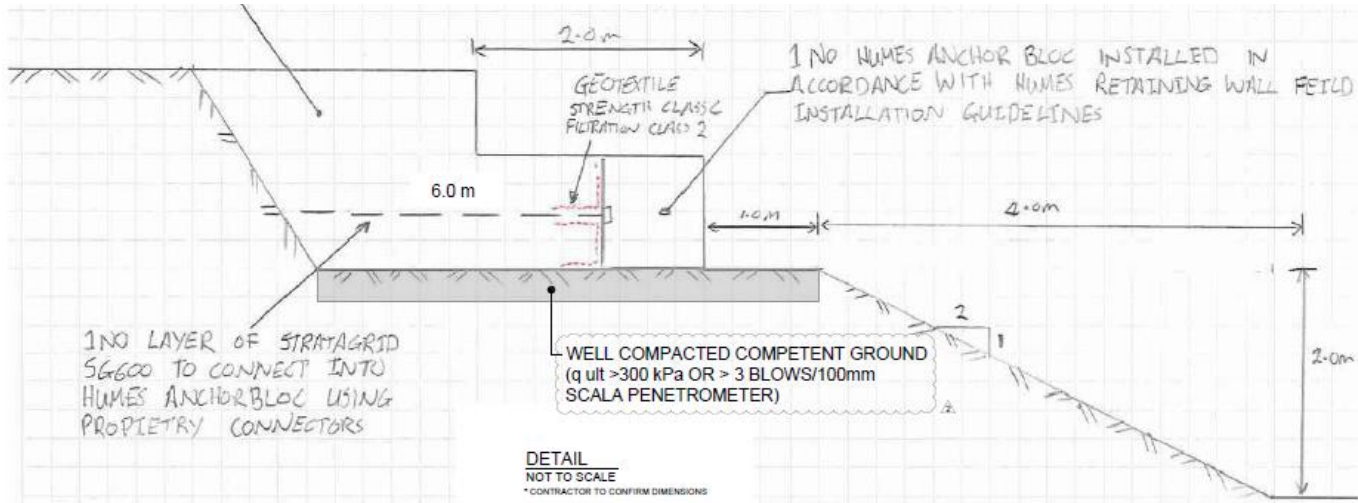


Emergency Response

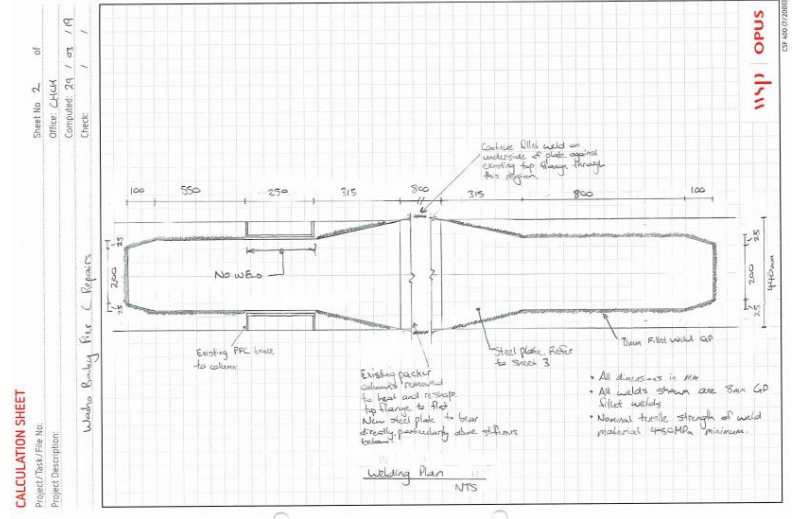
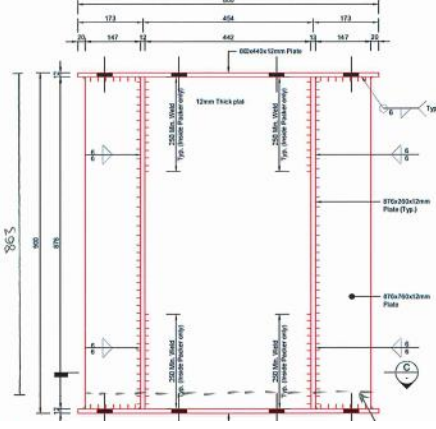
- \$2-3M cost per day to the West Coast Region
- Key engagement and decisions within the first 24 hours
- Three main work zones
- Everything on the critical path. Contingencies on contingencies



