Hawkes Bay Regional Council

WAIROA FLOOD SCHEME
RIVERBED LEVELS

17 DECEMBER 2024

FOR EXTERNAL USE

WAIROA FLOOD SCHEME
RIVERBED LEVELS

Hawkes Bay Regional Council

WSP
Christchurch
12 Moorhouse Avenue
Christchurch 8011
New Zealand
+64 3 363 5400
wsp.com/nz

REV	DATE	DETAILS
1	01/10/2024	Draft for client comment
2	16/12/2024	Issued

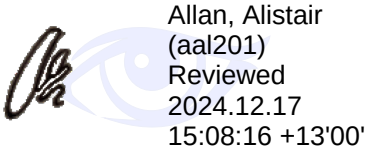
	NAME	DATE	SIGNATURE
Prepared by:	Mark Groves	16/12/2024	
Reviewed by:	Alistair Allan	17/12/2024	 Allan, Alistair (aal201) Reviewed 2024.12.17 15:08:16 +13'00'
Approved by:	Approved for release by Adele Jones		

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A bathymetric survey of the Wairoa River was completed in September 2024. The survey covered the extent of the river from the State Highway Bridge to Frasertown. WSP has reviewed the survey and compared this to the historic bed surveys provided by the Hawke's Bay Regional Council. Whilst there is limited historic information on bed level changes for the Wairoa River, the information available does not indicate that there has been widespread aggradation of the Wairoa River.

The most significant bed form changes appear to have been in the vicinity of the Ski Club on the river bend and is likely associated with bed scouring and downstream deposition of the scoured material.

1 INTRODUCTION

WSP have been asked by the Hawke's Bay Regional Council (HBRC) to summarise the historic information on riverbed levels for the Wairoa River to provide a more in depth understanding of how it might be changing over time. This request was made in light of the recent riverbed survey completed in September 2024.

This report summarises the bed survey information supplied by HBRC including the September 2024 survey results and draws observations based on the data. Note that the information is somewhat limited, with the scope of this assessment being restricted to the locations and extents of existing data available via HBRC.

2 SURVEY INFORMATION

HBRC have previously supplied WSP with historic bed surveys for the Wairoa River (Sections 3 to 28 in Figure 1 running inland from the coast) and a prior flood model of the Wairoa River which included bed bathymetry (amalgamated from various historic survey sources).

Figure 1 shows the full extent of the cross-section survey data included in the historic model. Note that there is duplication of cross section names. In the subsequent analysis and results this will be differentiated as 'coastal sections' and 'inland sections'.

A more recent sonar survey has also been completed (2024) covering the river from the Ski Club upstream to Frasertown. This does not consist of surveyed cross sections and instead consists of a 3D model of the bed.

The modern surveys (2010 to 2023) cover Sections 3 to 28 running inland from the ocean finishing just upstream of the Ski Club, whilst some select sections within this group also include more historic information, with 1949 being the oldest survey provided (one location only). The older survey information is more sporadic than the modern data.

The other sections (running inland to Frasertown) were obtained from a historic HBRC model and is a combined set of historic surveys undertaken between Mar-April 1985 (partial), Oct 1988 (partial), Jan 1992 (full), April – May 1996 (Full), Feb-June (full) and Dec 2003- Jan 2014 (partial).

The coastal cross sections and the time periods covered are summarised in Table 1 below:

Table 1. Cross section summary table

Distance from ocean (km)	XS Name	Period of time covered by surveys (years)
5.855	28	14
5.64	27	14
5.485	26	46
5.425	25A	40
5.37	25	29
5.295	24A	40
5.24	24	14
5.18	23	47
5.105	22A	40
5.06	22	75
5	21A	40
4.9	21	43
4.02	17	14
3.66	15	14
3.46	14	14
3.32	13	14
3.21	12	14
3.04	11	14
2.54	9	14
1.93	7	14
1.38	5	14
0.65	3	14

