

Kaiapoi River rehabilitation: Concept Development & Assessment Stage 1 - Area A

Presentation Monday 21 September 2015 to Kaiapoi Community Board

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Outline

- **Summary of our report:**
 - Based on current situation
 - Study objectives
 - Desired outcomes
 - What we did
 - What we found
 - What was recommended (with KRRWP)
 - What else could/should be done

- 1 Introduction**
- 2 Scope**
- 3 Rehabilitation objectives and criteria**
- 4 Situation Analysis**
 - 4.1 Historic changes
 - 4.2 Recent changes
 - 4.3 Sedimentation
 - 4.4 Hydraulic synopsis
- 5 Rehabilitation Options**
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 - 5.2 Description
 - 5.4 Aquatic Habitat Rehabilitation
 - 5.5 Hydraulic modelling
 - 5.6 Construction
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 - 5.7 Indicative costs
- 7 Assessment of rehabilitation options**
- 8 Further work**
- 9 Conclusions**

Scope:

Stage 1 Area A: Cam River flood gates to Mandeville Bridge

- **Study objectives:**
Concept designs & budget estimates for a two stage low flow & flood channel, with meandered channel concepts & treatment wetlands for consideration by the Kaiapoi River Rehabilitation Working Party



Desired outcomes:

- Maintain – enhance:
 - Rowing club use
 - Mahinga kai gathering
 - Fishing access
- Improve aquatic & riparian habit, water quality & amenity
- Maintain required hydraulic capacity
- Maintain infrastructure integrity
- Integrate with upstream & downstream rehabilitation (projects to follow)