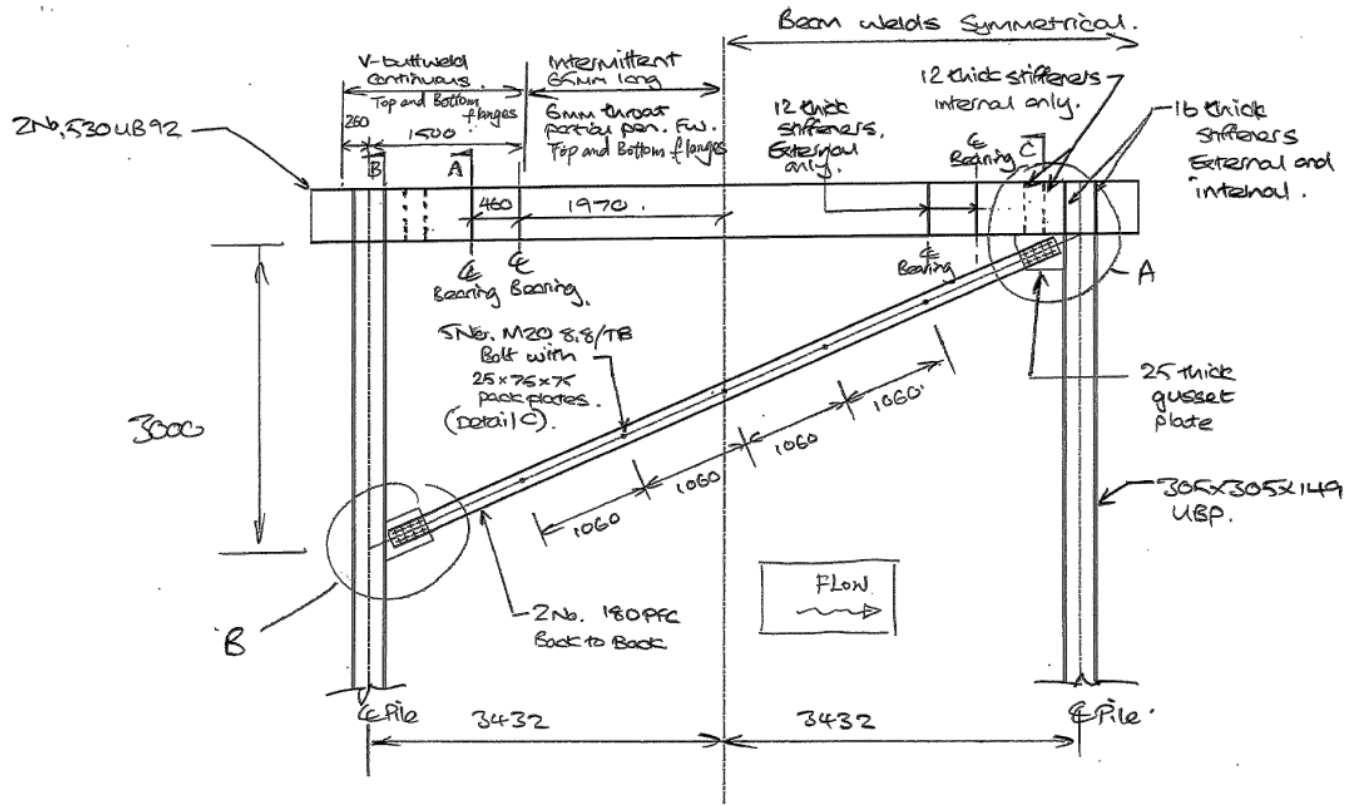
Design - Plans A and B for Nth Abut



Design - Pier C Repairs



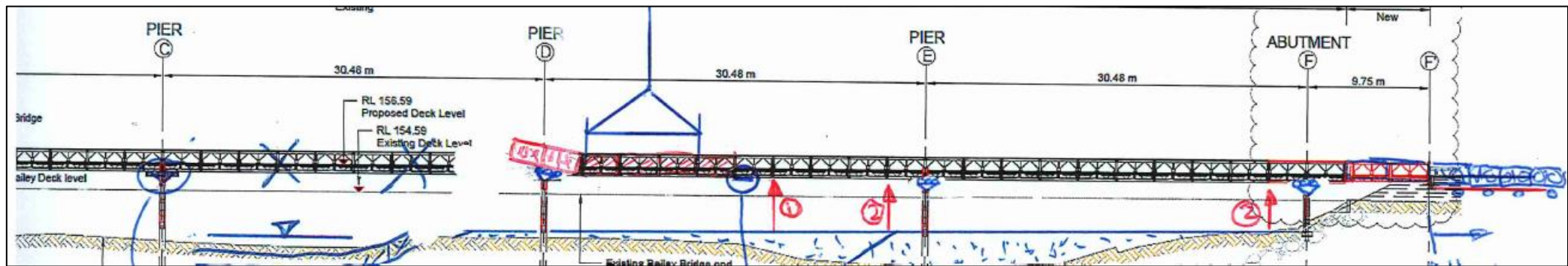