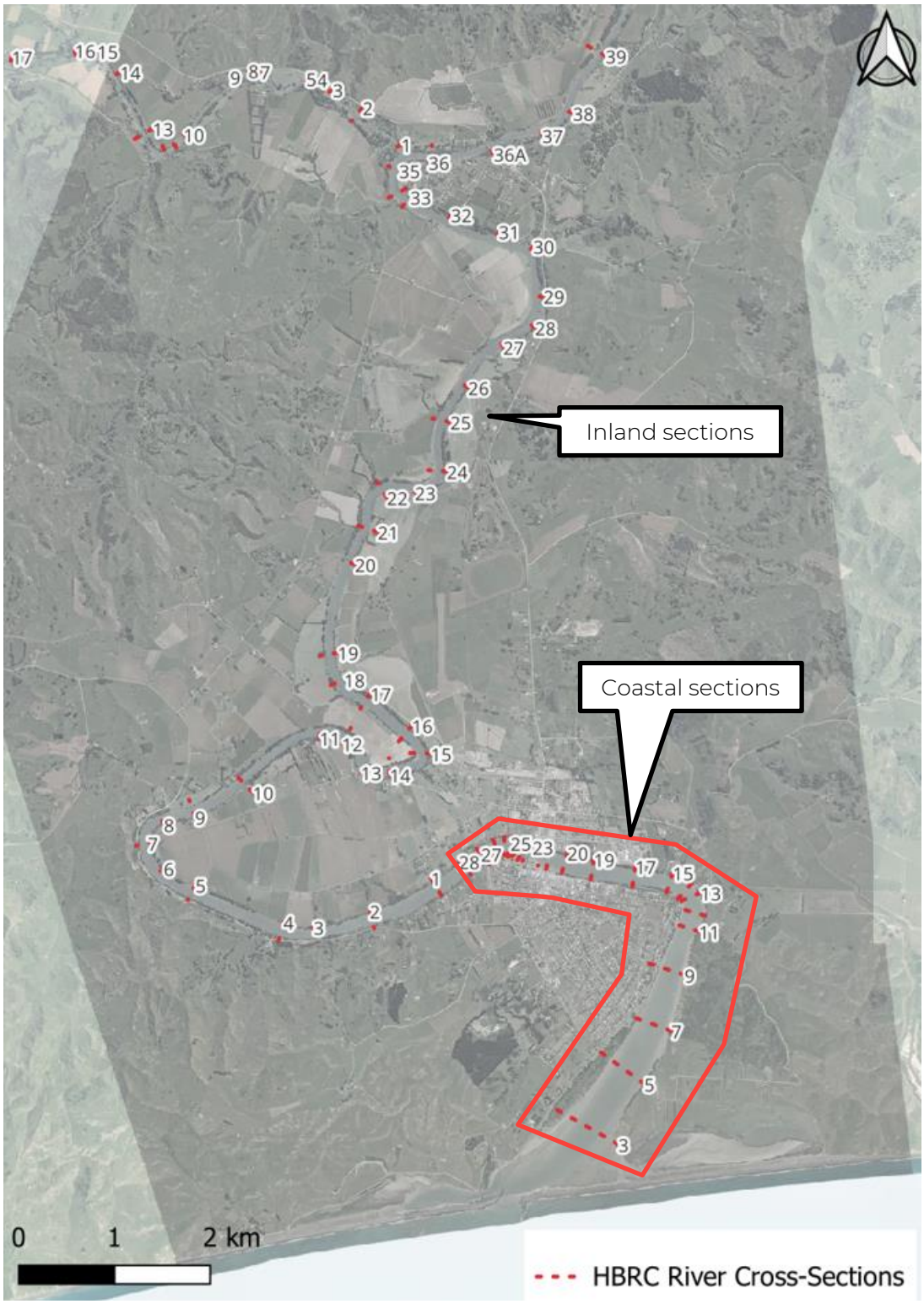


Figure 1. Cross-section locations

3 BED LEVEL CHANGE AND SEDIMENT TRANSPORT

Sediment transport and long-term changes in bed level is a complex process. Rivers and the sediment they transport are often in a continual state of flux and bed levels will vary spatially as the channel form and river alignment changes over time. This occurs even when the catchment is in a completely natural state and is a normal process. Land raised by ongoing tectonic uplift erodes over time and eroded sediment is transported towards the ocean, deposition of this sediment along the river course forms alluvial plains in the valleys.

In the case of Wairoa, the situation is influenced by young geology that is vulnerable to weathering and erosion combined with wider changes in catchment vegetation This has resulted in increased sediment yield. There used to be historic dredging of the lower river for ship navigation, this is no longer carried out. The location and geometry of the bar also influences sediment transport in the lower reach by modifying the river length and energy available to transport sediment.

