16 December 2025
Job No: 1092556.0020

Private and Confidential

Gisborne District Council
PO Box 747
GISBORNE 4010

Attention: Joss Ruifrok

Dear Joss

Te Karaka stopbank upgrade - Berm sediment accretion assessment

1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Gisborne District Council (GDC) to carry out an assessment of potential increased gravel and sediment accretion on the berms and floodplain of the Waipaoa River, in response to retreated stopbanks proposed in upgrading the Te Karaka stopbank. This assessment will inform the expected reduction over time in the stopbank level of service (LoS) of retreated stopbanks due to geomorphic processes. This letter report provides berm and floodplain accretion rates based on three scenarios for the reach of the Waipaoa River at Te Karaka, up to the proposed stopbank alignment, for the medium term (next 50 years). To assess the impact of these berm accretion scenarios on the stopbank LoS, these estimates will need to be assessed using the existing Waipaoa River flood model. This assessment follows optioneering design, high-level geomorphic assessment, and evaluation of potential solutions to mitigate flood risk at Te Karaka previously undertaken by T+T.

This report has been prepared in accordance with the variation order signed 31 October 2025 – Te Karaka stopbank upgrade – bridge and berm analyses.

1.1 Project objective and scope

This assessment of potential scenarios of berm and floodplain accretion has been prepared to support GDC in evaluating the level of service of the proposed retreated stopbank protecting the township of Te Karaka, over the medium term. The assessment aims to identify three potential scenarios which will inform understanding of reduced flow capacity and level of service of these stopbanks, considering a least extreme, average (moderate), and most extreme scenario.

The primary objectives of this assessment are to:

- Inform GDC's assessment of the future stopbank LoS reduction at Te Karaka due to gravel and sediment accretion.
- Review existing data on mean bed levels and river cross sections, in the bed and on the berms, to understand the historic trends of bed, berm, and floodplain evolution at Te Karaka.

- Utilise existing elevation and flood modelling data to characterise the channel, berm, and floodplain geomorphology at Te Karaka and the distribution of floodplain accretion.
- Incorporate existing literature covering:
  - Floodplain building processes on the Waipaoa River.
  - Mean bed level trend modelling on the Waipaoa River.
- Produce laterally varying predictions of vertical change across and extending from each survey benchmark at Te Karaka.

1.2 Background

The township of Te Karaka is positioned on a section of floodplain adjacent to the Waipaoa River. The Waipaoa River at this reach is a partly confined meandering river, which is now suspended load dominated, with cohesive, silty banks. Land use transformation of the Waipaoa River catchment and climatic variability have amplified the geomorphic responses of an already highly erodible geological landscape. This has resulted in sustained sediment overloading of the river system throughout the 20th and 21st centuries. This Anthropocene transformation of the catchment has also resulted in an overall contraction and reduction of bankfull width relative to its historical condition of a more gravel-bedded, laterally active river.

High sediment loads are expected to continue throughout the 21st century, despite efforts to mitigate catchment erosion because significant sediment sources known as 'badass gullies'[1] (e.g. Tarndale and Mangatu[2]) will continue to contribute substantial sediment volumes for decades to come. In addition, even if all erosion in the catchment were able to be shut down, the river will continue to rework substantial stores of sediment in its active channel bed. Furthermore, forecast climate change for the region will likely result in increased sediment delivery to the Waipaoa in response to increased magnitude and frequency of large storm events. The Waipaoa River's character and behaviour will continue to evolve in response to shifting sediment regimes and hydrological patterns. This provides significant uncertainty in estimating or modelling geomorphic change and accretion patterns on the floodplain at Te Karaka but also shows the importance of developing flood management strategies in alignment with the geomorphology and trajectories of the catchment and reach, to ensure long-term resilience.

The Waipaoa River near Te Karaka has been artificially confined on the true right bank with stopbanks and is naturally confined by valley margins on the true left bank. This confinement, together with the nature of sediment lining the channel, limits the river's capacity for lateral migration, despite the river's inherent (historic) tendency to adjust its bed and banks in response to sediment load and flow variability. Even with a retreated stopbank alignment, adjustment will primarily take place in the form of deposition and erosion of temporary sediment stores within the channel and on the adjacent floodplain. This sediment is episodically reworked, especially where it is subject to more frequent high energy flows, leading to alternating phases of erosion and deposition. Elevated portions of floodplain which do not receive high-velocity flows, especially with a retreated stopbank alignment, are more likely to experience sediment drapes in events which overtop the channel banks and reach the floodplain.

---

[1] Marden, M., Fuller, I. C., Herzig, A., & Betts, H. D. (2018). Badass gullies: Fluvio-mass-movement gully complexes in New Zealand's East Coast region, and potential for remediation. *Geomorphology*, 307, 12-23.
[2] Fuller, I. C., Strohmaier, F., McColl, S. T., Tunnicliffe, J., & Marden, M. (2020). Badass gully morphodynamics and sediment generation in Waipaoa Catchment, New Zealand. *Earth Surface Processes and Landforms*, 45, 3917-3930.

At Te Karaka, the Waipaoa River exhibits a two-stage channel form, with a base channel and wider macro-channel (see Figure 1.1, Figure 1.2). The macro-channel exhibits point bars, as well as longitudinal and mid-channel bar features. This macro-channel is approximately two metres lower than the surrounding floodplain and so experiences more regular inundation and higher velocity flows, while the surrounding floodplain would naturally (without stopbanks) experience less regular, lower velocity flows which would naturally drape sediment across it. Figure 1.2 displays the Relative Elevation Model (REM) which visualises the local floodplain topography by displaying the elevations above the river channel.

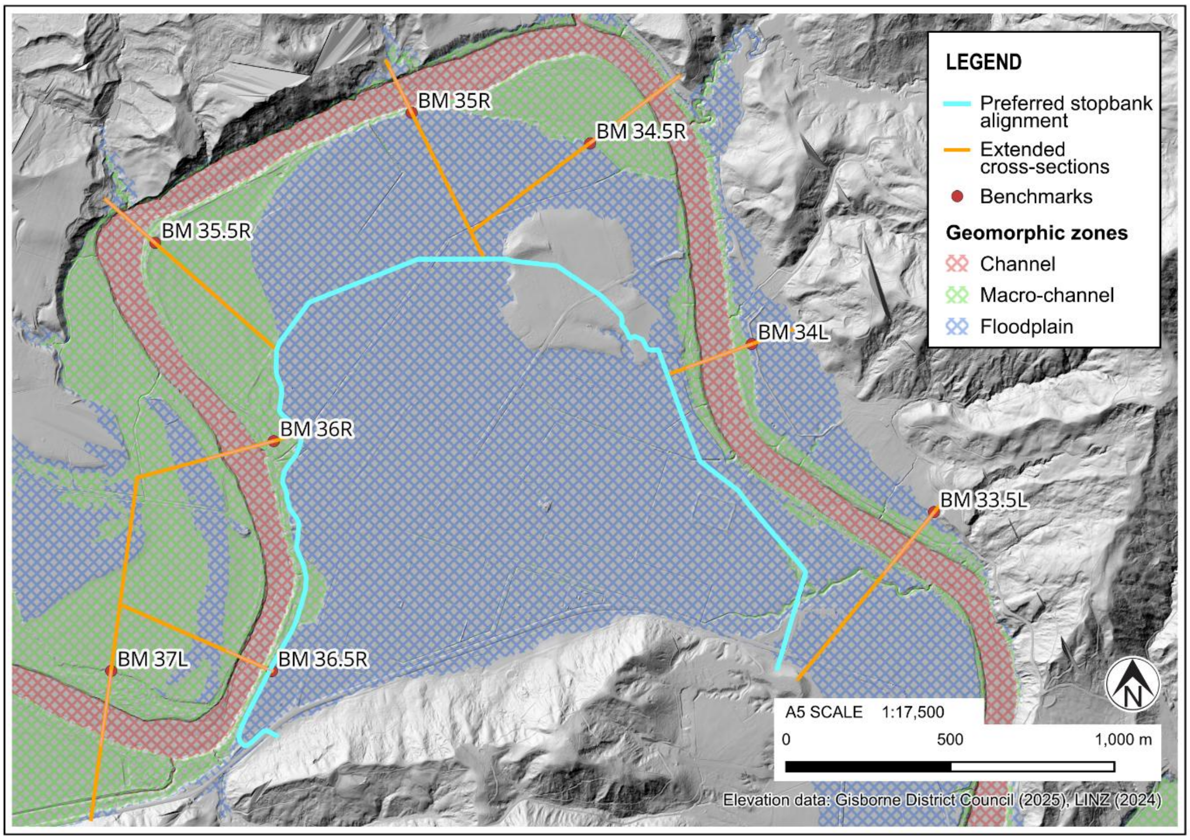


Figure 1.1: Delineated geomorphic zones at Te Karaka with the extended cross-section alignments used to show elevation change at each benchmark (Figure 3.6). Note: all sections are mapped and shown in Figure 3.6 from true (river) left to right.

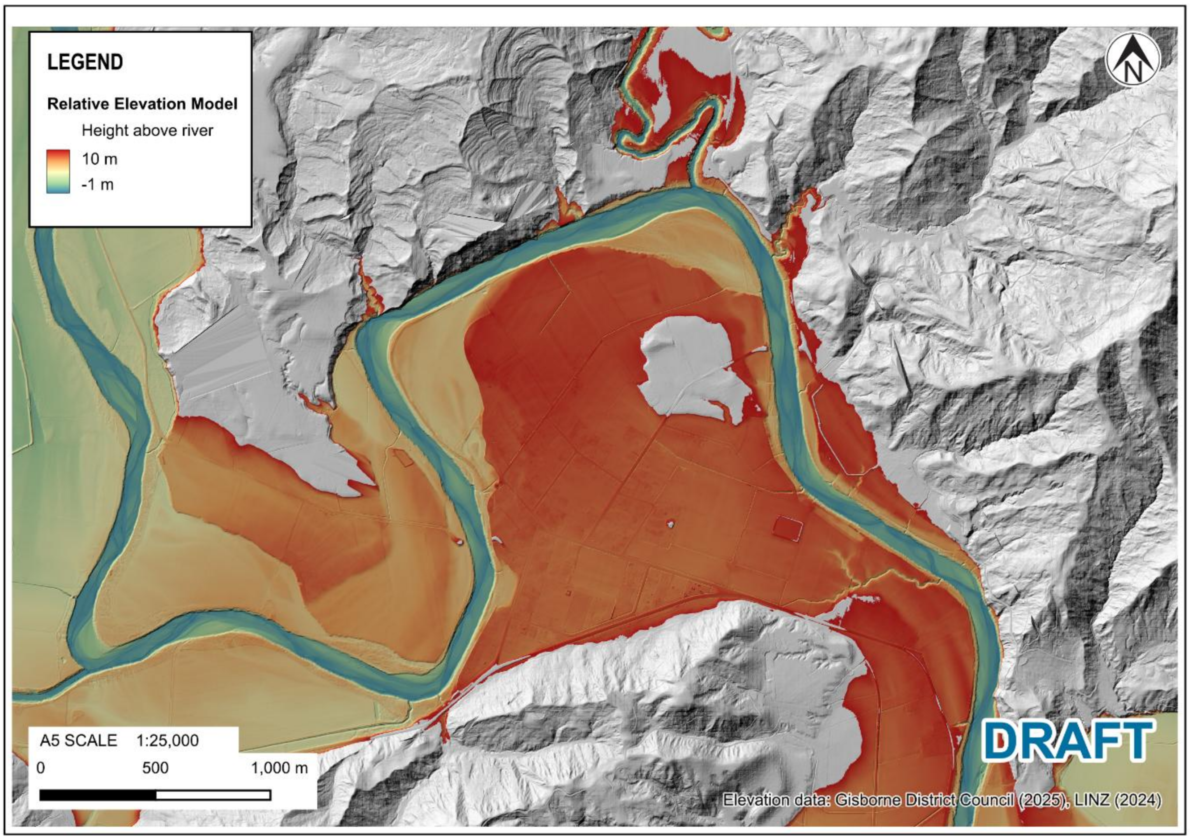


Figure 1.2: Relative Elevation Model (REM) at Te Karaka.