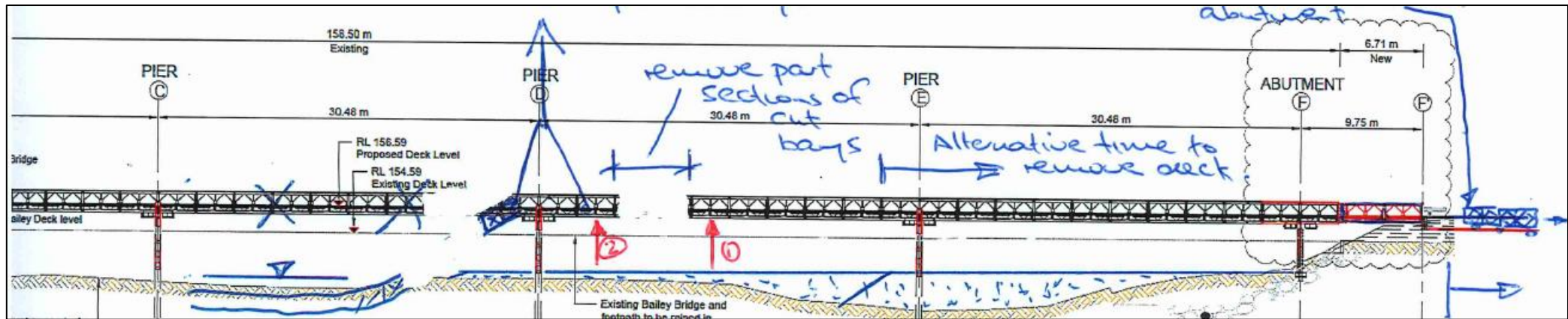
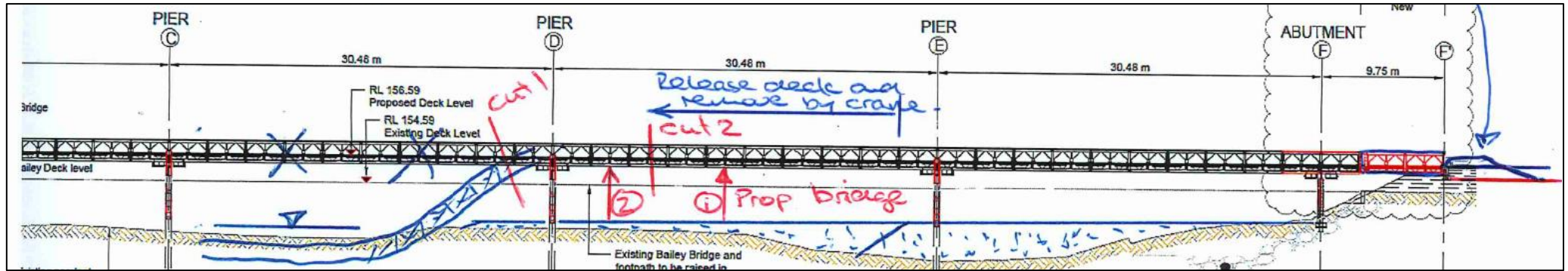
Design - Pier B replacement



