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Wharekawa coast 2120 - wider river flood assessment

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Abstract

Wharekawa Coast 2120 aims to bring the Wharekawa communities together to define their path for the future while enabling flexibility to respond to changing conditions such as projected climate change. This Wider River Flood Assessment is part of that process, with the purpose of this report to inform the Wharekawa Coast 2120 Community Panel, Technical Advisory Group and Joint Working Party to understand the historical impacts of past river flooding events in the project area.

Information within this report was collected from a range of sources, including council documents on past flooding event impacts, and community eyewitness accounts and stories. Flooding event information presented in this report stretches back to the 1960s through to the present day (June 2022), including 16 river flooding and/or coastal inundation events that have been documented. A wide range of small to significant impacts are documented across the four wellbeing's and environments, e.g. impacts to building, property, and cultural impacts.

This report recommends priority work areas for further investigation based on our new understanding of the impacts of historical riverine flood events. A better understanding of the drainage capacity and flood dynamics in these priority areas will improve our understanding of the hazard and in turn the risk these streams pose to the community, particularly in the vicinity of the Whakatīwai and Waharau Streams.

The River Management Work Programme is a key piece of work developed conjointly with the Community Panel and technical experts from the representative councils, Hauraki District Council and Waikato Regional Council. The Programme identifies site specific low cost stream, catchment and drainage maintenance options that can be implemented relatively quickly to reduce the flooding risk in the project area in the short term. Though these options are not intended to reduce the flood risk completely. The River Management Work Programme is part of the community panel's Recommendations Report and will be used to prioritise work to guide future funding options to inform both councils' Long Term Plans commencing 2024/2034.

Executive summary

The Wharekawa Coast 2120 project will look at a wide range of natural hazard related issues within the project area to provide for a resilient and prosperous future, with one of the focuses being on climate change and natural hazards. To understand the impacts of climate change and natural hazards in the Wharekawa Coast 2120 project area, several reports have been compiled.

This Wider River Flood Assessment is part of that process, which is informed by historical river flood event information documented by Waikato Regional Council (WRC), Hauraki District Council (HDC), the former Franklin District Council (FDC). Additional information and data were also provided by the Wharekawa Coast 2120 Community Panel, the wider community, and other organisations. The purpose of this assessment is to:

1. Collate the historical and current river flooding information across the whole Wharekawa Coast 2120 project area and understand the impacts of these river flood events on the community.
2. Identify key priority work areas which may require further river flood investigation, such as refining catchment hydraulic models.
3. Collaboratively develop a River Management Work Programme which looks to identify site-specific low-cost stream maintenance options that can be implemented relatively quickly to reduce the flooding risk in the short term. These are not intended to be long-term mitigation options or to reduce the flooding risk completely.

The findings from this report have been used to inform the Wharekawa Coast 2120 Community Panel, Technical Advisory Group and the Joint Governance Group, to better understand the historical river flooding impacts and provide the groups with the best available information to make informed decisions (with the information they hold) when determining adaptation option pathways for each compartment.

Findings from historical flooding events

The impact information presented in this report ranges from the 1960s through to 2022. A wide range of low to high impact events are documented across the four environments (natural, build, social and cultural) and wellbeings covering all five compartments in the Wharekawa Coast project area.

This research indicates that the project area has been exposed to at least 16 documented riverine and/or coastal inundation events throughout the 1960 to 2022 period. The exposure and risk associated with these historical events vary across the project area. The coastal township of Kaiaua has a relatively high risk of river flooding due to the Hauarahi Stream migrating through the centre of the township and discharging into the Firth of Thames, this partnered with the township being the main community hub for the coast, means a high number of people, infrastructure and services are potentially affected. Residential buildings in Kaiaua have been flooded on several occasions throughout the last 60 years, most recently in 2011, 2017, and 2018.