It is important to acknowledge that aggradation (the build-up of deposited bed sediment) may occur under some flow conditions or in some specific locations, but that it may not influence the rivers' overall ability to convey flood water during major flood events. Aggradation of the bed is only an issue where it reduces the rivers conveyance on a broad scale over a long period of time. Infilling of historic scouring of the bed, for example, may have minimal effect on flood extents and may be moved again by subsequent high flows in the river.

In the case of Wairoa, much of the riverbed is lower than sea level and hence does not provide an obstruction to flood conveyance

During a major flood event, previously deposited sediments may also be removed as the river's energy is increased and widespread lowering of the bed will occur during the flood, especially as the mouth opens and enlarges. The level of scour will be greater where energy becomes more concentrated, ie in narrower sections of channel, where the river is confined by natural or man-made structures, or on the outside of bends.

The rivers' ability to scour bed sediment during major floods reduces the impact of accumulated sediments between flood events. Observations indicate that during Cyclone Gabrielle there was bed erosion in the range of 2m (on average) across the whole river width, much of which likely backfilled as the flood ended, energy decreased, water flow rate reduced and as a result sediment was deposited.

4 RIVERBED ANALYSIS

4.1 COASTAL SECTIONS

The 'coastal' cross-section data has been tabulated by distance and lowest point in the channel elevation for the different years of data available and plotted along a longitudinal section of the lower Wairoa River. The data is presented below in Figure 2. Note that the values are offset approximately 10 m higher than mean sea level.

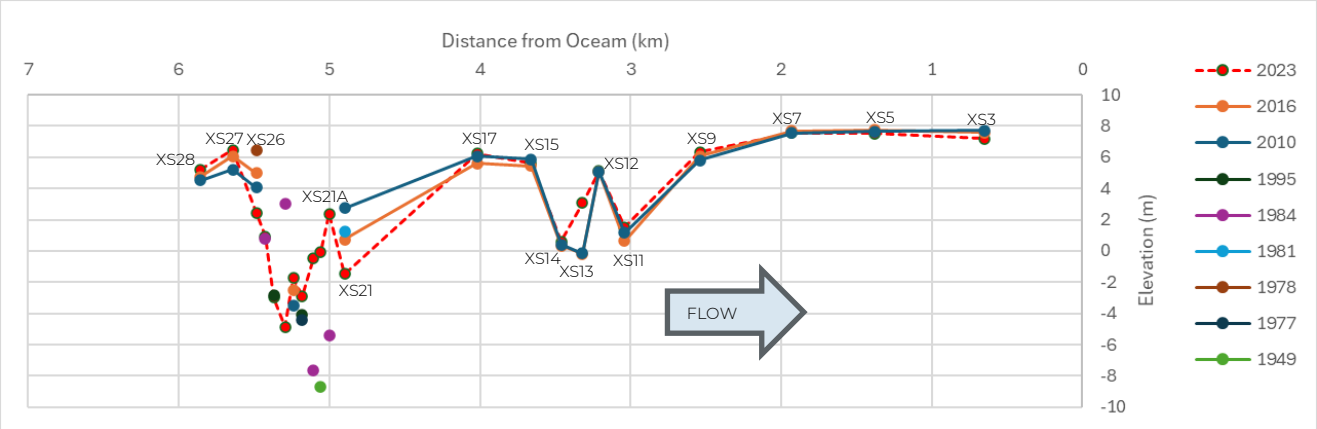


Figure 2. Comparison of historic survey data

Note some years cover only a single cross section and are thus plotted as a point only.

The results show that bed variation is fairly consistent downstream of the bend in the river by the Ski Club over the last 13 years. Variation is most significant on the bend at the Ski Club (5.37km from ocean), where the river appears to be downcutting at the upstream end (XS24A) and depositing the scoured material at the downstream end of the bend (XS24 toXS21A over a 240m distance). There has also been historic bank erosion / slumping at this location which may have contributed to the aggradation observed.

XS 22 (shown below) shows that the current river channel is now wider than in 1988 in this location, but that the invert has aggraded significantly. Refer to Figure 3 below.