More background to the geomorphology of the Waipaoa River at Te Karaka can be found in the high-level geomorphic assessment (T+T, 2025).

2 Methodology

2.1 Overview

The methodology used for this assessment (Figure 1.2) considers repeat cross-sectional surveys, relative elevations, and existing stratigraphical work on the floodplain at McPhail's bend (around 20 km downstream of Te Karaka) (Gomez, et. al., 1998), and modelling of bed level change trajectories (Gomez, et. al., 2009). The key steps in this assessment are:

1. Delineate channel, macro-channel and floodplain zones across the assessment area using a Relative Elevation Model (REM).
2. Examine cross-section surveys at Te Karaka and extract an annualised rate of bed level change.
3. Compare this with McPhail's bend as validation.
4. Examine cross-section survey BM 34.5 at Te Karaka to identify annualised rate of accretion within the macro-channel
5. Compare this with McPhail's bend as validation
6. Based on the comparison of macro-channel and bed level change at Te Karaka and McPhail's bend, extrapolate annualised rate of vertical accretion on the floodplain at McPhail's bend derived from stratigraphical evidence to the floodplain at Te Karaka.

7 Extract factors/multipliers for three future bed level change trajectories at Te Karaka from existing bed level modelling and extrapolate these rates to the accretion in the macro-channel and on the floodplain.

8 Apply estimates of vertical accretion for the three future trajectories, across the different zones.

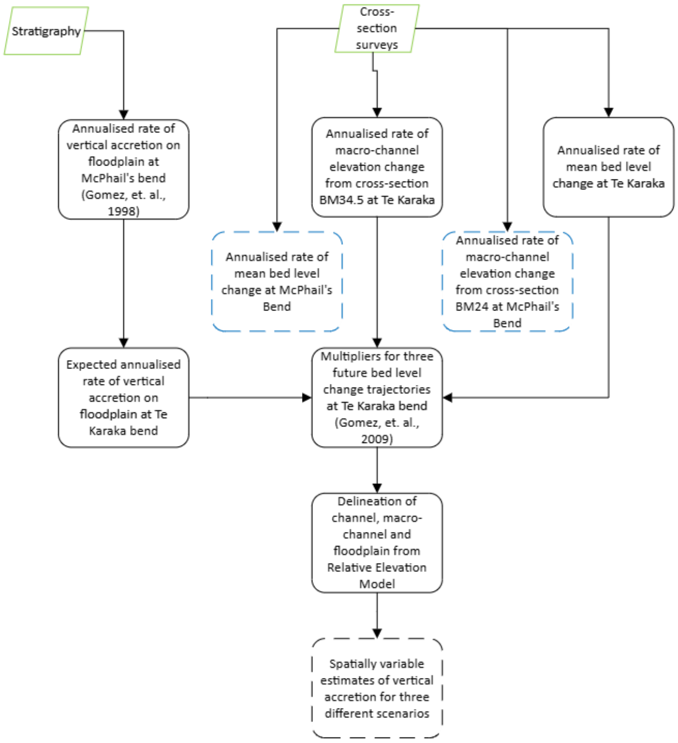


Figure 2.1: General workflow used to produce estimates of accretion on the berms at Te Karaka.

During the course of this assessment, several refinements were made to the methodology originally proposed to GDC (variation order, 31 October 2025). These changes were implemented to better align the assessment with the available data and to improve the predictions.

First, the Relative Elevation Model (REM) was adopted as the primary geomorphic input for delineating depositional zones instead of using shear stresses from the flood model. This change was necessary because the flood model represents an extreme design event rather than the more frequent moderate floods (approximately 5-year ARI) that primarily drive floodplain accretion, and the shear stress distribution exhibits high spatial variability that may not represent typical sediment-depositing conditions. The REM provides a more robust basis for identifying different depositional zones based on relative elevation above the channel thalweg, which better correlates with inundation frequency and the balance between erosional and depositional processes.

Second, accretion rates were applied laterally by geomorphic landform units rather than varying longitudinally by cross-section, as the available floodplain and berm accretion data are from limited sites and represent averaged values, and bed level change modelling is similarly averaged across the reach. Given that historic survey data show variable rates through Te Karaka bend over the last 80 years, and may not represent future patterns, there was insufficient information to reliably differentiate rates of change longitudinally.

These refinements allowed different accretion trajectories for geomorphic landform units to be mapped across the entire extent of the area assessed. The deliverables were improved to include spatially continuous raster datasets showing elevation changes and projected elevations across the full assessment area, in addition to the originally proposed elevation change profiles at cross-sections.

2.2 Data sources

Table 2.1: Key data sources used in assessment

Name	Source	Type
Gisborne LiDAR 1m DEM	LINZ, 2024.	Raster DEM
Waipaoa River Bathymetric DEM	GDC, 2025.	Raster DEM
Waipaoa River Survey	GDC, 2025.	Repeat cross section survey
Stratigraphical evidence from McPhail's Bend	Gomez, et. al., 1998.	Journal article in *Earth Surface Processes and Landforms*[3]
Modelled bed level change in the Waipaoa River	Gomez, et. al., 2009.	Journal article in *Global and Planetary Change*[4]

3 Results

3.1 Stratigraphy and bed level assessment

At Te Karaka, trends in mean bed level between 1958 and 2017 showed an average annual rate of aggradation of 14 mm/yr (13 mm/yr from 1958 to 1998), although there was significant variability in this rate between each of the eight cross-section surveys and at each section, throughout the period of monitoring (see Appendix A). Cross-section surveys also captured changes in the macro-channel area at BM 34.5, at Te Karaka (see Figure 3.1) for the same period, which was subjected to repeated inundation in out-of-bank flows. This bar surface experienced a total of around 1.6 metres of accretion over the period, equivalent to approximately 27 mm/yr, nearly twice the rate of bed level change for the same period.

[3] Gomez, B., Eden, D.N., Peacock, D.H., Pinkney, E.J. (1998). Floodplain construction by recent, rapid, vertical accretion: Waipaoa River, New Zealand. *Earth Surface Processes and Landforms, 23*(5), 405–413.
[4] Gomez, B., Cui, Y., Kettner, A.J., Peacock, D.H., Syvitski, J.P.M., (2009). Simulating changes to the sediment transport regime of the Waipaoa River, New Zealand, driven by climate change in the twenty-first century. *Global and Planetary Change.* 67, 153-166.

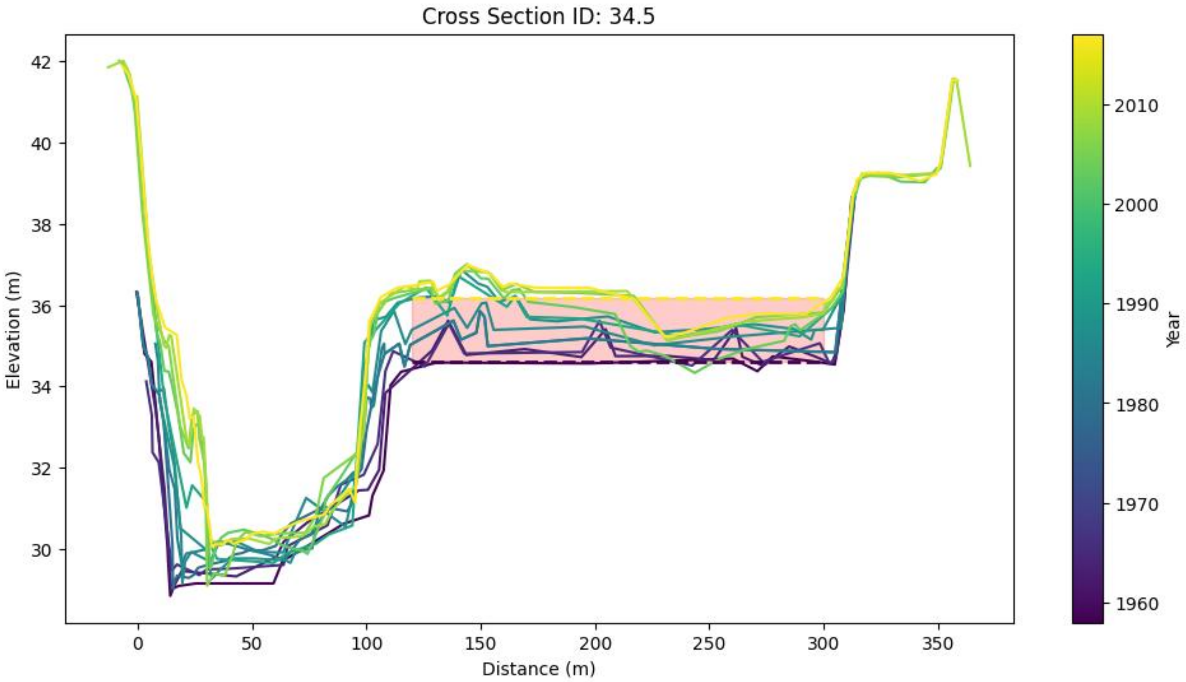


Figure 3.1: Repeat cross-section survey at benchmark 34.5 (Te Karaka) showing accretion on the macro-channel area, with the difference in the mean bar surface elevation shown between the two dashed lines, in red.

At McPhail's bend, trends in mean bed level and berm accretion from repeat cross-section surveys were also assessed as comparison and validation at a reach connected to its natural floodplain without stopbanks. Between 1948 and 2018, this reach showed an average annual accretion rate of 18 mm/yr (17 mm/yr from 1948 to 1998). This rate is slightly higher than at Te Karaka, potentially as a consequence of less artificial confinement, allowing flows to spill and reducing bed shear stresses which may limit aggradation at Te Karaka. At BM 24 (McPhail's Bend), berm accretion is captured (see Figure 3.2) between 1948 and 2017, where approximately 1.6 metres of accretion has occurred, equivalent to approximately 23 mm/yr, similar to Te Karaka.