The flooding risk in Kaiaua led FDC to investigate the development of flood protection for Kaiaua township on two separate occasions, following each of the 1985 and 1995 joint riverine & coastal inundation events. However, flood protection assets were not constructed due to the economic cost of the development. This has left the Kaiaua township vulnerable to flooding and it is widely accepted in the community that these events will increase because of the projected effects of climate change. Further flood hazard modelling of the Hauarahi Stream under present day and future climate scenarios has been undertaken by WRC and built upon by a Master of

Engineering student from the University of Auckland. WRC is currently undertaking further flood modelling of the Hauraki Stream to account for updated LiDAR information.
Other streams across the project area present their own hazards and risks as evidenced by historical flood events. These include two consecutive Whakatīwai Stream flood events in the 1960s which severely impacted most buildings in the village, left 150 acres of farmland unusable for 12 months, and took the lives of almost 500 ewes. These events initiated the development of the Whakatīwai stopbanks by FDC which has successfully reduced the flooding risk to the Whakatīwai village, however residual risk still remains.

The Waharau community has also been the victim of a major flood event, when the April 2017 Ex-tropical Cyclone Debbie event closed the Waharau bridge south of the village and a slip blocked East Coast Road to the north of the village, leaving the community isolated by road for up to two weeks. Events like this highlight the secondary impacts that can be associated with some of these larger events, which have the ability to disrupt the routines of individuals' everyday lives, such as not being able to access essential services.

Flood events associated with other major and minor streams in the project area are also documented in this report.

Identification of priority work areas for further flood hazard investigation
The findings of this report provide a basis for identifying flood priority work areas where further flood hazard investigation would be required to have a whole of project area holistic overview to flooding risk.

The objective of identifying these flood priority work areas is to highlight key streams where the impacts documented in this report are deemed to be intolerable, and further flood modelling and risk identification efforts may be required.

Flood priority work areas identified include the following:

- Updates & remodelling of existing river models with new input datasets such as LiDAR (currently being completed).
- A rapid Flood Hazard Assessment for the Whakatīwai Stream.
- A stopbank performance review for the Whakatīwai, Taramarie, Pūkorokoro and Miranda Streams.
- A roading and bridge abutment impact assessment during different high flow events along East Coast Road.
- An erosion study for Waharau Stream.

River Management Work Programme
The purpose of this section is to provide an overview of a River Management Work Programme (also known as the quick-fix options) for all watercourses in the project area that drain into the Firth of Thames, that can be completed relatively quickly and at a low cost that may help to reduce the risk posed by the streams in the short term. It is highly likely that if these options are successful, the maintenance of them over the longer term could suffice for effective flood risk management, however the options are not intended to replace effective flood management options like stopbanks.

These options were developed in a staged approach, first with the expert guidance from both WRC and HDC drainage and river managers to help identify options suitable to the project area's specific streams. These were then further refined with the guidance of the River Flood Focus Group, which community panel members were involved with. They provided local situational

awareness, such as indicating which streams are of cultural significance, require local iwi consultation, and included any further input to options not previously included. This was then followed by fieldtrip investigations to further refine options and bring additional knowledge/information to light.

An important issue that was raised across all settlements in the project area during this exercise is the maintenance of all the drainage assets (culverts and drains). Almost all drains and culverts across the project area are requiring general maintenance to be completed to ensure they perform effectively under flood conditions. A summary of the main options provided in the programme include:

- Upper catchment stability control (e.g. planting)
- River management work
- Ensuring asset performance under flood conditions, structural integrity and stability. Ensuring blockages are removed to allow the assets to perform effectively.
- Stream mouth opening
- Investigating improvement plans.

The fundamental option that is relevant across all streams and water outlets is stream mouth dredging and clearing to allow for easy discharge during high flow events.

Glossary

The following definitions are those used within the context of this report:

Adaptation pathways – options identified to help manage climate change risk under guidance from the Ministry for the Environment (Ministry for the Environment, 2017).

Annual Exceedance Probability (AEP) – the statistical likelihood of an event happening in any one year, expressed as a percentage. A 1% AEP is equivalent to a 100-year average return period (ARP).