ELEVATION - NEW PIER A
NOT TO SCALE
* CONTRACTOR TO CONFIRM DIMENSIONS



Design - Bailey Removal



Recovery - Equipment



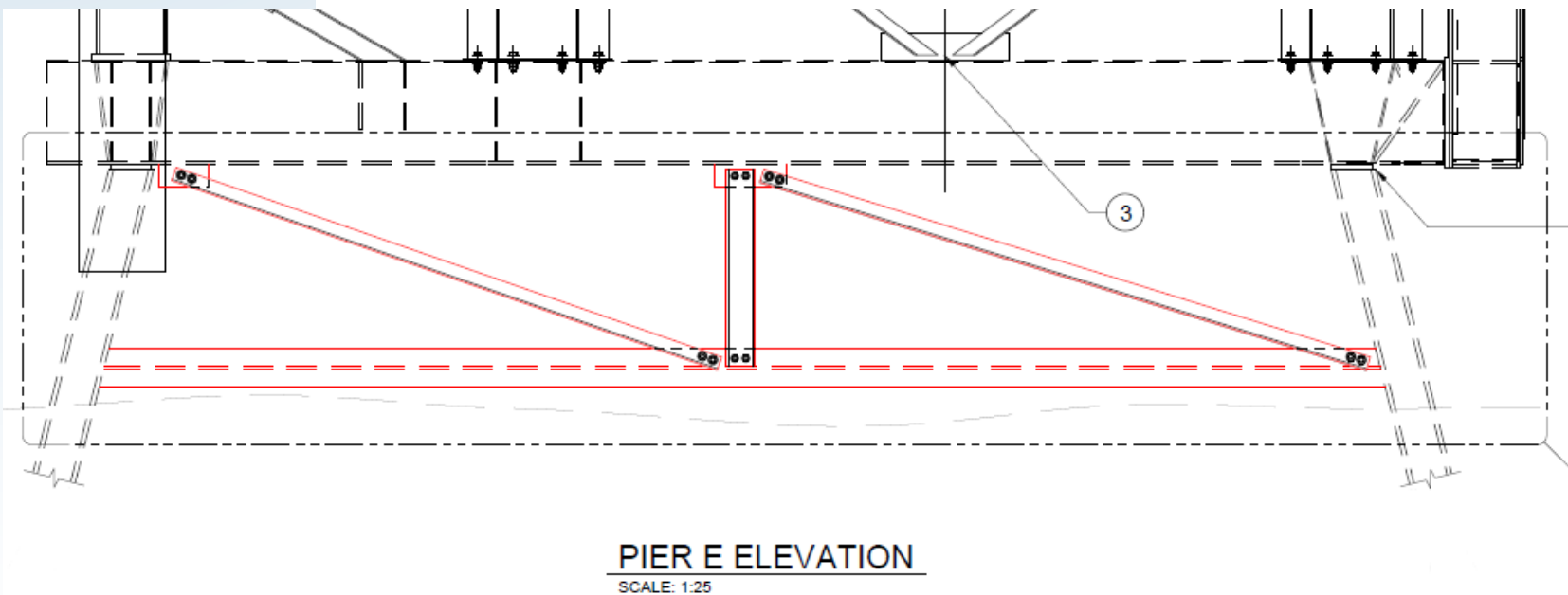
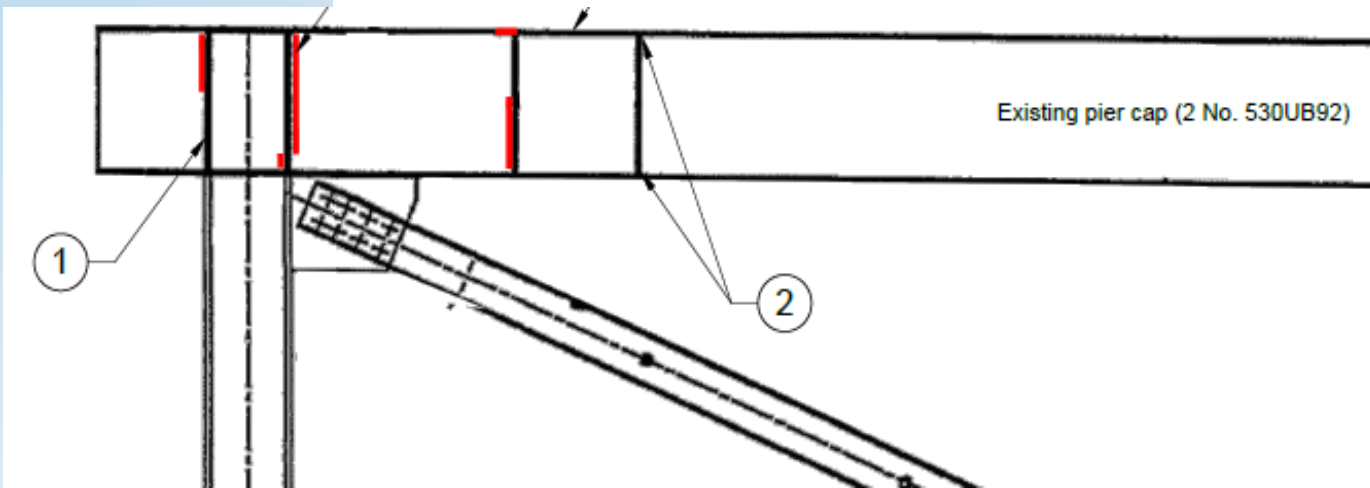