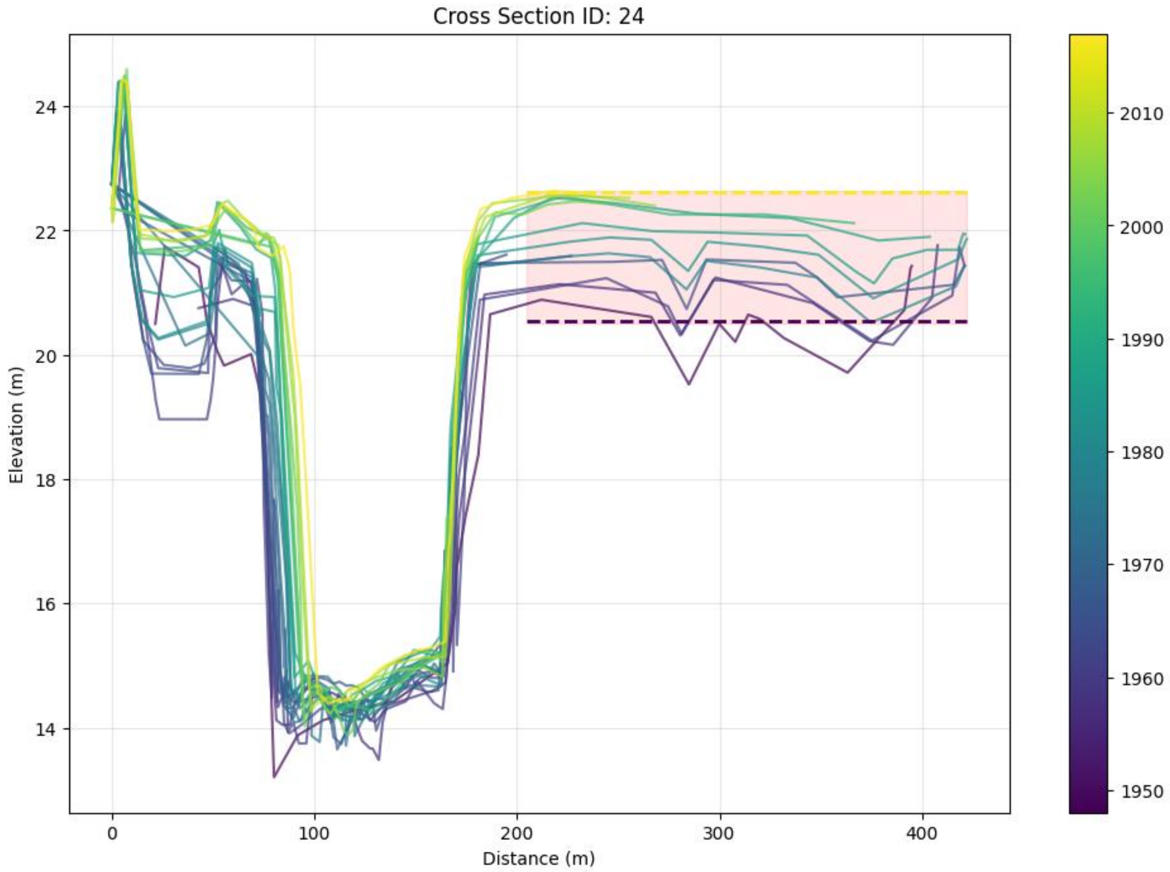


Figure 3.2: Repeat cross-section survey at benchmark 24 (McPhail's Bend) showing accretion on the macro-channel area, with the difference in the mean bar surface elevation shown between the two dashed lines in red.

The similarity in these rates shows that the behaviour on the berms within the macro-channel extent at both McPhail's bend and at Te Karaka have been similar over the last 80 years. For the macro-channel at Te Karaka, future rates of berm accretion within the macro-channel can simply be based on the historical accretion at BM 34.5 (Te Karaka), with the evidence from McPhail's bend acting as validation for this rate, and the comparable relationship between bed aggradation and berm accretion. Additionally, evidence from McPhail's bend, as a reach with connected floodplain, can be used to infer potential accretion rates on the wider, proposed re-connected floodplain at Te Karaka.

Historic data from a stratigraphic study conducted by Gomez et al. (1998) on McPhail's Bend (20 km downstream from Te Karaka) showed an annualised rate of vertical accretion of 43 mm/year during the period of survey (1948-1996) (see Figure 3.3). This is adopted as the predicted annualised rate of change (under existing conditions) at Te Karaka, with a lack of other evidence, and validated by the similar rates of aggradation/accretion between the two sites based on cross section analysis.

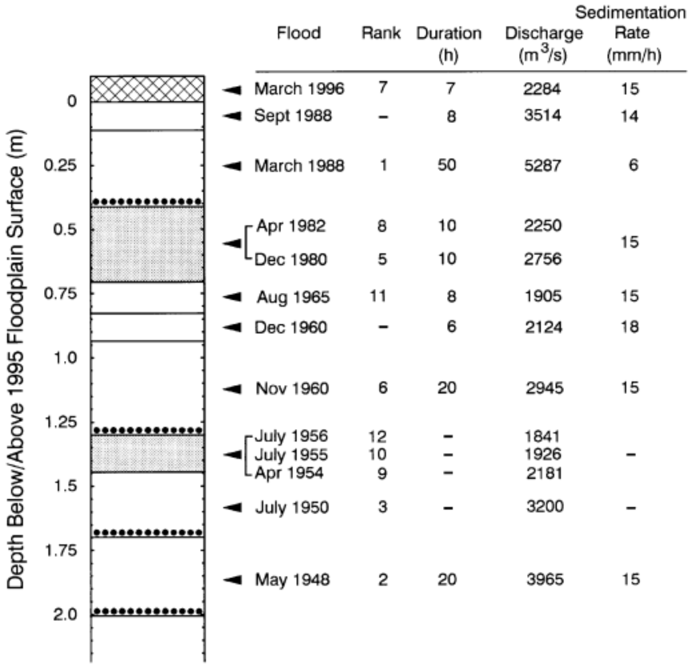


Figure 3.3: Thickness of overbank deposits at McPhail's bend from stratigraphical record. From Gomez, et. al., 1998 (Figure 6).

3.2 Scenario development

Four future change scenarios were developed based on the study by Gomez, et. al. (2009), which used two models (*HydroTrend* and *TUGS*) to predict bed level change in the Lower Waipaoa River out to 2080 (see Figure 3.4). These four scenarios each were associated with a rate of bed level change at Te Karaka:

1. No change/degradation: -0.2 mm/yr.
2. Least extreme: 6 mm/yr.
3. Moderate: 14 mm/yr.
4. Most extreme: 24 mm/yr.

The assumptions relating to these scenarios are detailed in Table 3.2, below.

Table 3.1: Future change scenarios based on Gomez, et. al. (2009)

Scenario	Rate (mm/yr)	Assumptions/conditions	Comparison to historical rates
No change/degradation	-0.2	Gomez et. al.: Reduction in sediment load; mean flow of Waipaoa River decreases with climate change*	
Least extreme	6	Gomez et. al.: No change in boundary conditions; flow and sediment load continue at modern-day mean rates	Factor of 0.42; about 40% of historical rates
Moderate	14	T+T: Current observed changes at Te Karaka between 1958-2018 continue	
Most extreme	24	Gomez et. al.: No reduction in sediment load; mean flow of Waipaoa River decreases with climate change*	Factor of 1.7; about 70% higher than historical rates

*Note: Numerical modelling from *HydroTrend* conducted by Gomez, et. al., 2009, suggest that the mean flow in the Waipaoa River could decline to between 64 and 100% of its present value by the 2080s. Gomez, et. al., 2009, suggest this may reduce the recurrence interval of the contemporary bankfull discharge in the lower reaches, limiting the transport capacity of the river. This 2009 assumption has not been revisited by T+T and may have been superseded by more recent regional climate change modelling; however, it's T+T's opinion that these scenarios give a reasonable range for assessing potential future trajectories.

The "no change/degradation" scenario was not progressed further as the scope was to consider reduction in the level of service of the proposed stopbanks. In light of the expected trajectory of the Waipaoa outlined in Section 1.1, the best-case scenario is likely to be continuation of current rates of sedimentation at the site.

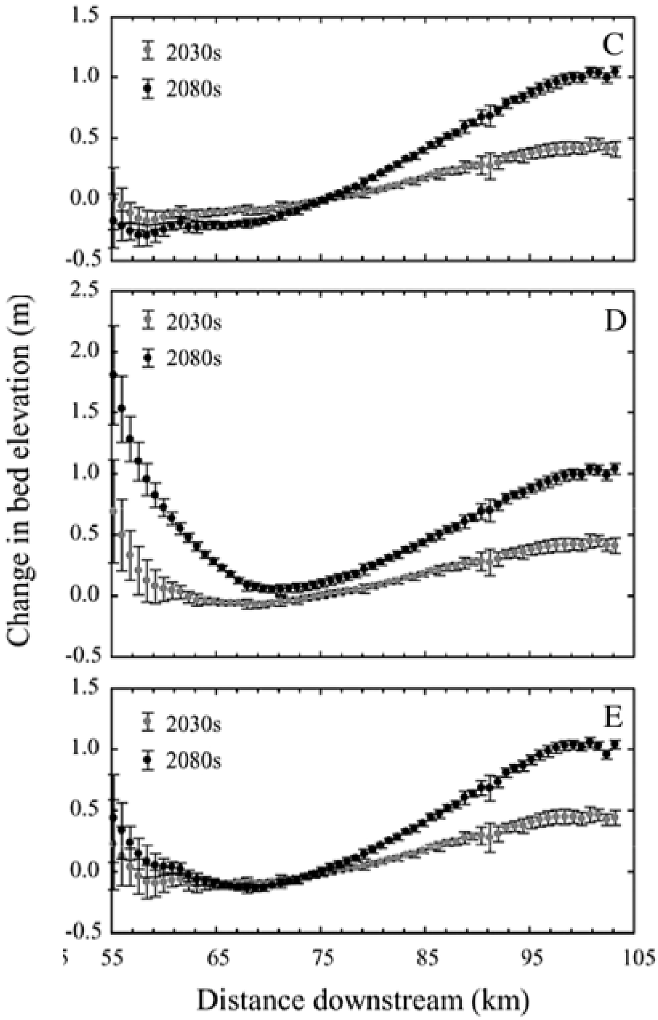


Figure 3.4: Modelled bed level elevation changes in the Waipaoa River, from Gomez, et. al. (2009). C) represents a scenario where sediment supply decreases and mean flow decreases. D) represents a scenario where sediment supply stays consistent while mean flow decreases. E) represents no change to the existing boundary conditions.