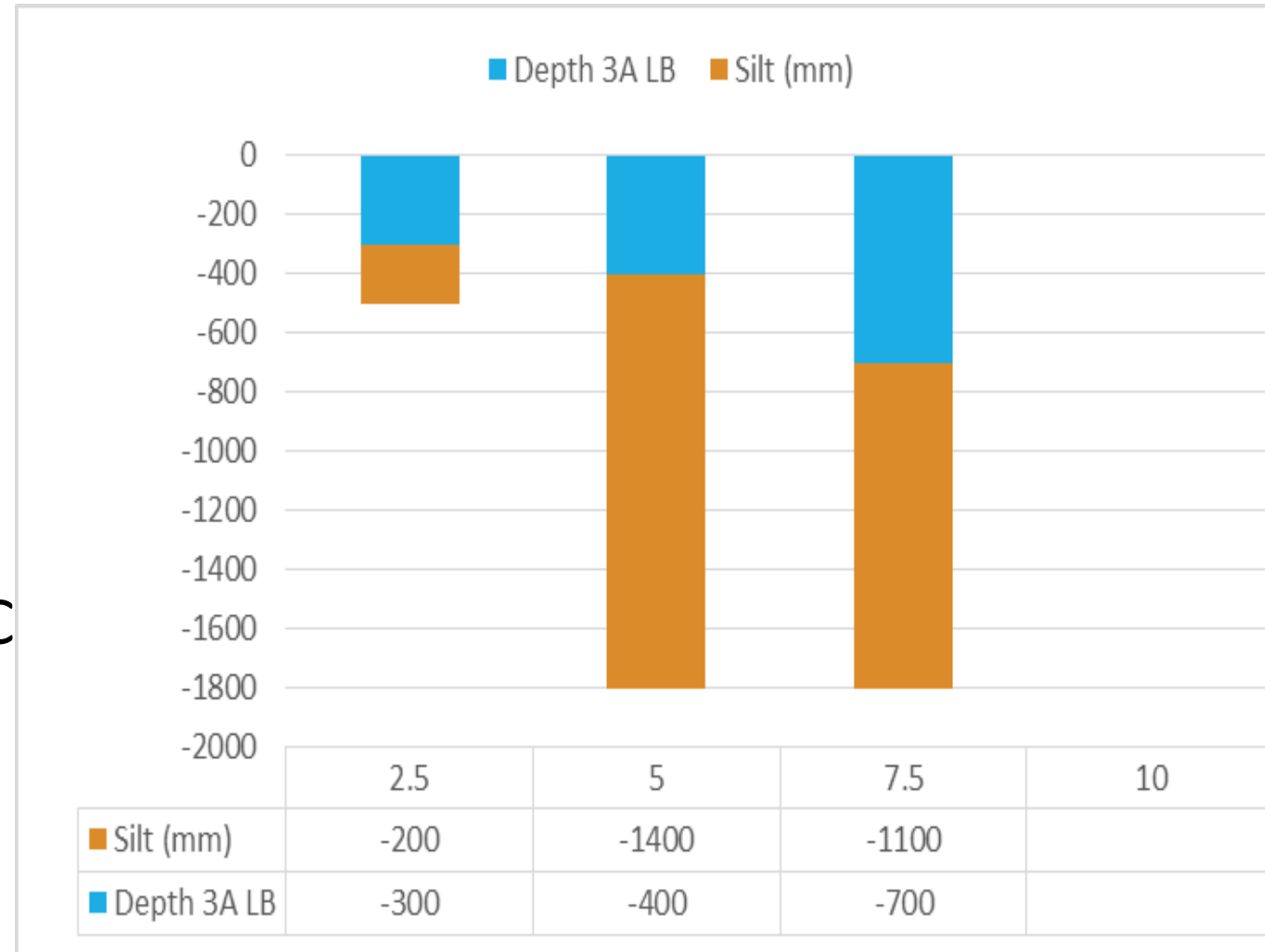
Rehabilitation options assessed

1. Alternate planting of banks to create meandering low flow channel without any dredging or physical channel works; or
2. Excavate meandering low flow channel & deposit dredged material by alternately building out, stabilising & planting of the banks to meander the channel; and
3. Extensive instream works to reform the Kaiapoi River including:
 - Channel excavation & bank reshaping
 - Riparian enhancement
 - Treatment & linear wetlands
 - Sediment traps



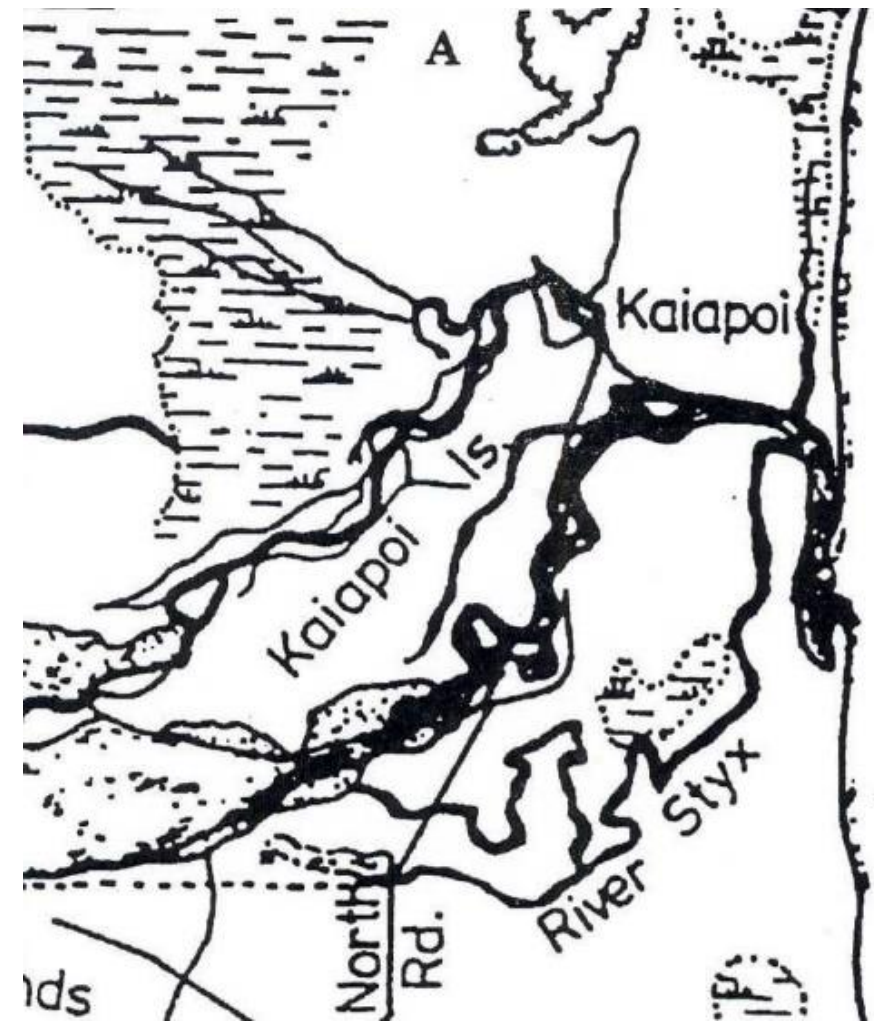
Investigations

- Background – context
- Visual inspection to determine present instream & riparian vegetation
- Recent cross sections surveys provided by ECan
- LIDAR data from Waimakariri DC
- Site investigation of fine sediment deposits in the study reach by probing