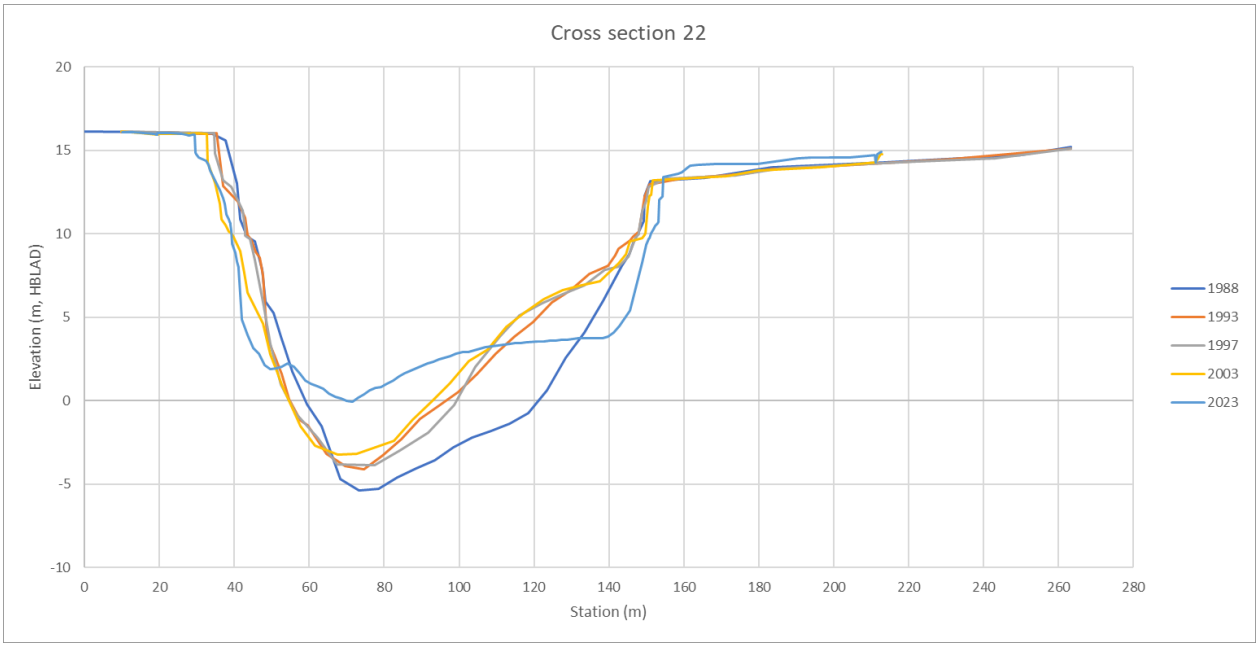


Figure 3. Cross-section at XS22

Review of the rivers hydraulic grade line indicates that this location is not a specific constriction for the river, the area of aggradation still sits lower than the wider bed elevation. Targeted dredging of this area is thus unlikely to have any benefit for North Clyde.

Whilst there are some other areas that also indicate change (XS26, XS27 and XS9) the cross-sectional area available for conveyance has remained similar e.g. bed aggradation in one area has been offset by lowering elsewhere in the channel. This means that these changes do not influence flood levels. At XS9 for example, whilst there is a 0.54 m increase in the lowest bed level, but the overall cross-sectional area below RL 12m has changed by less than 1%.