NZTA 019704710 14:00:11

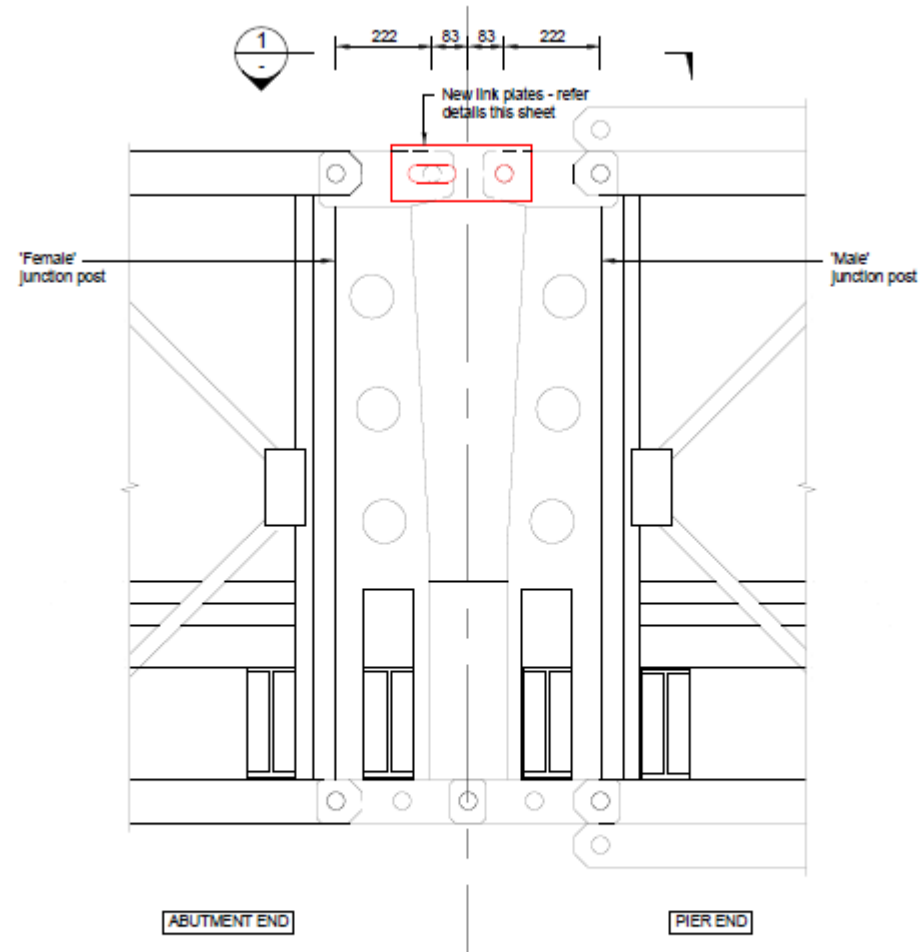
Challenges – there were many!