In each scenario, the estimations were spatially differentiated based on different rates of sediment deposition across the floodplain:

- Main channel: aggradation change factor multiplied by historic bed level change.
- Macro-channel: aggradation change factor multiplied by historic accretion on the berms in the macro-channel at Te Karaka.
- Inundated floodplain: aggradation change factor multiplied by historic accretion on the floodplain at McPhail's bend.
- Outside of the inundation extents: no change

In this assessment, projections were made to 2075, at the end of the 50-year "medium-term" planning horizon. Table 3.2 shows the total change in different sections of the modelled extents for each scenario, up to 2075.

Table 3.2: Estimated vertical accretion across zones for each potential scenario

Zone	Total vertical change (m) to 2075 in scenario		
	Least extreme	Moderate	Most extreme
Channel	0.30	0.72	1.20
Macro-channel	0.56	1.35	2.25
Inundated floodplain	0.90	2.15	3.58

3.3 Spatial representation of estimates

These zones were delineated across the floodplain width between sections BM 37 (upstream) and BM 33.5 (downstream). Delineation used the Relative Elevation Model (REM) based on a composite of the 2023 LiDAR survey and the 2024 bathymetric survey. Areas less than three metres above the channel thalweg were delineated as channel, between three metres and 7.5 metres as macro-channel, and between 7.5 metres and ten metres as floodplain (Figure 1.1).

A composite Digital Elevation Model (DEM) was created by merging the bathymetric LiDAR survey and the regional LiDAR survey, using values for the bathymetric survey where they were lower, to represent the bed elevations within the wetted channel. Existing stopbanks were removed from the DEM (using a smoothing algorithm) where the preferred stopbank option alignment is at a retreated position.

Using the delineated zones (Figure 1.1) and the estimates of vertical accretion in Table 3.2, the generated DEM was vertically raised for the three estimates. The resulting, projected DEM was then smoothed with a morphological filter to ensure there were not steep boundaries between different zones. These generated elevation models were also sampled across sections extending laterally across the floodplain from each of the benchmarks. Figure 3.5 shows the generated DEM (left), the generated Relative Elevation Models (centre), and the elevation changes applied (right) for each of the three scenarios. Figure 3.6 shows the sampled sections (from Figure 1.1) with estimated elevations for each of the three scenarios.

The tendency for the modified DEM to amplify small, relative high points in some of the cross-sections is discussed in Section 4, below.

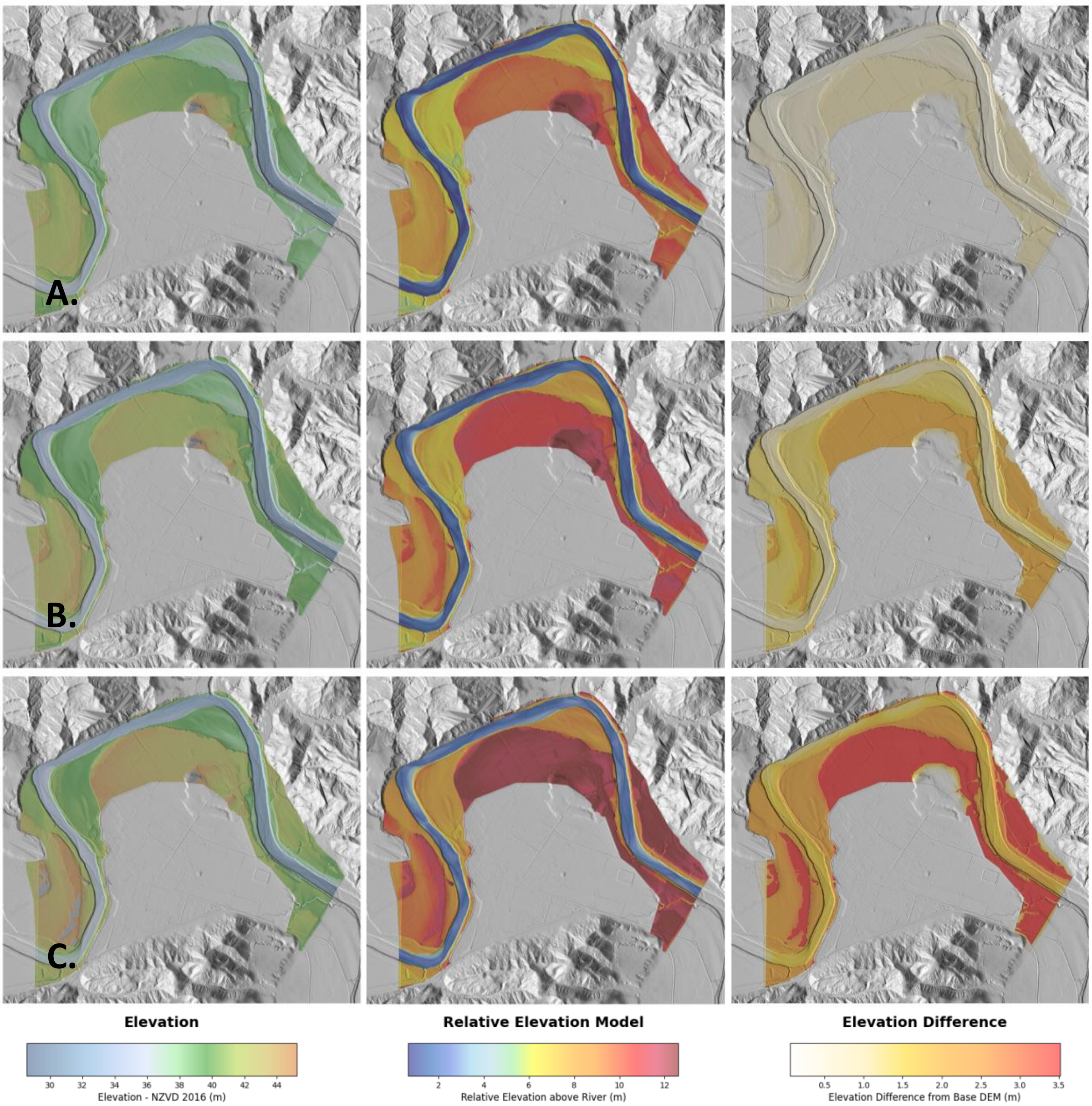
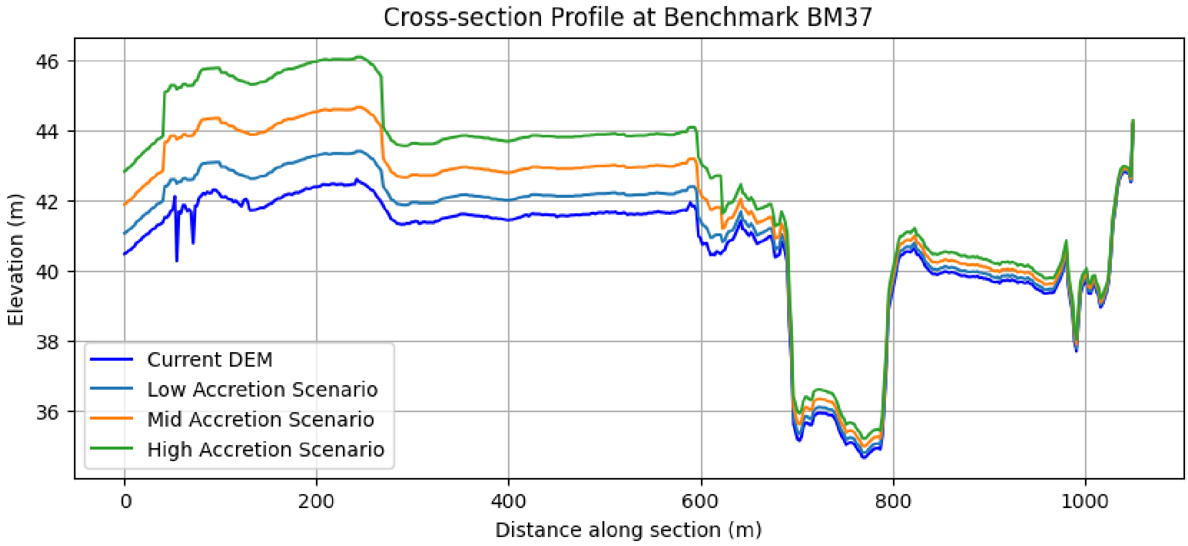
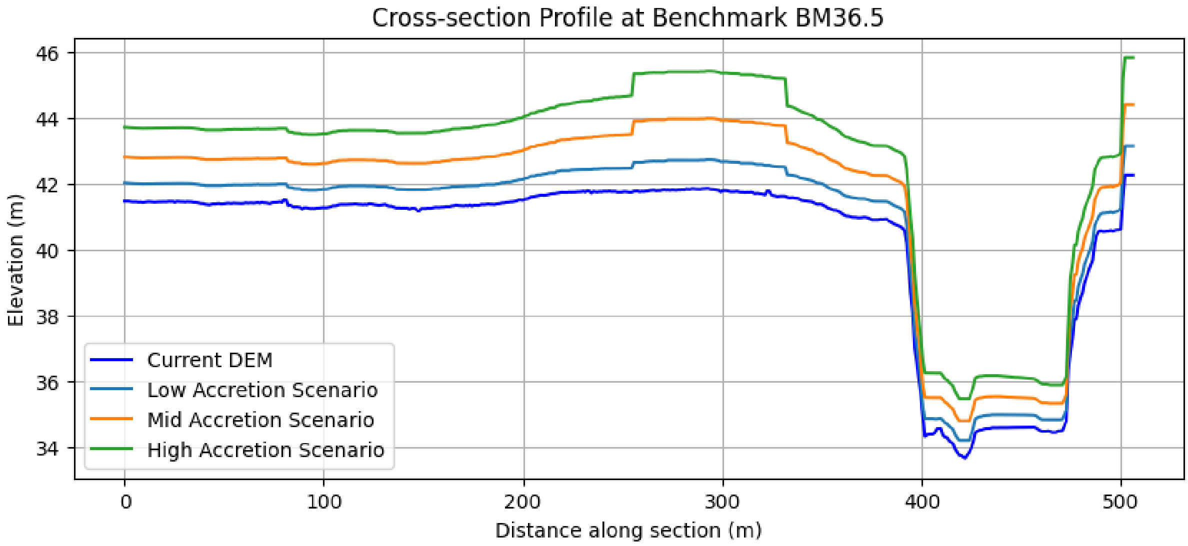
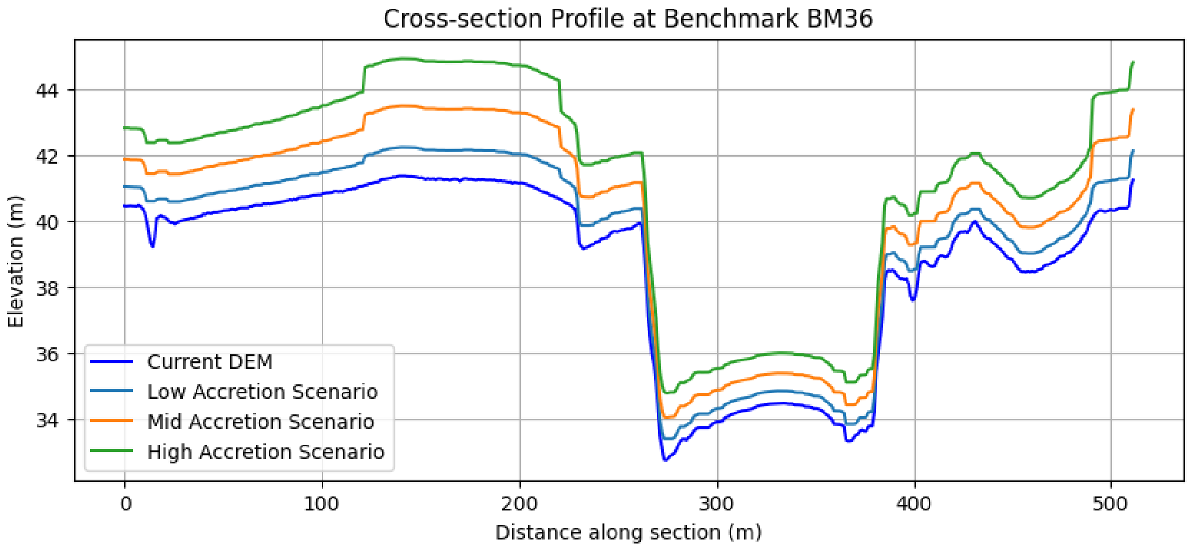
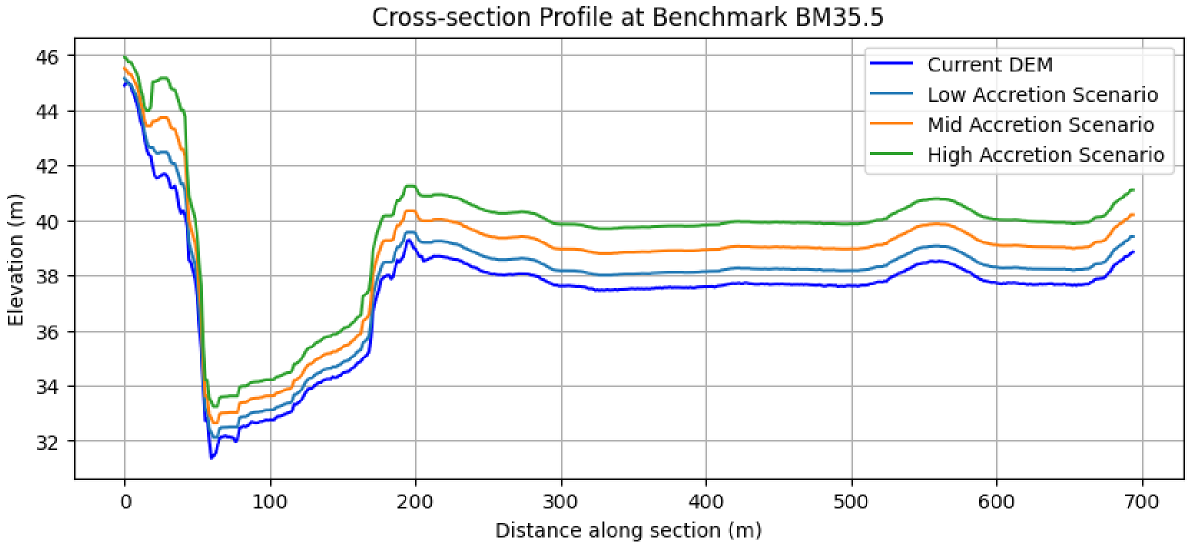