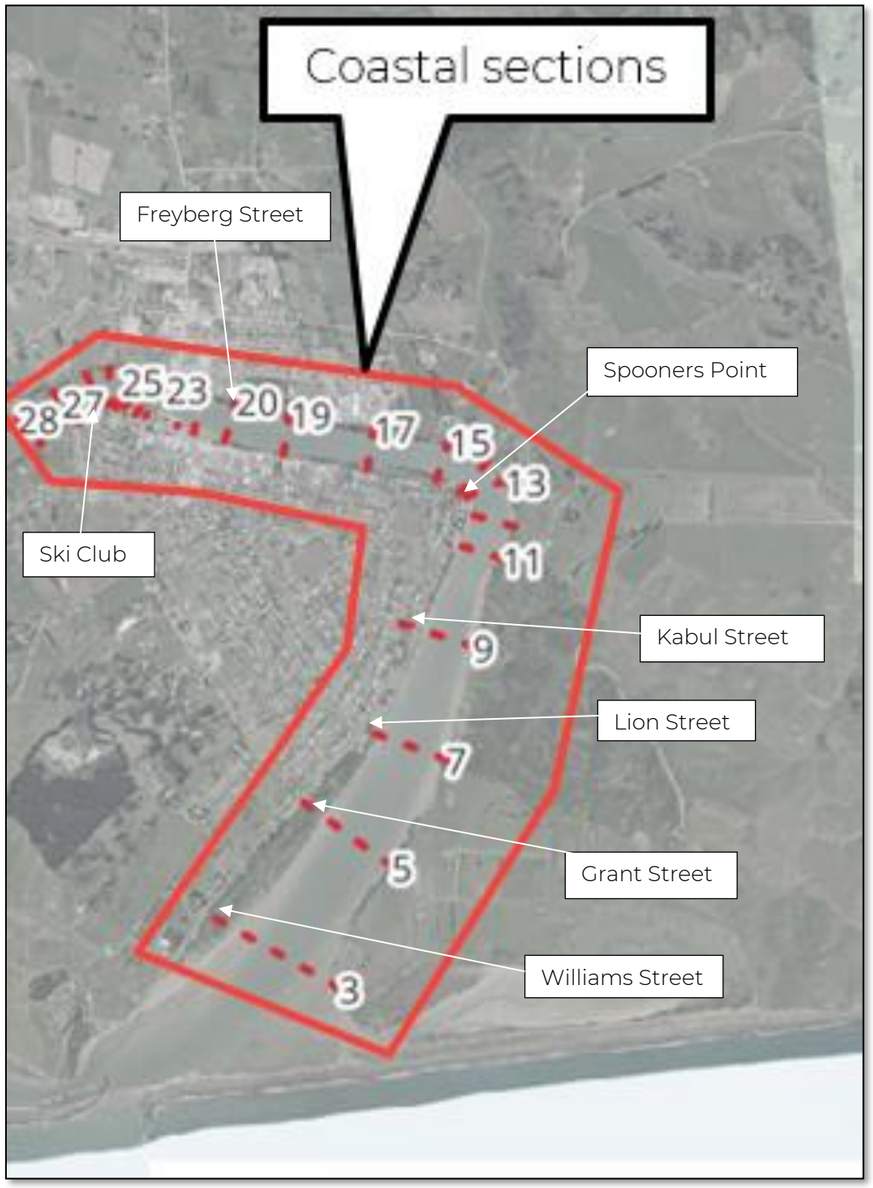
These locations are shaded in Table 2 grey and noted as 'No net change in conveyance' despite the apparent changes in the lowest bed level.

There is also one isolated point of significant aggradation downstream at the next river bend (XS13), but this is likely due to bank slumping into a historic area of scour on the outside of the bend, or the scour hole refilling, as the adjacent cross sections show minimal change.

The sectional data and the changes are summarised in Table 2.

Table 2. Results of analysis

Distance from Ocean (km)	XS Name	Time (years)[1]	Change (m)[1]	Change Rate (m/yr)	Classification	Observations / Notes
5.855	28	13	0.69	0.053	Aggradation	General channel aggradation
5.64	27	13	1.26	0.097	Aggradation	No net change in conveyance
5.485	26	45	-3.99	-0.089	Degradation	No net change in conveyance
5.425	25A	39	0.15	0.004	Minimal Change	
5.37	25	28	-0.15	-0.005	Degradation	
5.295	24A	39	-7.855	-0.201	Degradation	
5.24	24	13	1.76	0.135	Aggradation	Significant Bola scour occurred at this location
5.18	23	46	1.52	0.033	Aggradation	Large changes around Ski Club - bank slumping
5.105	22A	39	7.18	0.184	Aggradation	Potentially deposition of scoured material
5.06	22	74	8.65	0.117	Aggradation	Potentially deposition of scoured material
5	21A	39	7.77	0.199	Aggradation	Potentially deposition of scoured material
4.9	21	42	-2.735	-0.065	Degradation	Bed lowering (NZTA Bridge)
4.02	17	13	0.17	0.013	Minimal Change	
3.66	15	13	-0.24	-0.018	Minimal Change	
3.46	14	13	0.19	0.015	Minimal Change	
3.32	13	13	3.23	0.248	Aggradation	Potentially due to bank slumping
3.21	12	13	0.01	0.001	Minimal Change	
3.04	11	13	0.34	0.026	Aggradation	
2.54	9	13	0.54	0.042	Aggradation	No net change in conveyance
1.93	7	13	0	0.000	Minimal Change	
1.38	5	13	-0.12	-0.009	Minimal Change	
0.65	3	13	-0.54	-0.042	Degradation	



[1] 2023 post cyclone – earliest survey available

4.2 INLAND SECTIONS

Comparing the 2024 sonar bed survey to the merged set of historic bed survey included in the original Wairoa flood model ('inland sections', there appears to have been (overall) bed degradation, rather than general aggradation upstream of the SH Bridge.