Planting schemes: Objectives

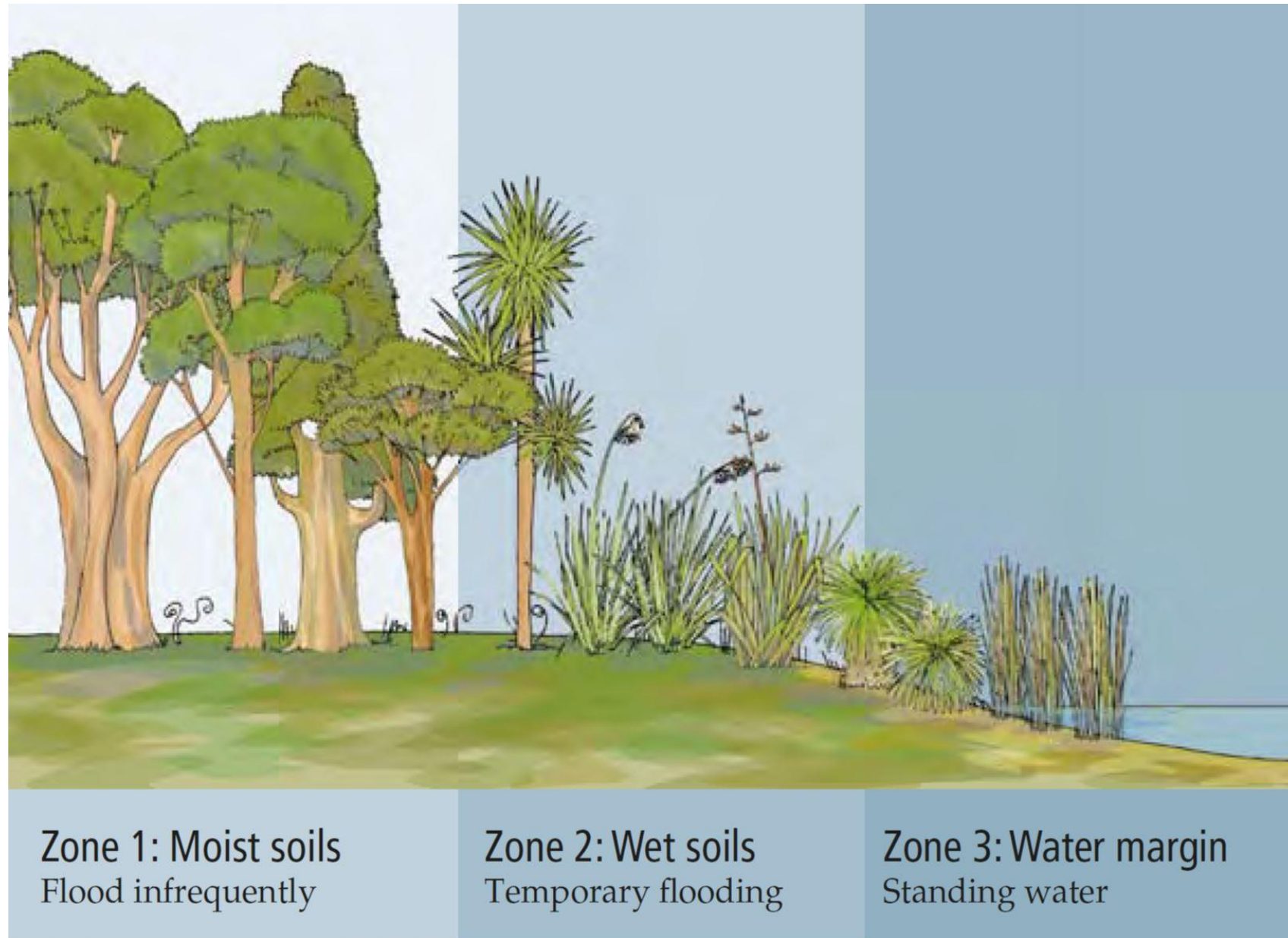
- Context sensitive
- Physical constraints
- Biological outcomes
- Community views



Black Map 1865

Planting schemes:

- Focus on “wet edge”
 - Site suitability
 - Biological outcomes
 - Amenity
 - Aesthetics
- Community views
 - River corridor landscape (separate)