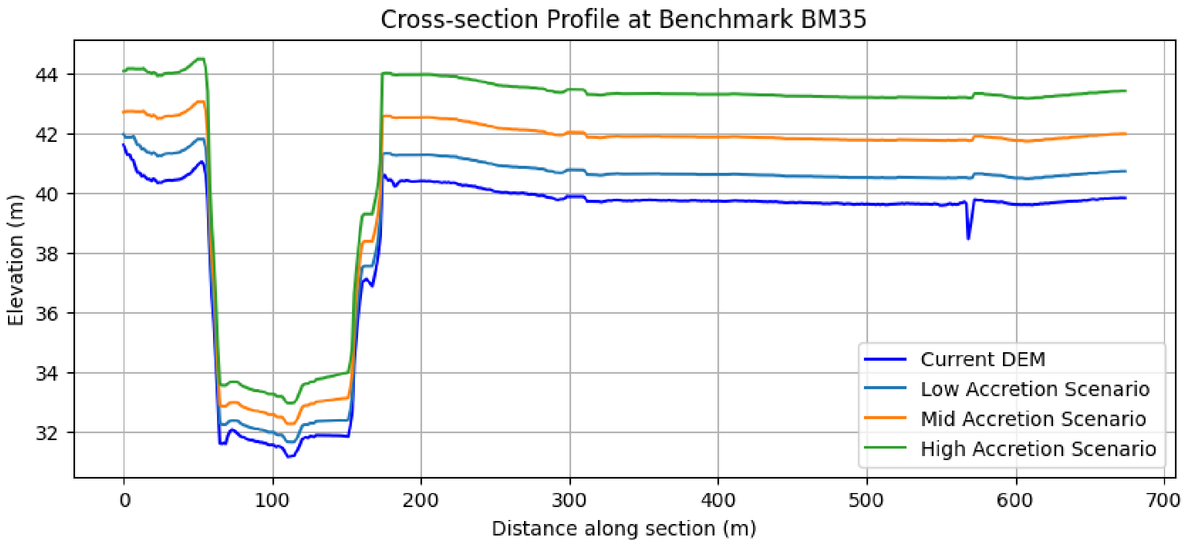
Figure 3.5: Comparison of A (least extreme), B (moderate), and C (most extreme) scenario bed, berm and floodplain elevations using (left to right) the Digital Elevation Model (DEM), Relative Elevation Model (REM) and Elevation difference from the Base DEM (generated from the bathymetric LiDAR and the regional DEM).

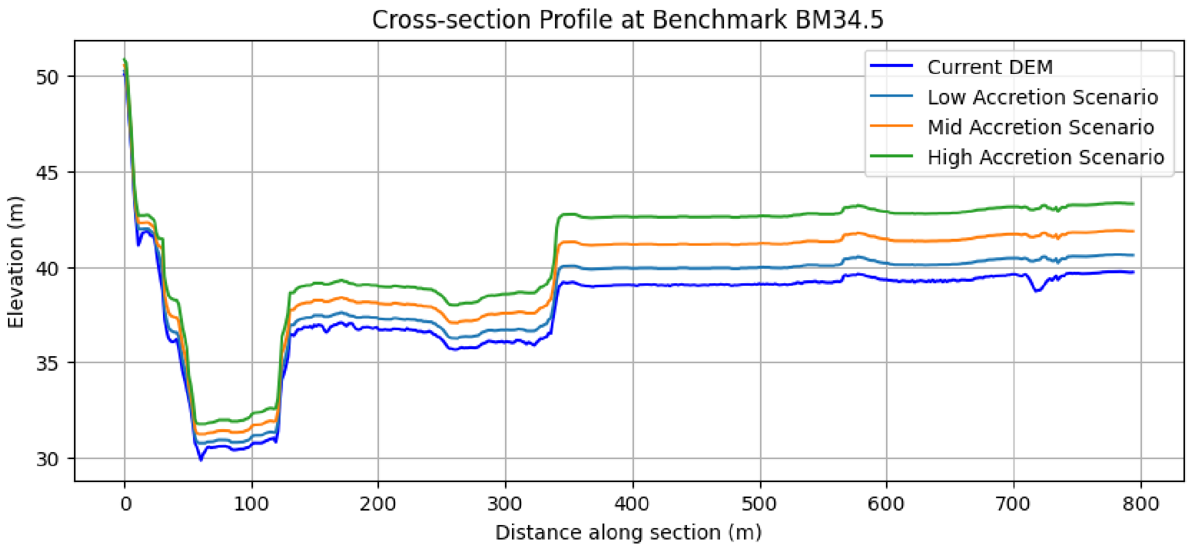

Cross-section Profile at Benchmark BM37
Elevation (m)
Distance along section (m)
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario


Cross-section Profile at Benchmark BM36.5
Elevation (m)
Distance along section (m)
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario


Cross-section Profile at Benchmark BM36
Elevation (m)
Distance along section (m)
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario


Cross-section Profile at Benchmark BM35.5
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario
Elevation (m)
Distance along section (m)


Cross-section Profile at Benchmark BM35
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario
Elevation (m)
Distance along section (m)


Cross-section Profile at Benchmark BM34.5
Current DEM
Low Accretion Scenario
Mid Accretion Scenario
High Accretion Scenario
Elevation (m)
Distance along section (m)