A histogram for the change between 2023 and 2024 indicates a median change of -0.5m. This section represents the river upstream of the SH bridge and is of specific relevance to the flooding that occurs in North Clyde.

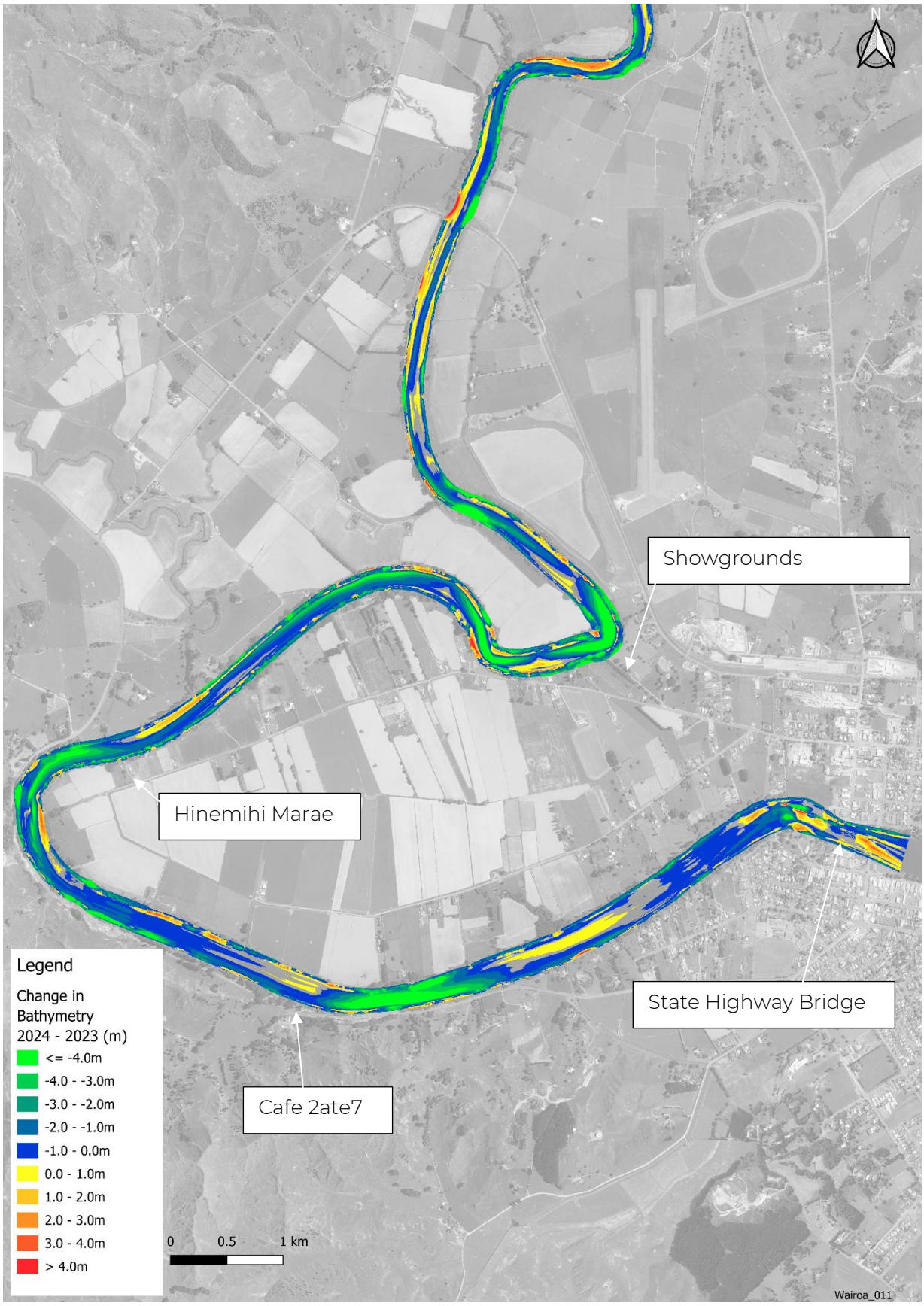


Figure 4. Comparison of the latest 2024 bed survey with the historic survey information (various survey dates combined). Blue and green is erosion, yellow and orange is aggradation.