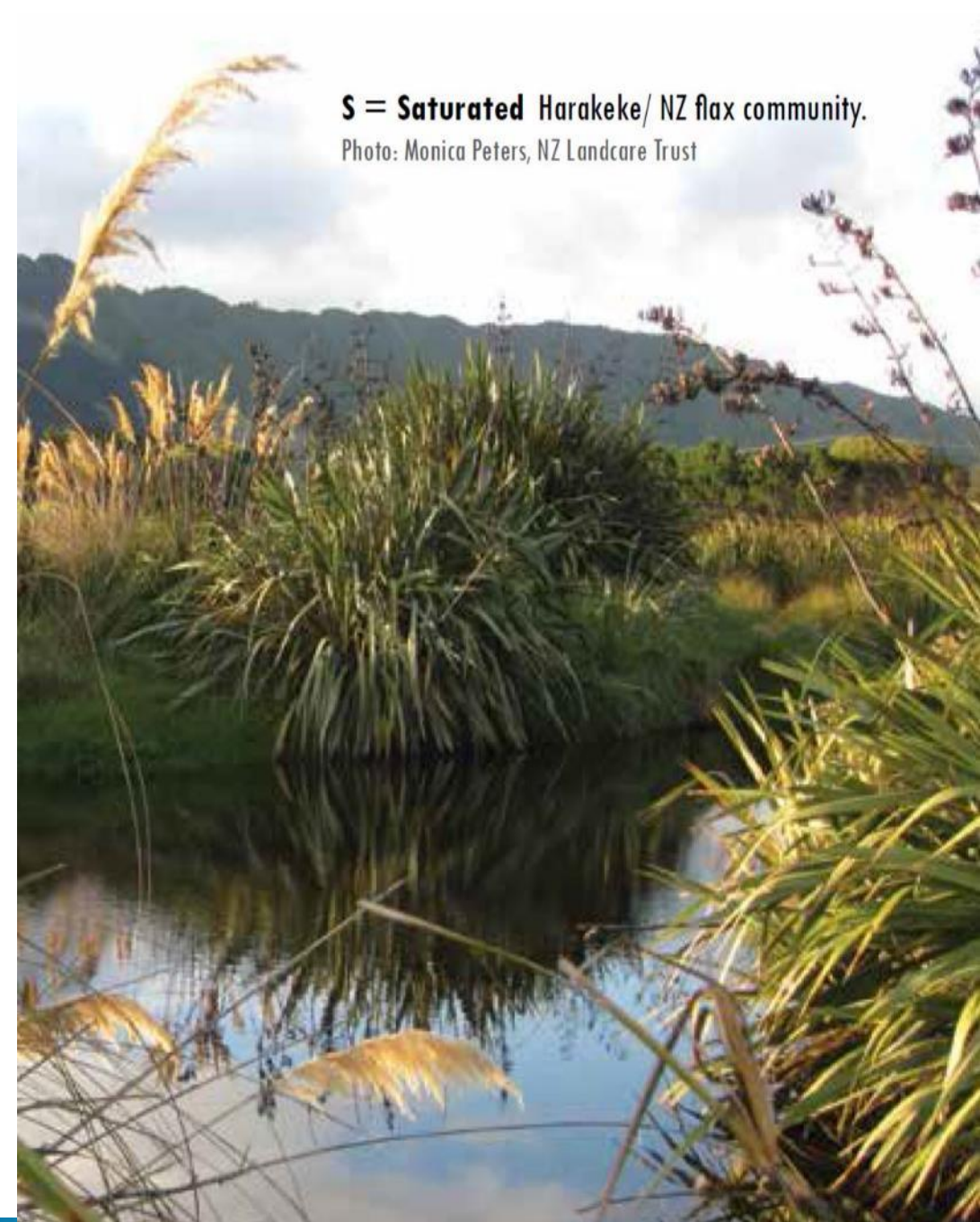
Planting zone	Common name*/Botanical name	Wetland type/habitat	Installation	Additional planting zone
E = Emergent	jointed twig rush <i>Baumea articulata</i>	shallow water, lake edge	plants	Also shallower parts of A
	kuta, tall spike sedge <i>Eleocharis sphacelata</i>	swamp, shallow water, lake edge	plants, seeds, or rhizomes	Also shallower parts of A
	marsh clubrush <i>Bolboschoenus fluviatilis</i>	lake edge	plants or rhizomes	
	raupo <i>Typha orientalis</i>	swamp, shallow water, lake edge	plants or rhizomes	Also shallower parts of A
S = Saturated	baumea <i>Baumea arthropphylla</i>	swamp, lake edge	plants or rhizomes	Also shallower parts of E
	baumea <i>Baumea rubiginosa</i>	swamp, fen	plants or rhizomes	
	cabbage tree, ti kouka <i>Cordyline australis</i>	swamp, fen	plants, seeds	Also M
	harakeke, NZ flax <i>Phormium tenax</i>	swamp, fen	plants (can be divided), seeds	Also M
	mingimingi <i>Coprosma propinqua</i>	swamp	plants, seeds	Also M