Coastal inundation – flooding of coastal land caused by elevated water levels at the coast.

Exposure – People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses (Rovins et al., 2015).

LiDAR – Light detection and ranging (laser scanning for high resolution topography).

MVD-53 – Moturiki Vertical Datum 1953.

Natural hazard – A natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (Rovins et al., 2015).

Representative Concentration Pathway (RCP) – Four scenarios of future radiative forcing driven by cumulative greenhouse gas emissions used to model future climate pathways (Ministry for the Environment, 2020).

Risk – Effect of uncertainty on objectives (AS/NZS ISO 31000:2009, Risk management standard). Risk is often expressed in terms of a combination of consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (Ministry for the Environment, 2020).

Reduced Level (RL) – the elevation value provided is relative to a specific datum. E.g., RL3.0 m (MVD-53), means that the elevation is 3.0 m relative to Moturiki Vertical Datum 1953.

Riverine flooding – flooding occurring when excessive rainfall, snow melt or ice jams over a period causes a river to exceed its capacity, becoming overbank flooding once flows exceed the riverbanks.

River Management Work Programme – A programme developed by the River Flood Focus Group, which is a subset of the Wharekawa Coast 2120 community panel and technical advisory group members, which outline short term river and drainage maintenance options that help to reduce the flood risk in the project area.

TVD-52 – Tararu Vertical Datum 1952.

Qualitative – A description of the impacts (Ministry for the Environment, 2020).

Quantitative – Uses units of damage or loss, disruption period, monetary value of impacts or environmental effect (Ministry for the Environment, 2020).

1 Introduction

1.1 Wharekawa Coast 2120

The Wharekawa Coast 2120[1] project aims to bring the Wharekawa communities together to define their path for the future while enabling flexibility to respond to changing conditions (such as those caused by projected climate change). Wharekawa Coast 2120 will look at a wide range of issues within the Wharekawa Coast 2120 project area (project area), to provide for a resilient and prosperous future, with a focus on:

1. climate change and natural hazards,
2. future development and land use,
3. economic opportunities, and
4. community infrastructure and social wellbeing.

To understand the impacts of climate change and natural hazards in the project area, the following suite of reports have been or are being compiled:

- Coastal Processes and Hazards (coastal inundation, coastal erosion, and tsunami)
- Rapid Flood Hazard Assessment of Hauarahi Stream
- Climate Driven Impacts on Fluvial Inundation Hazards in coastal Kaiaua
- Ngāti Paoa / Ngāti Whanaunga Values Assessment (assessment to be updated)
- Ecological Values Impact Assessment
- Natural Hazards Social Impact Assessment for Wharekawa
- Natural Hazard Risk Assessment; and
- Wider River Flood Impact Assessment (this report)

This report will document the historical river flooding events within the project area and the associated impacts on the community. The report will then provide recommendations on where in the project area further river flooding investigation may be required (such as further flood modelling) and make recommendations for a river management work programme that identifies short term stream maintenance options, that is intended to be used to prioritise works for guiding future funding options to inform both councils Long Term Plan 2024-2034.

The results from this report have helped inform the Wharekawa Coast 2120 Technical Advisory Group (TAG) and Community Panel (the panel) and the Joint Working Party (JWP) to understand the scope of historical river flooding impacts across the project area. This report has also helped the groups to make the best-informed decision (with the information they hold) when determining adaptation option pathways for each compartment in the project timeline.

1.2 Purpose

The purpose of this assessment is to:

1. Collate the historical and current river flooding information across the whole Wharekawa Coast 2120 project area and understand the impacts of these river flood events on the community.
2. Identify key priority work areas in which may require further river flood investigation, (e.g., further river flood modelling).

[1] Wharekawa Coast 2120 - Home - Wharekawa Coast 2120 (hauraki-dc.govt.nz)

3. Recommend short term stream maintenance options which can be implemented in the short term to reduce the flooding risk in the Wharekawa Coast 2120 project area. These are not intended to be long term mitigation options or to reduce the flooding risk completely.