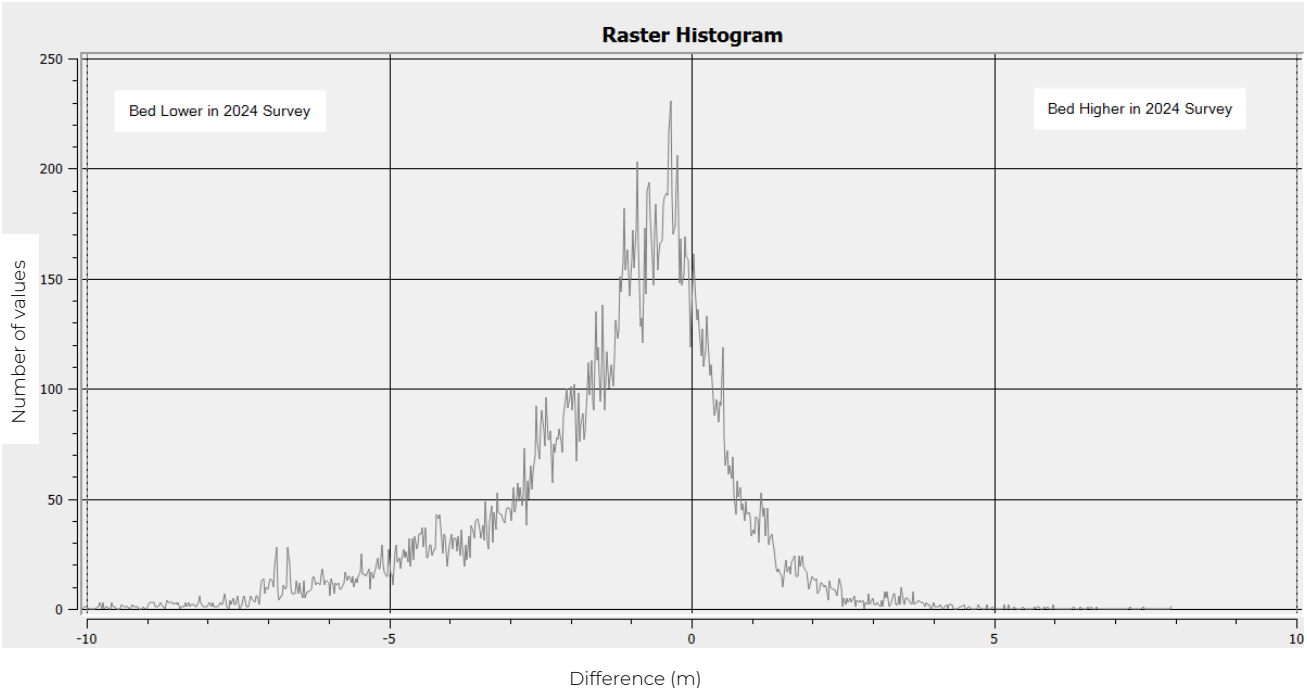


Figure 5. Histogram of change in inland bed elevation (2024 vs the original model bathymetry)

4.3 COASTAL SECTIONS

Comparing the 2023 cross sectional survey to historic bed survey for the coastal section (from the SH2 bridge to the most downstream survey extent) shows that there has been some variation in bed form, but that overall, there is no area wide aggradation. Whilst some areas have risen, other areas have commensurately lowered.

The most significant change is at Spooner Point on the true left bank. The change here indicates that there may have been recent bank slumping / landslides. This constriction of the channel has resulted in a localised lowering of the bed as the river readjusts to balance potential and kinetic energy.