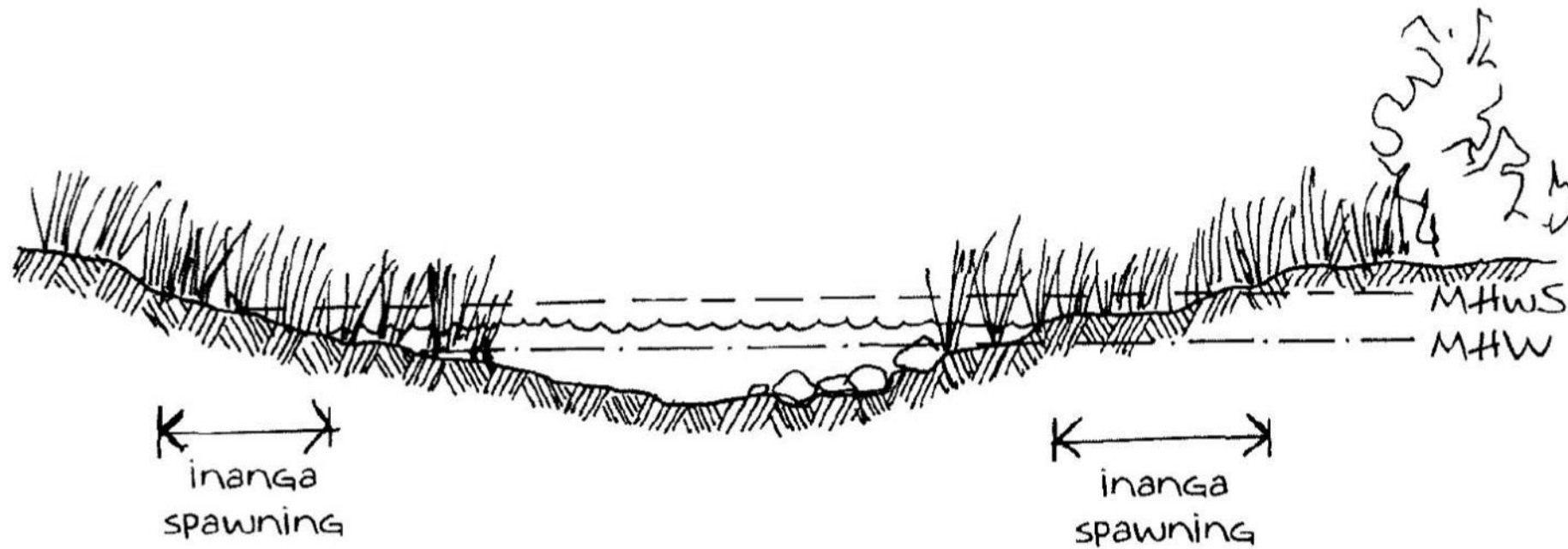
E = Emergent Raupo.

Outcomes: (e.g. target fish)

Species	Riparian (overhead) cover	Instream cover
Banded kokopu	Riparian trees with canopy closure over stream	Holes under the bank, in wood debris, beneath large rocks
Giant kokopu	Riparian trees with canopy closure over stream	Holes in the banks of large pools
Koaro	Riparian trees with canopy closure over stream	Rock/boulder interstices in rapids
Shortjaw kokopu	Riparian trees with canopy closure over stream	Hole under rock/boulder in large pools
Inanga	Vegetation hanging over stream bank into water	Emergent vegetation and macrophytes
Torrentfish	None	Boulder interstices in rapids
Bluegill bully	None	Boulder interstices in rapids
Redfin bully	Riparian tree cover preferred, but not canopy closure	Rocks and boulders Holes under large (20 cm diameter) flat rocks are required for spawning
Longfin eel	None	Holes in hard or soft substrate
Shortfin eel	None	Holes in hard or soft substrate



Biological outcomes ...