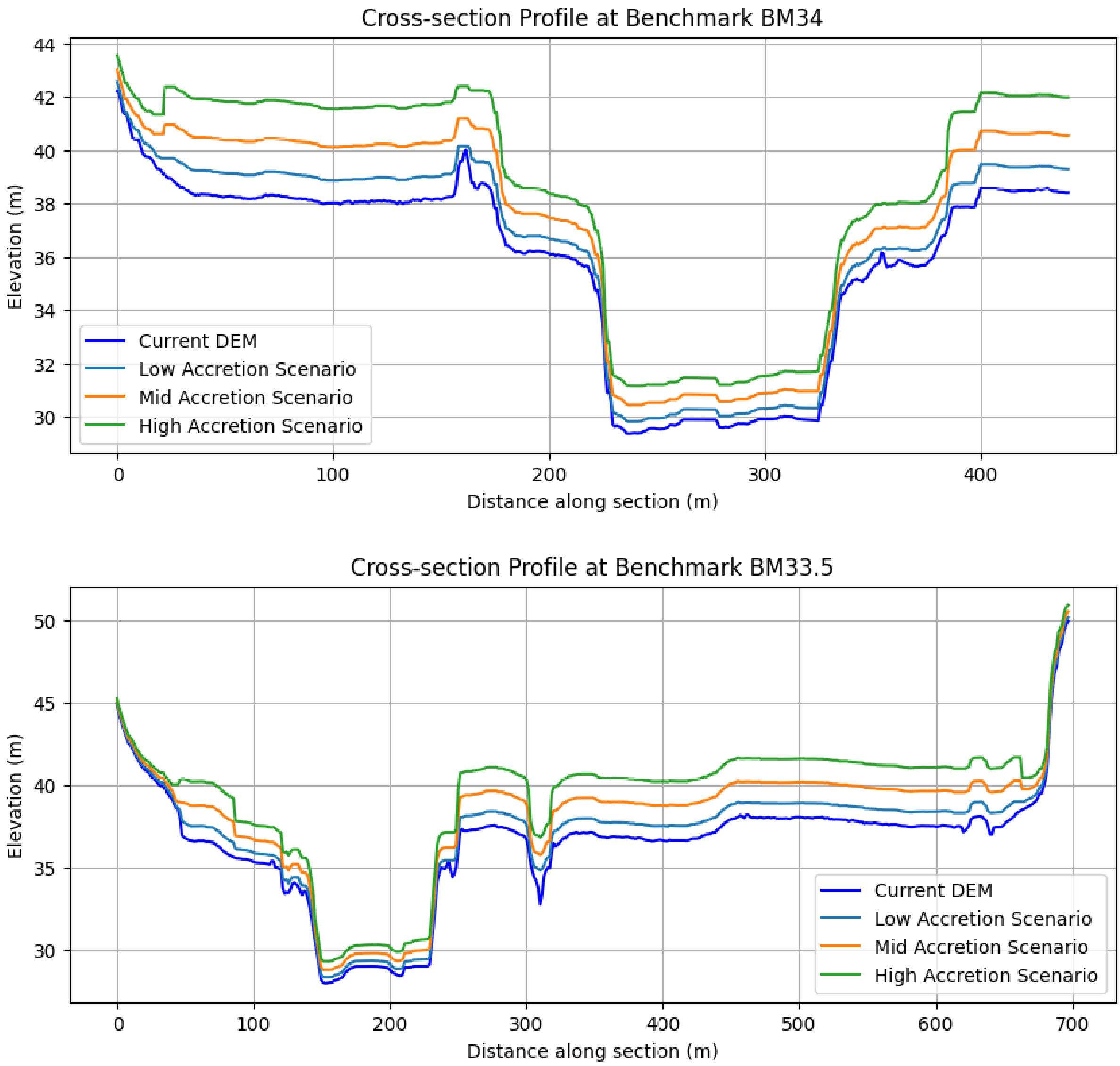


Figure 3.6: Cross-sectional profiles at each benchmark location at Te Karaka, showing accretion scenarios. Note: all profiles are from true (river) left to right, as shown in Figure 1.1

4 Discussion and limitations

This assessment provides three accretion scenarios (least extreme, average, and most extreme) to inform the potential reduction in level of service for the proposed Te Karaka stopbanks over a 50-year planning horizon. The methodology integrates historical survey data, stratigraphic evidence, and published bed level change modelling to generate spatially differentiated predictions across the channel, macro-channel, and floodplain at Te Karaka.

A fundamental assumption is that stratigraphic evidence from McPhail's bend (located 20 km downstream) is reasonably representative of floodplain accretion processes at Te Karaka. Supporting this assumption is that both sites are on the same river system characterised by high suspended sediment loads where floodplain building is typical during Q_5 and larger events[5], both exhibit similar geomorphic conditions (comparable width, gradient, and sediment calibre), and both feature similar meander geometry. However, limitations include the downstream distance with associated fining and slope reduction, the fact that McPhail's bend has not been historically confined by stopbanks, and that the stratigraphic evidence represents only a single site. Despite these limitations, the similarity in macro-channel accretion rates observed between the two sites (approximately 27 mm/yr at Te Karaka BM 34.5 versus 23 mm/yr at McPhail's bend BM 24) provides some validation for the comparative approach.

The methodology assumes that floodplain accretion and macro-channel bar aggradation are reasonably proportional to bed level change, allowing future scenarios developed from bed level modelling to be extrapolated across different geomorphic zones. This assumption is supported by the observed historical relationships, where macro-channel accretion occurred at approximately 1.9 times the bed level change rate, and floodplain accretion at McPhail's bend occurred at approximately 2.3 times the bed aggradation rate. However, these relationships may change under future flow and sediment regimes, particularly as climate change and land use evolution affect the catchment.

The assessment relies on the work of Gomez et al. (1998, 2009) for stratigraphic data and bed level change trajectory modelling. These peer-reviewed publications represent the best available scientific understanding of the Waipaoa River floodplain, though they necessarily include their own uncertainties and modelling assumptions, particularly regarding future climate and land use scenarios.

Historical survey data show significant variability in aggradation rates between the eight cross-section surveys at Te Karaka and at each section throughout the monitoring period. The decision to apply averaged rates across the reach rather than varying them longitudinally reflects the limited spatial coverage of accretion measurements and the recognition that historical variability may not represent future patterns. The floodplain accretion data from McPhail's bend are derived from a single stratigraphic survey location, limiting confidence in spatial extrapolation.

A limitation of this approach is that small differences in elevation can become magnified with the modelled accretion/aggradation and may be unrealistic at a highly localised scale. These are apparent in the cross-sections above at BM 36, 36.5 and 37. This approach provides a high-level assessment of changes adjacent to the Waipaoa River at Te Karaka, suitable for understanding the changes across the broader area, but it cannot be relied upon as a predication at specific points within the floodplain/river.

[5] Gomez, B., Eden, D.N., Peacock, D.H., Pinkney, E.J. (1998). Floodplain construction by recent, rapid, vertical accretion: Waipaoa River, New Zealand. *Earth Surface Processes and Landforms, 23*(5), 405–413.

The Waipaoa River has experienced sustained sediment overloading throughout the 20th and 21st centuries due to land use transformation and climatic variability, and sediment overloading is expected to continue through the 21st century. Hydrological regime changes, land use changes, sediment dynamics in gully systems and within the upper catchment, as well as the impacts of climate change, all provide significant uncertainty to the boundary conditions used to inform this assessment. Meanwhile, the local sediment dynamics and distribution of shear stresses within individual flood events provide additional uncertainty at the local scale. Nevertheless, the rates of sedimentation forecast on the basis of this assessment are likely to be reasonable approximations of the future state of the Waipaoa floodplain.

5 Conclusion

This assessment provides three potential scenarios—least extreme, average (moderate), and most extreme—for berm and floodplain accretion along the Waipaoa River at Te Karaka to inform the design of proposed stopbanks over a 50-year planning horizon. By integrating historical cross-section data, stratigraphic evidence, and published bed level change models, this report quantifies a range of potential vertical accretion to the year 2075.

The key findings are:

- Under the moderate scenario, which assumes a continuation of historical trends, the inundated floodplain is projected to aggrade by approximately 2.2 m over 50 years.
- The most extreme scenario projects up to 3.6 m of accretion on the floodplain, while the least extreme scenario projects 0.9 m.
- These projections are spatially differentiated across the channel, macro-channel, and floodplain, providing a basis for evaluating the future level of service of the proposed stopbanks (through flood modelling or other assessment).

6 Applicability

Guidance note: Check the client name below is the full legal entity name and update if needed.

This report has been prepared for the exclusive use of our client Gisborne District Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

Matt Adams
Water Resources Consultant

Authorised for Tonkin & Taylor Ltd by:

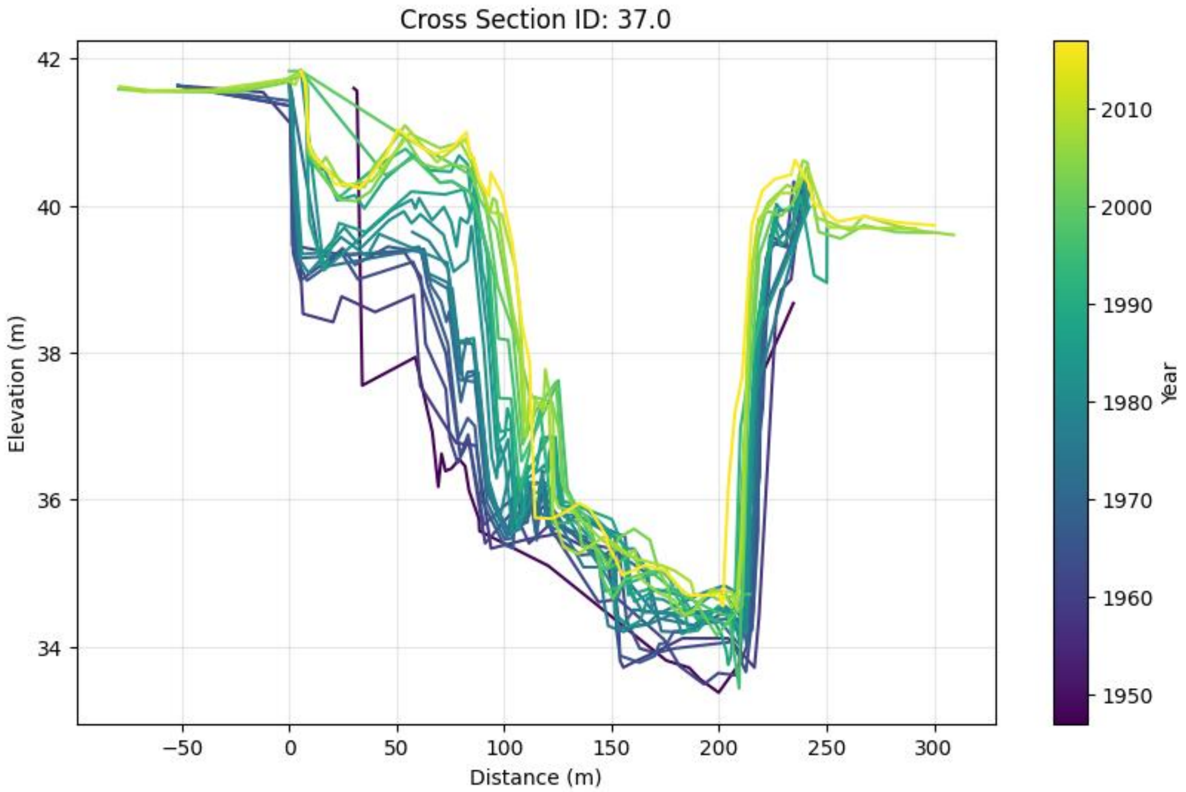
Damian Velluppillai
Senior Water Resources Engineer