- 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)

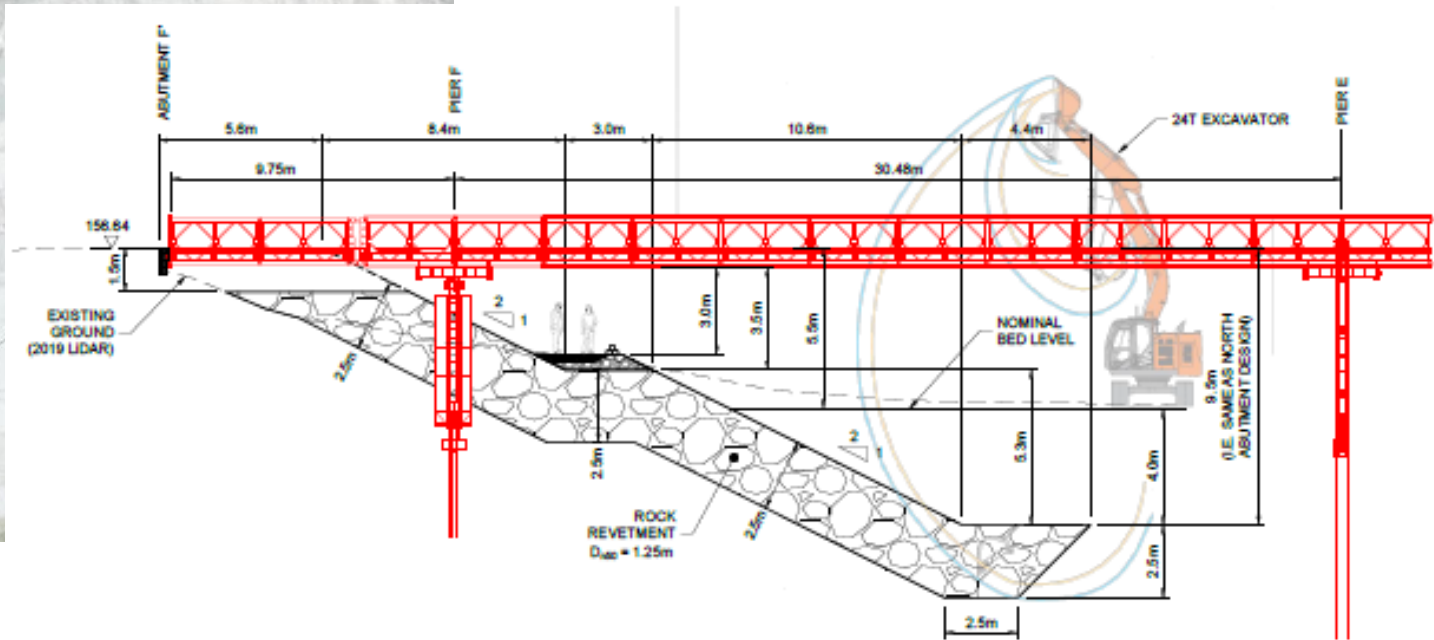
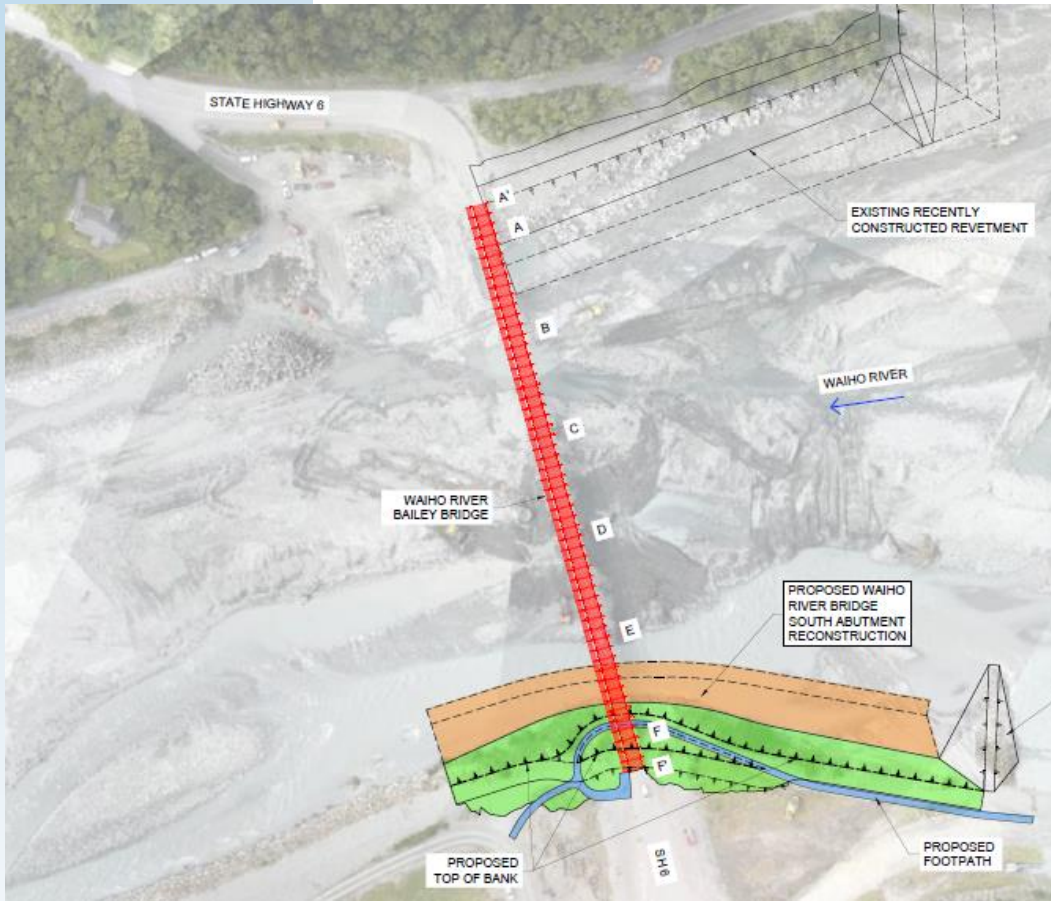
Recovery - Further Repairs



Recovery - Improved Resilience



Recovery - Improved Resilience



TYPICAL SECTION - ROCK REVETMENT
SCALE 1:100 (A1) 1:200 (A3)

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

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

waiiau

1. River of swirling currents
2. Smoking waters



Acknowledgements

- NZ Transport Agency
- WSP Opus
 - *Christchurch Bridges and Civil Structures team*
 - *Christchurch Geotech team*
 - *Greymouth Team*
 - *Wellington Hydraulics Team*
- Key Contractors:
 - *Fulton Hogan*
 - *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

wsp