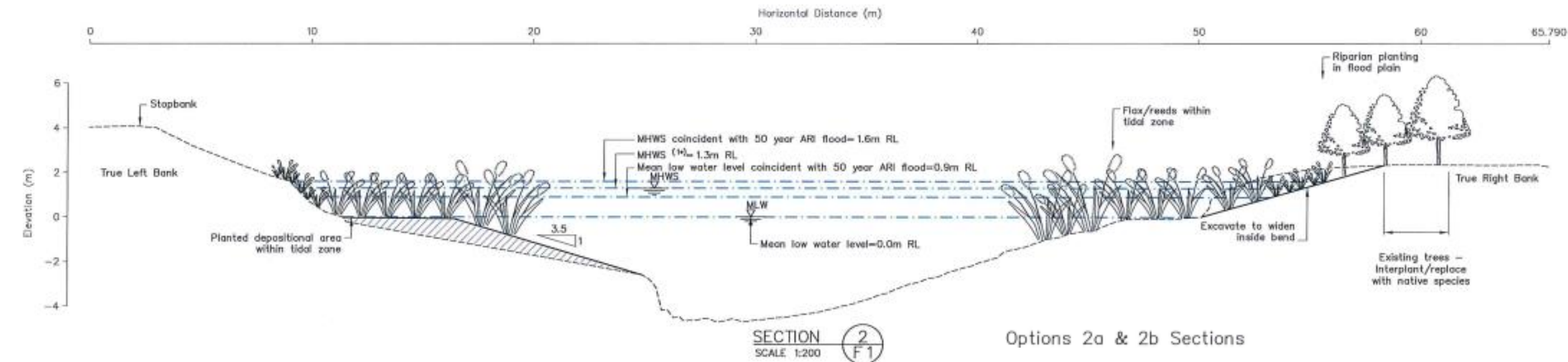
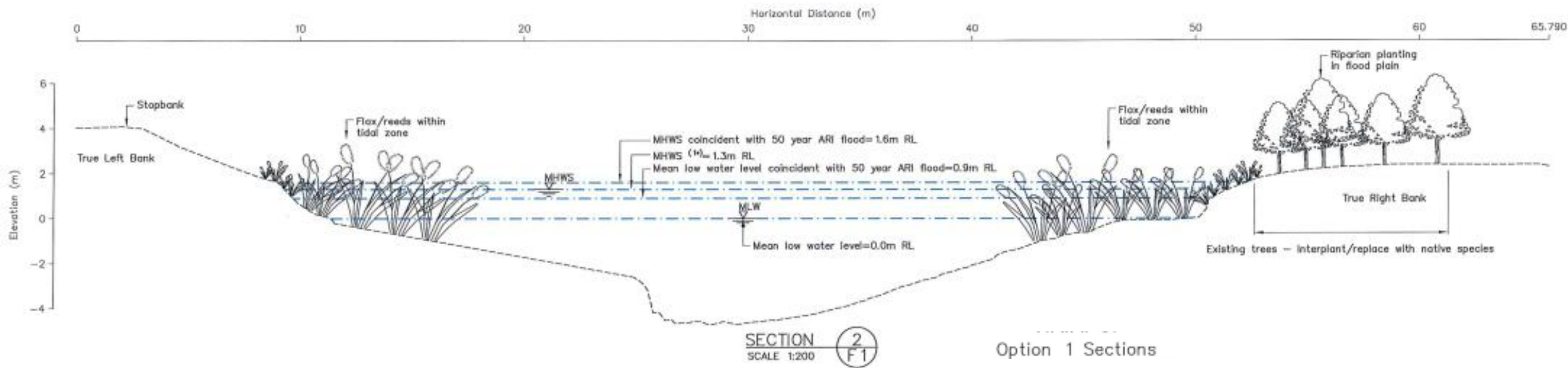
Hydraulic modelling

- Consultation with ECan river engineers
- River model development based on ECan survey & consultation
- Evaluate design concept effects on water levels & velocities
- Determine potential impacts on sediment mobilisation & deposition
- Flows: small fresh ($\sim 10 \text{ m}^3/\text{s}$) to ~ 50 year floods



Hydraulic modelling - results

- Kaiapoi River level is strongly controlled by tidal levels as expected
- Existing channel has excess capacity (i.e. dredging in this reach has no real hydraulic benefit)
- Riparian planting & slight narrowing of river reach (Option 1 & 2) has minimal effect on flood capacity but:
 - Decreases edge velocities promoting sediment deposition
 - Increases mid channel velocity promoting sediment mobilisation
- Waimakariri River flood tailwater effect remains regardless of which option selected
- Kaiapoi River stopbank effectiveness remains unchanged by proposed rehabilitation options (tailwater controlled).



Hydraulic modelling implications

1. With existing channel overcapacity & minimal effect of wet edge & riparian planting on flooding risk, the desired outcomes could be accomplished **without expensive extensive channel reshaping with excavation (i.e. with option 1)**
2. A multi-stage channel will develop within the existing overall channel structure, by encouraging the natural tendency of the straightened, over widened & over deepened river to develop a sinuous low flow channel

Recommendations

- Plant the wet edge & stream margin of the existing shallows to:
 - Increase mid channel river velocities to mobilise loose sediment deposits; & expose gravel in the upper section near the Cam Mouth & perhaps further downstream
 - Decrease velocities in the planted areas to accelerate trapping of sediment along the channel margins
 - Trap & treat contaminants in the planted areas (linear wetlands)
- Extend the wet edge & stream margin planting downstream of Area A (i.e. Mandeville Swing Bridge) to become a transition to Area B (The Williams Street Bridge reach) where channel modifications for navigation are proposed.

What



Figure 20 Edge planting of raupō, carex secta (pukio/flax) and kiokio fern (*Blechnum novae-zelandiae*) with cabbage tree (*Cordyline australis*) in the background

Where











Approach and cost of planting?



- 6,850 sqm (includes 1,700 sqm Williams Bridge reach)
- Commercial cost: \$5.50 - \$8.50 → ~\$38,000 - \$58,000 for ~950 m river reach
- Could be reduced with community approach & natural spread (e.g. raupo self limiting)
- Avon approach extra ~\$160,000 plus excavation plus ballast infill for 240 m river reach

Additional recommendations

The prerequisite for successful rehabilitation of the Kaiapoi River (and Cam River) is the control of excessive sediment & contaminants entering the rehabilitation reach.