1.3 Scope

This wider river flooding report is intended to provide an overview of the known river flooding events that have impacted the project area up to June 2022 (outlined in section 4), through

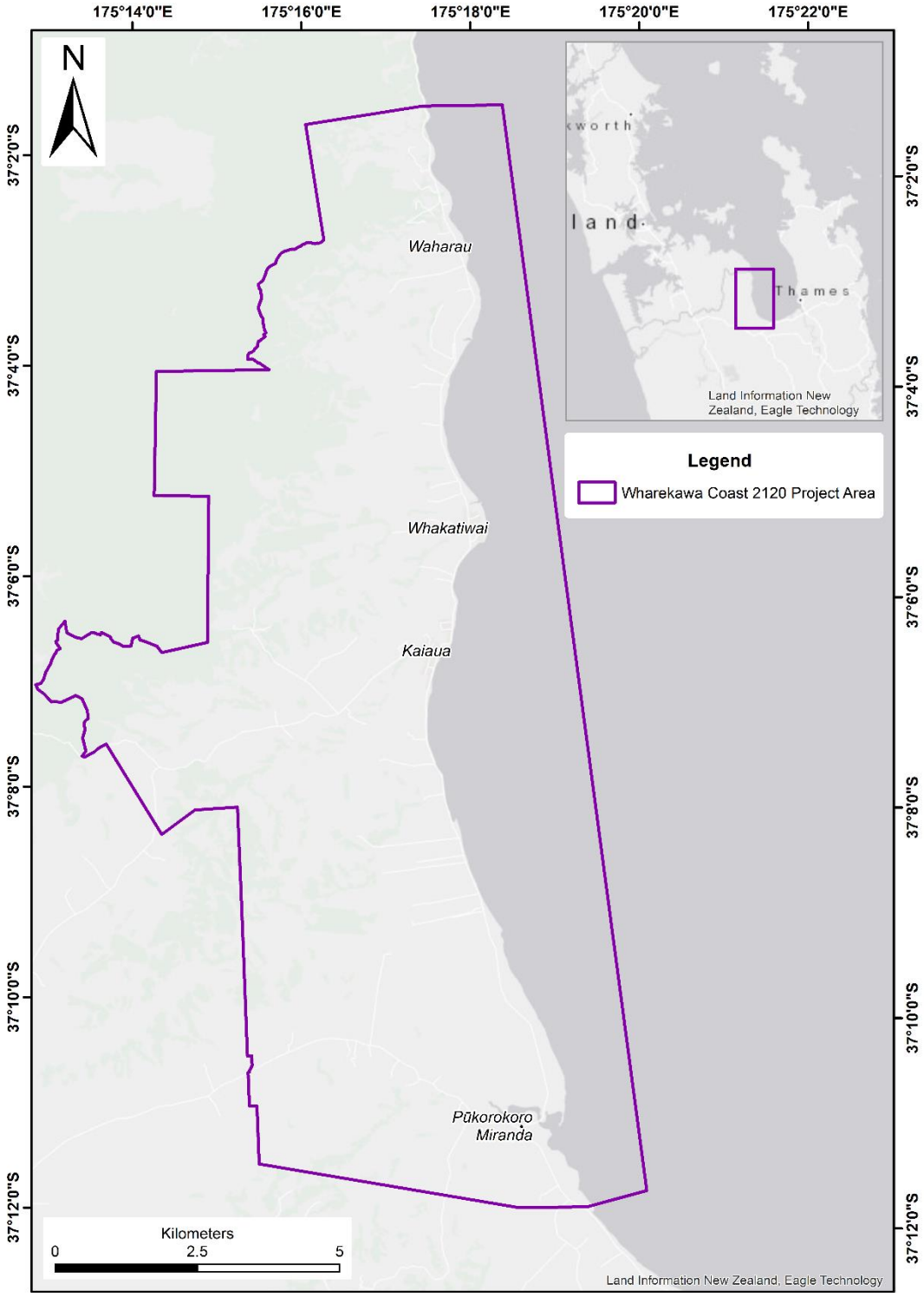

Figure 1 Wharekawa Coast 2120 project area.