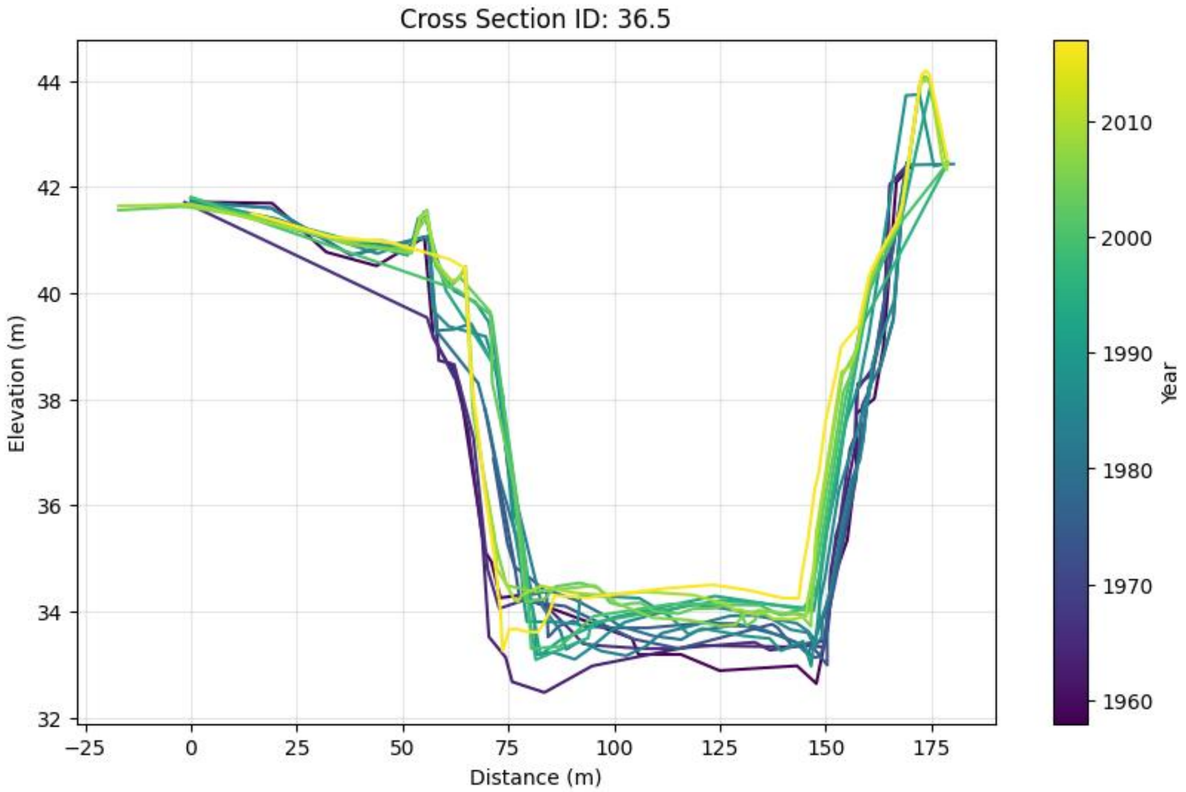
Technical review by:

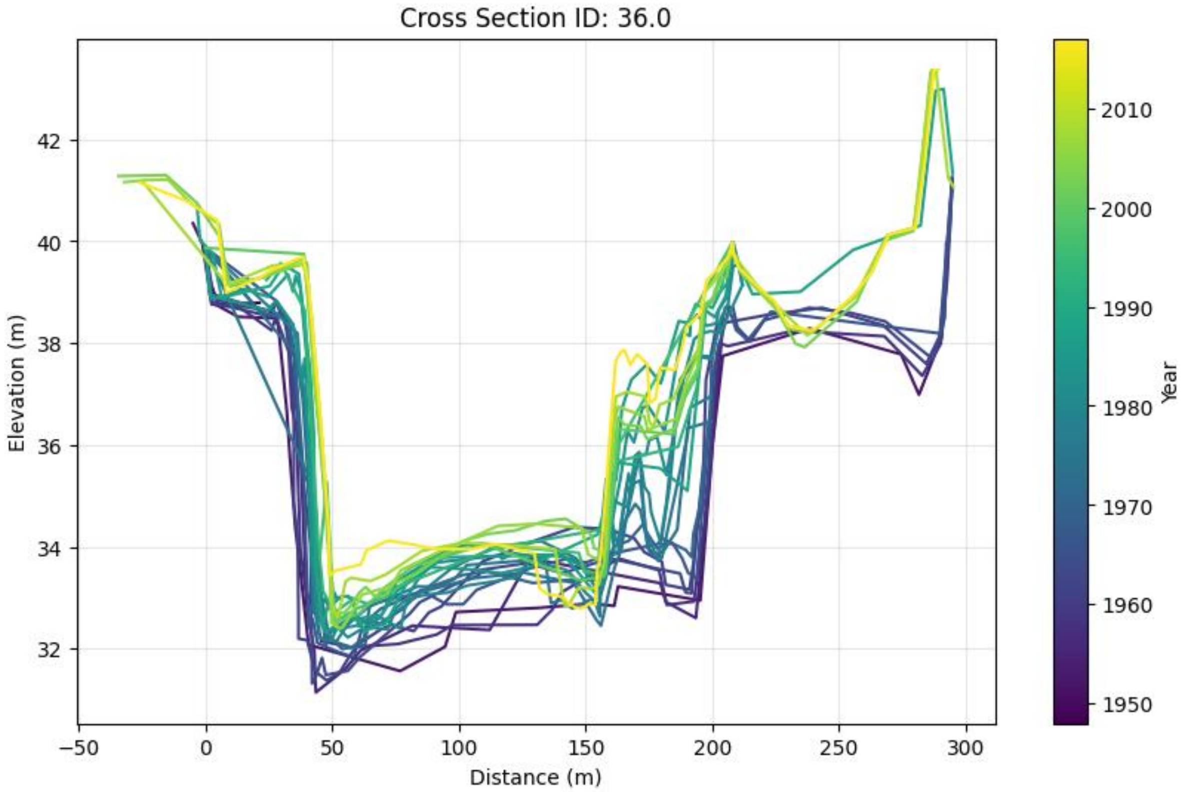
Prof. Ian Fuller
Principal Fluvial Geomorphologist

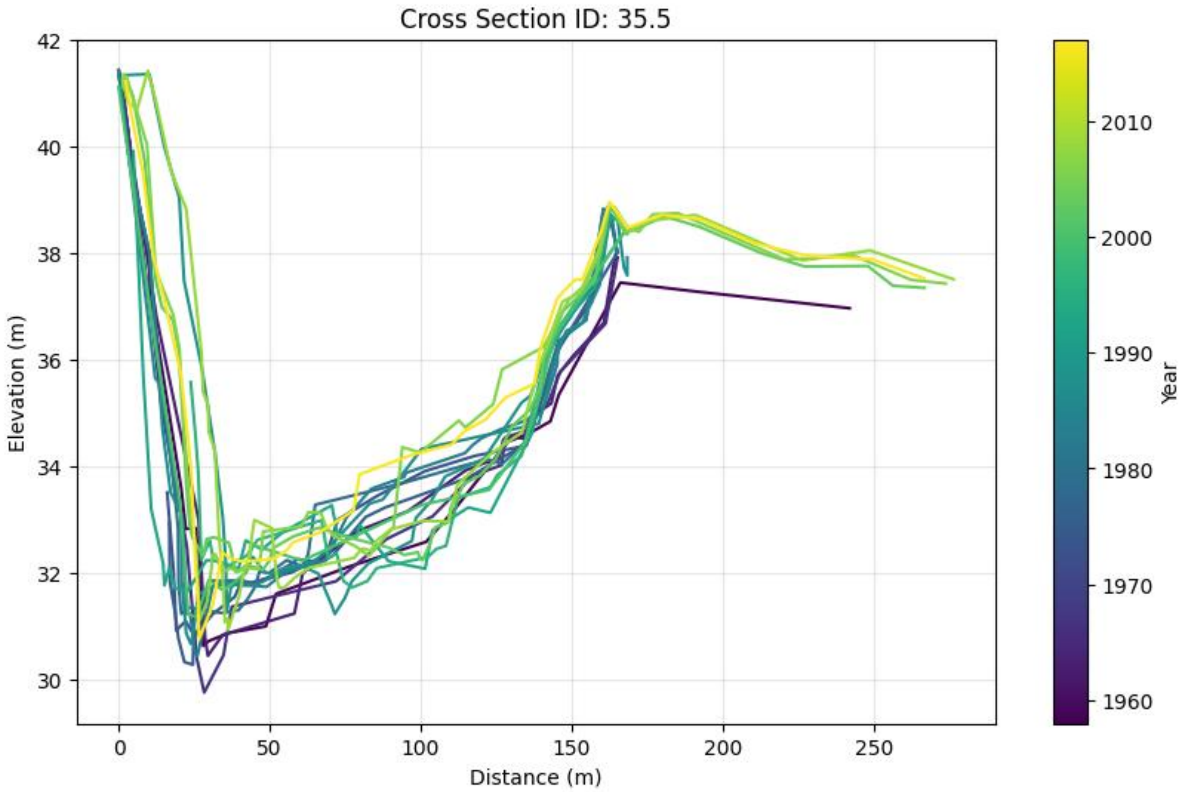
15-Dec-25
t:\wellington\tt projects\1092556\1092556.0020 te karaka optioneering\workingmaterial\berm assessment\reporting\draft - letter report - te karaka stopbank upgrades - berm assessment.docx