The Kaiapoi concept design is intended to further proposals to construct sediment traps & treatment wetlands in the upper Kaiapoi River & tributaries.

Two specific actions are recommended which require further investigation:

1. Re-establish a sediment trap as a precursor to or as part of the rehabilitation of Area E; and
2. Realign the elbow bend at the old mouth of the Cam River & establish a drainage outfall wetland.

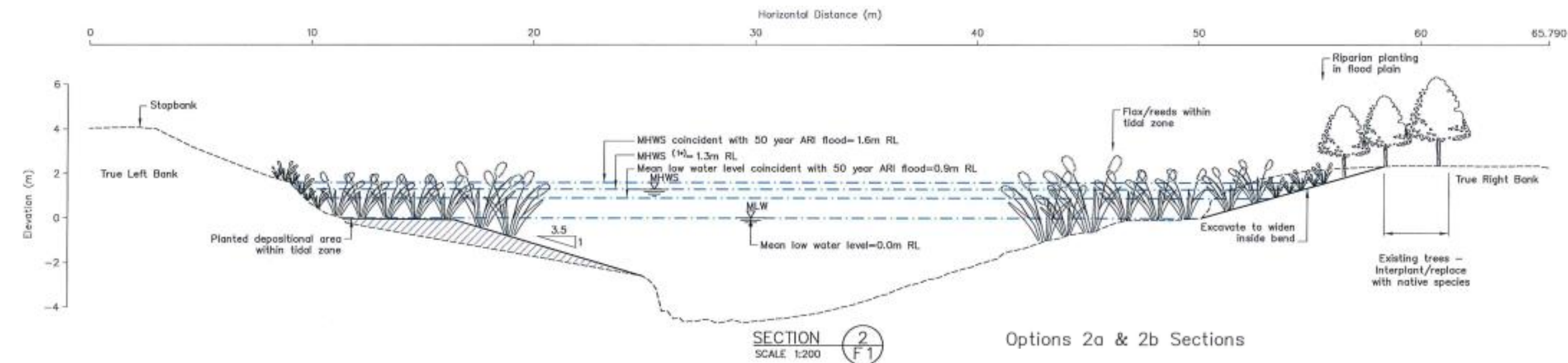
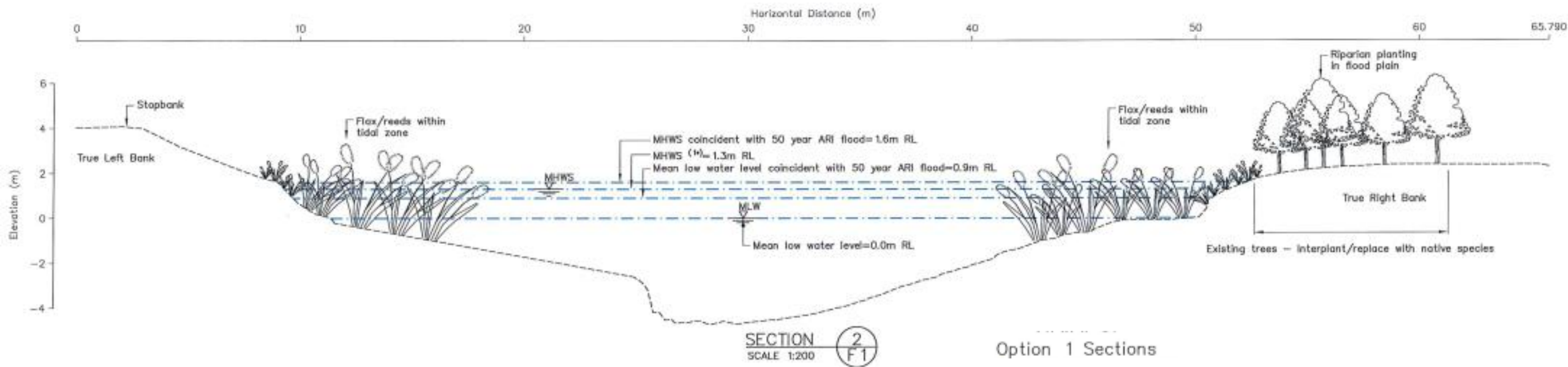
Sediment trap

- Deep silt to MW bridge
- Sediment sources upstream & downstream
- ~10,000 m³ to be removed from trap
- Small freshes sediment from upstream, but ~1/4 back into Cam from tidal flush
- Large Waimakariri floods probable major source of sediment



Bend







Thank you for your attention.

We welcome any questions or comments.