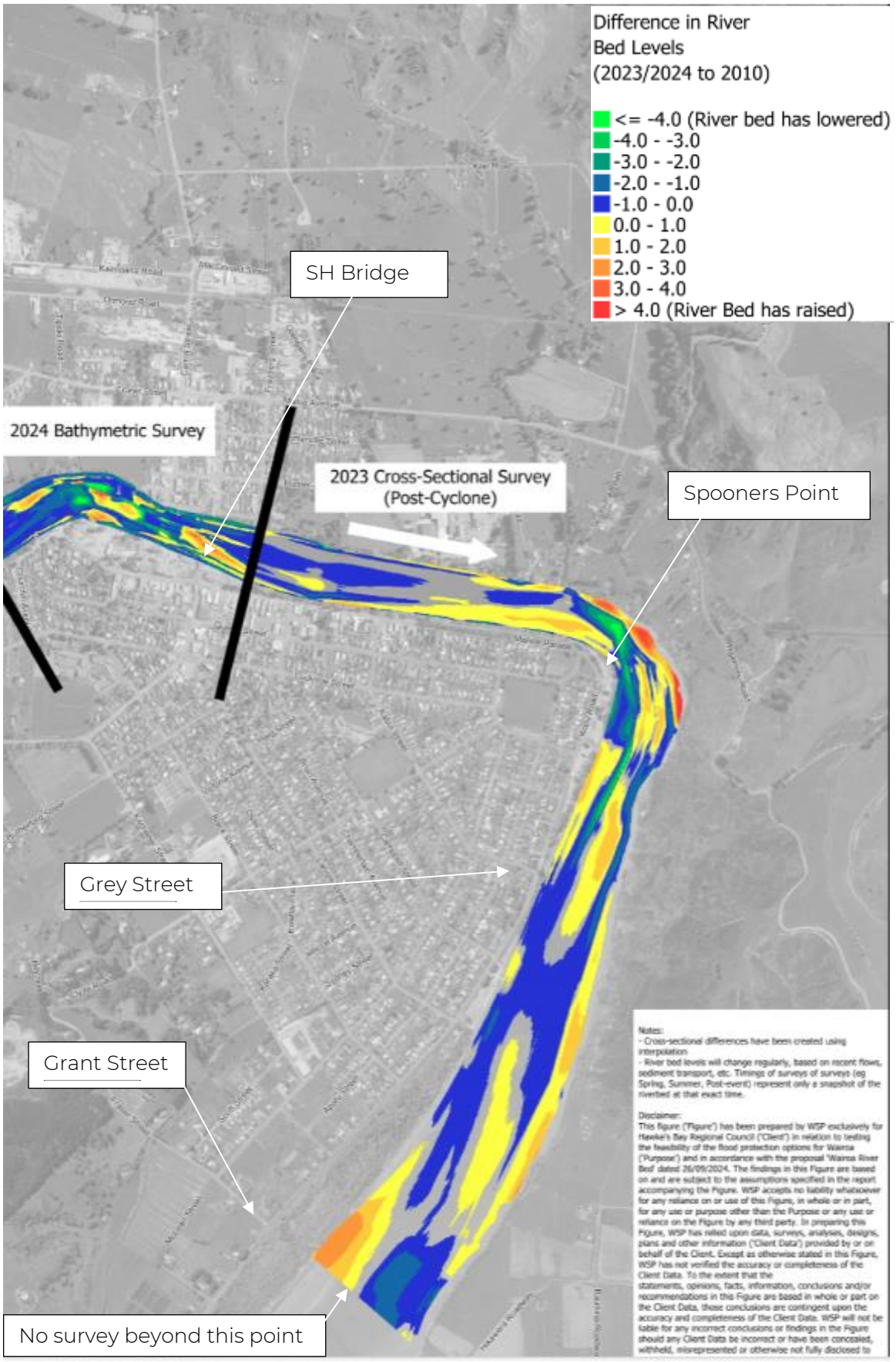


Figure 6. Comparison of the latest 2024 bed survey with 2010 survey. Blue and green is erosion, yellow and orange is aggradation

5 SUMMARY

Whilst there is limited historic information, which is not uncommon, the information available indicates an average change of -0.5m in the inland area and minimal change in the coastal section (generally neutral). This includes at least one data point back to 1949.

The most significant bed form changes appear to have been in the vicinity of the Ski Club on the river bend and is likely associated with bed scouring and downstream deposition of the scoured material and localised bank slumping. As the localised areas of aggradation are at points lower than the wider bed levels, targeted dredging of these areas is unlikely to have any benefit for North Clyde flood reduction.

DISCLAIMER

This report ('**Report**') has been prepared by WSP exclusively for Hawke's Bay Regional Council ('**Client**') in relation to testing the feasibility of the flood protection options for Wairoa ('**Purpose**') and in accordance with the proposal 'Wairoa River Bed' dated 26/09/2024. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.