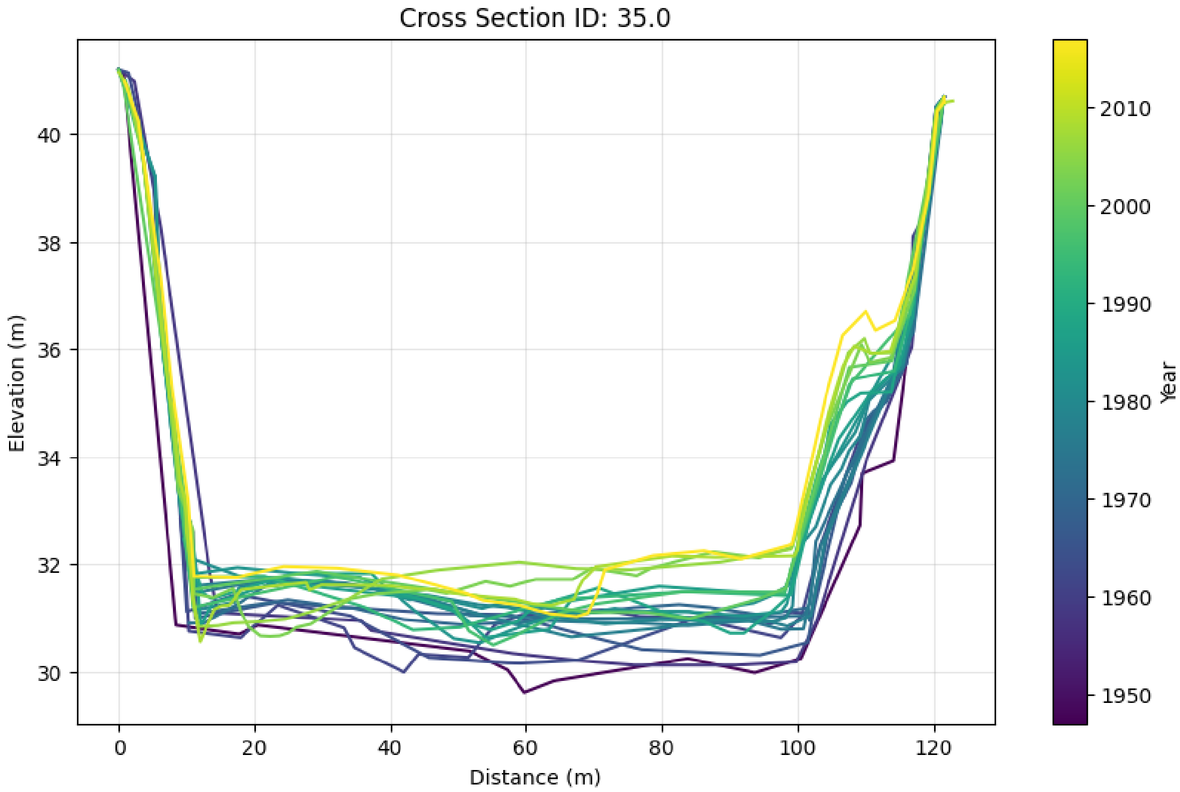
Appendix A Cross-section plots

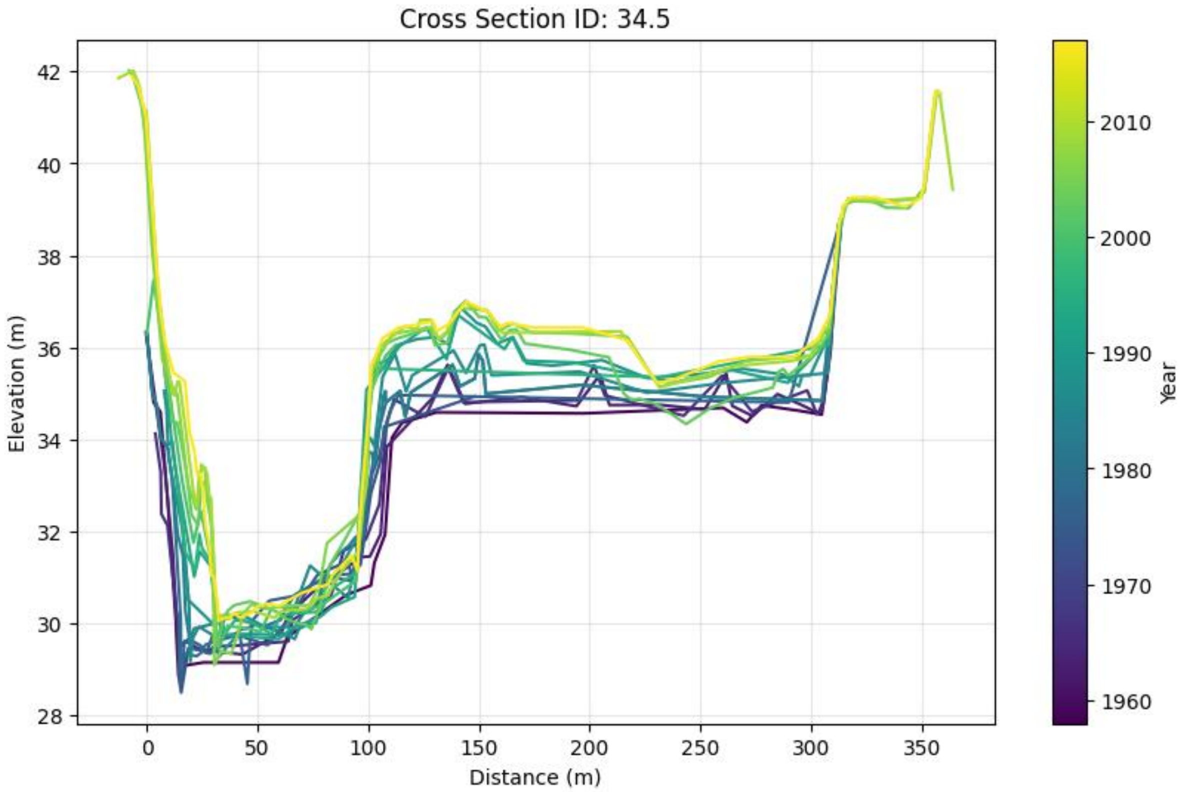


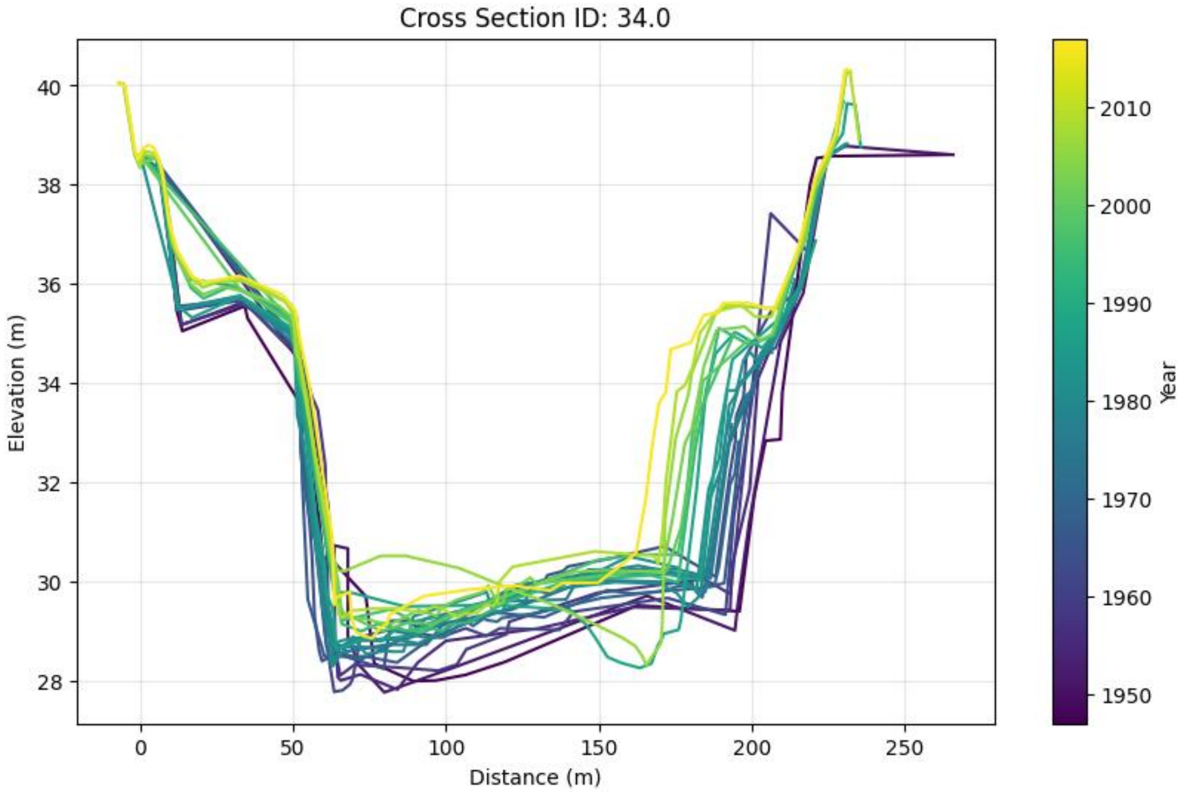



Cross Section ID: 36.0
Elevation (m)
Distance (m)
Year
−50
0
50
100
150
200
250
300
32
34
36
38
40
42
1950
1960
1970
1980
1990
2000
2010


Cross Section ID: 35.5
Elevation (m)
Distance (m)
Year
0
50
100
150
200
250
30
32
34
36
38
40
42
1960
1970
1980
1990
2000
2010


Cross Section ID: 35.0
Elevation (m)
Distance (m)
Year
30
32
34
36
38
40
0
20
40
60
80
100
120
1950
1960
1970
1980
1990
2000
2010


Cross Section ID: 34.5
Elevation (m)
Distance (m)
Year
28
30
32
34
36
38
40
42
0
50
100
150
200
250
300
350
1960
1970
1980
1990
2000
2010



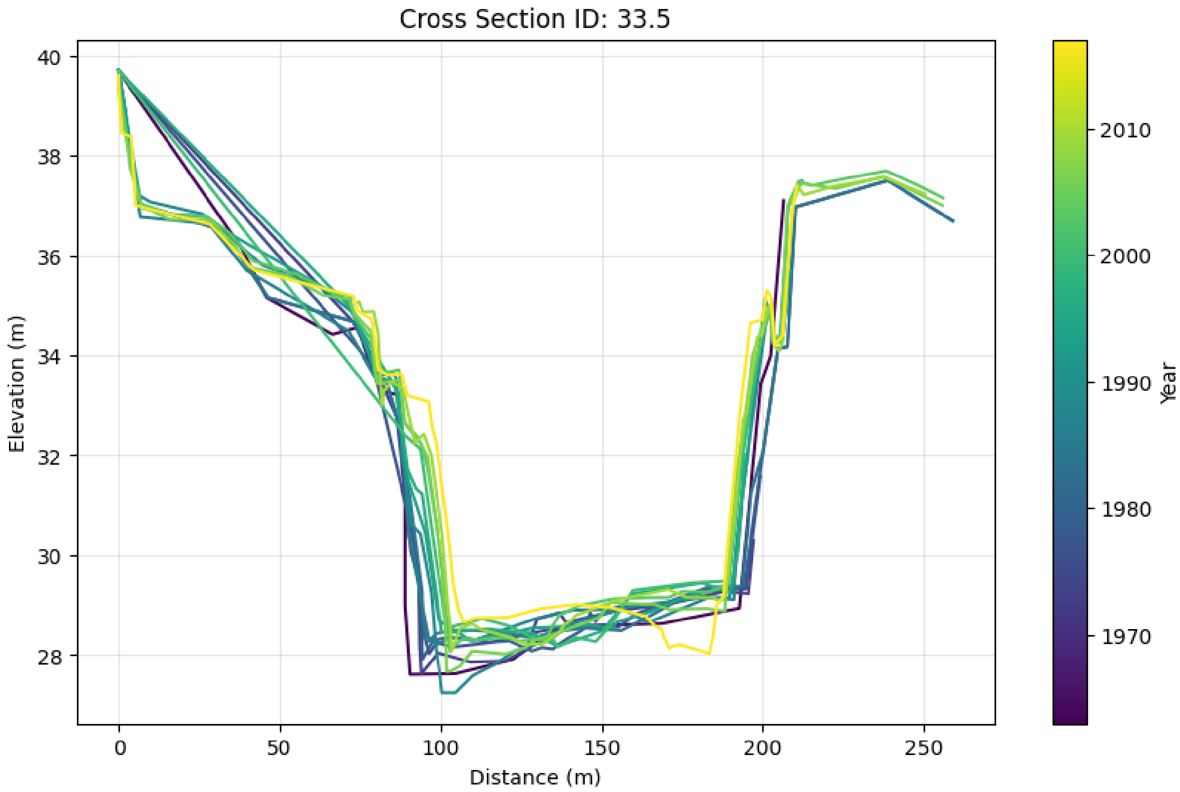


Figure Appendix A.1: Cross section plots for repeat survey benchmarks at Te Karaka.