Bend

- Current geometry (90 deg bend) pushes flood flows against the Charles St stopbank area (hence armour) and encourages deeper channel on true left
- A little cut batter on true right bank with planting could help flow around the corner and increase sediment capture area (at banks) along this section of river
- Helps **direct flow** within river channel without reducing flood capacity



NOTE: It is key that fishing access be maintained along the river as part of the riparian planting – Rehabilitation should improve and encourage use of the river.

Hydraulic modelling

- River cross-section survey (provided by ECan)
Survey in 2015
Survey in 2011
- Post earthquakes 2014 LiDAR data (Waimakariri DC) used to extend cross-sections for flood plain extents.
- Working 1D HEC-RAS model developed to assess the impacts of the proposed rehabilitation options
- Model complements the Mike 11 river model developed separately by ECan.

Hydraulic modelling

- River boundary conditions:
 - Tidal influence (0 m – 1.3 m amsl Lyttelton Datum)
 - Confluence with Waimakariri River
 - Upstream levels beyond tidal influence zone based on normal depth (channel flow)
- A range of flows looked at:
 - Small fresh ($\sim 10 \text{ m}^3/\text{s}$)
 - ~ 50 year ARI floods
 - $270 \text{ m}^3/\text{s}$ as per ECan model.
 - $140 \text{ m}^3/\text{s}$ as per EQC IFV TufLOW overland flow model
- Roughness values:
 - Sensitivity check

Hydraulic modelling - Results

- The Kaiapoi River level is strongly controlled by tidal levels
i.e. Model is performing as expected
- Rehabilitation Option 1 – Alternate bank planting
 - Increased riparian zone/bank roughness has minimal effect of hydraulic conveyance
 - Increased channel velocities (0.1 - 0.3 m/s) in main channel during flood
 - Existing channel has excess capacity (i.e. dredging in this reach has no real hydraulic benefit)
- Rehabilitation Option 2 – Excavating/dredging & building out channel
 - Increased riparian zone/bank roughness & narrowing of river reach has minimal effect of hydraulic conveyance during floods
 - Increased channel velocities (0.4 - 0.6 m/s) in flood would result in improved fines mobilisation (i.e. cleaning of silt deposits from main channel)
 - Depositional/suspended sediment capture zones have lower velocities (suspended sediment is settled & stabilised)

Hydraulic modelling – results...

- Rehabilitation Option 1 – Alternate bank planting
 - Increases main channel velocities in flood cleaning the main channel of sediment
 - Captures & traps sediment in planted zones with lower velocities
- Rehabilitation Option 2 – Building out banks to narrow channel
 - Further increases main channel velocities in flood cleaning the main channel of sediment
 - Captures & traps sediment in planted zones with lower velocities
- Rehabilitation Option 3 – Multi-stage channel with extensive instream works
 - Not modelled given identified excess capacity & Working Party direction to focus on river naturalisation rather than “hard engineering”.

Conclusions & recommendations

1. The river is oversized with respect to the current flows (because the present day Kaiapoi River is the historic North Branch of the Waimakariri River that was cut off from the realigned Waimakariri River in the 1930's);
2. The Kaiapoi River & lower Cam River have been substantially straightened & enlarged with works in the 1960s & 1980s (which has created a very hydraulically efficient flow channel with significant tidal flow);
3. Excessive fine sediment deposition has occurred in the Kaiapoi & lower Cam River, which sloshes back & forth with tidal flows;
4. Sediment is depositing in similar point bar & side bar locations which is reverting the river back toward a more sinuous, smaller, flow path last observed in the mid 1960's before major channel works;
5. Increased riparian planting & narrowing of the river channel up to that modelled **does not reduce** the flood routing capacity of the river providing significant flexibility in rehabilitation options; &
6. Increasing the bank roughness & constraining the channel width increases the main channel river bed velocities to improve mobilisation of fine sediment, while reducing the planted edge & riparian zone velocities to facilitate trapping of fine materials in those locations.

Future work

1. Evaluate the recommendation to excavate a sediment trap in the old bend of the realigned Kaiapoi River between the Motorway Bridge & Cam River mouth.
2. Assess the requirements & effects of improving the elbow bend at the old mouth of the Cam River by lowering the inner bend, & infilling & planting the old Cam mouth as a drainage outfall wetland.
3. The planting concept plan presented is deliberately limited to the wet edge that is tidally flooded & channel margins that are frequently flooded **because these plantings are central to the rehabilitation of the river itself to address specific objectives**. Integration of the planting concept plans into a community endorsed planting & management plan is recommended.
4. A planting trial is recommended to investigate if limited planting, & natural spread of target species, can accomplish the desired extent of planting without dense planting over the entire area;
5. Further community involvement initiatives should be investigated to undertake planting & maintenance as a river care group and/or other types of involvement (e.g. school projects).