collating impact information from past district and regional Council flood event documents and community knowledge. The geographical extent of the project area is shown on Figure 1
The information presented in this report is qualitative, where the impacts from previous events are described in detail and may refer to some historic quantitative impact information. The level of information presented in this report is granular and outlines very specific impacts that have occurred in different compartments in the project area.

The report is formatted into six sections:

1. Background information regarding the project area and flood event registry.
2. Hydrological catchment setting and hazard drivers where an overview of key catchment specific information is provided for all the major streams in the project area and a brief overview section of the key scientifical processes that influence river flooding.
3. Historical flooding event impact information provided in chronological order from the 1960s through to the most recent river flooding event in April 2017.
4. Overview of Hauarahi Stream flood models completed by different organisations and the 1997 Kaiaua Flood Protection Study that took place between 1995 to 1998 by Franklin District Council.
5. Identification of priority work areas where the impacts documented in this report are potentially deemed to be too intolerable and further flood modelling and risk identification may be required.
6. Recommendation of short-term river and drainage maintenance options which can be implemented to help reduce the flooding risk in the short term.

The level of detail provided in this report is specific enough that it has been used to help inform the Natural Hazard Risk Assessment work completed for the wider Wharekawa Coast 2120 project.

The impacts of historical coastal inundation events are excluded from the scope of this report, unless otherwise stated because the event coincided with a river flooding event. The *Natural Hazard Risk Assessment* by Grant et al., (2020) and Hume T, (2020) *Coastal Processes and Hazards* report (which address coastal inundation, coastal erosion, and tsunami) completed for the Wharekawa Coast 2120 Project, outline historical coastal inundation events and their associated impacts and processes.

1.4 Limitations and assumptions

- Information presented in this report may appear incomplete. Documented and community knowledge from past flooding events that has not been picked up in the information gathering stage of this process will exist. This report will be updated to include any new information identified by the Panel on documented river flooding events. Information will be gathered from the community until *June 2022* to reduce continual adjustments post review. Community members should contact Waikato Regional Council prior to this date if they would like further impact information to be included.
- No known rainfall gauge sites exist within the project area. Data from the nearby Watercare Mangatangi Dam rainfall gauge has been used for this study. This gauge is in the Hunua Ranges, 8km west of Kaiaua township, near the uppermost point in the Hauarahi Stream catchment. For terms of use copyright and disclaimers please read Terms of use | Waikato Regional Council.
- The Tararu tide gauge has been used to analyse tide levels throughout its telemetry lifespan to audit documented coastal inundation events against tide data. However, the Tararu tide gauge is located on the other side of the Firth of Thames, near Thames

township. For terms of use copyright and disclaimers please read Terms of use | Waikato Regional Council.

- In the case of combined coastal and river flooding events, this report does not state which natural hazard is driving flooding in a particular area. For example, a dwelling in Kaiaua is identified as being impacted by flooding during a certain event where both coastal inundation and Hauarahi Stream flooding has occurred, however, it is not specified which natural hazard impacted the dwelling. In some cases, flooding of a specific property may be caused by a combination of the two.
- Limitations that are carried over from other reports and modelling undertaken to assess coastal hazards and Hauarahi Stream flooding in which this report cites – these are detailed in the relevant reports. These are provided in Appendix 1.

2 Background

2.1 The Project Area

The project area has experienced many historical river flooding events, due to the low-lying nature of the area, which is situated on the western side of the Firth of Thames in the North Island of New Zealand. The project area has many major and minor streams originating from the Hunua Ranges in the west that travel cross farmland and through residential villages out to the Firth of Thames.

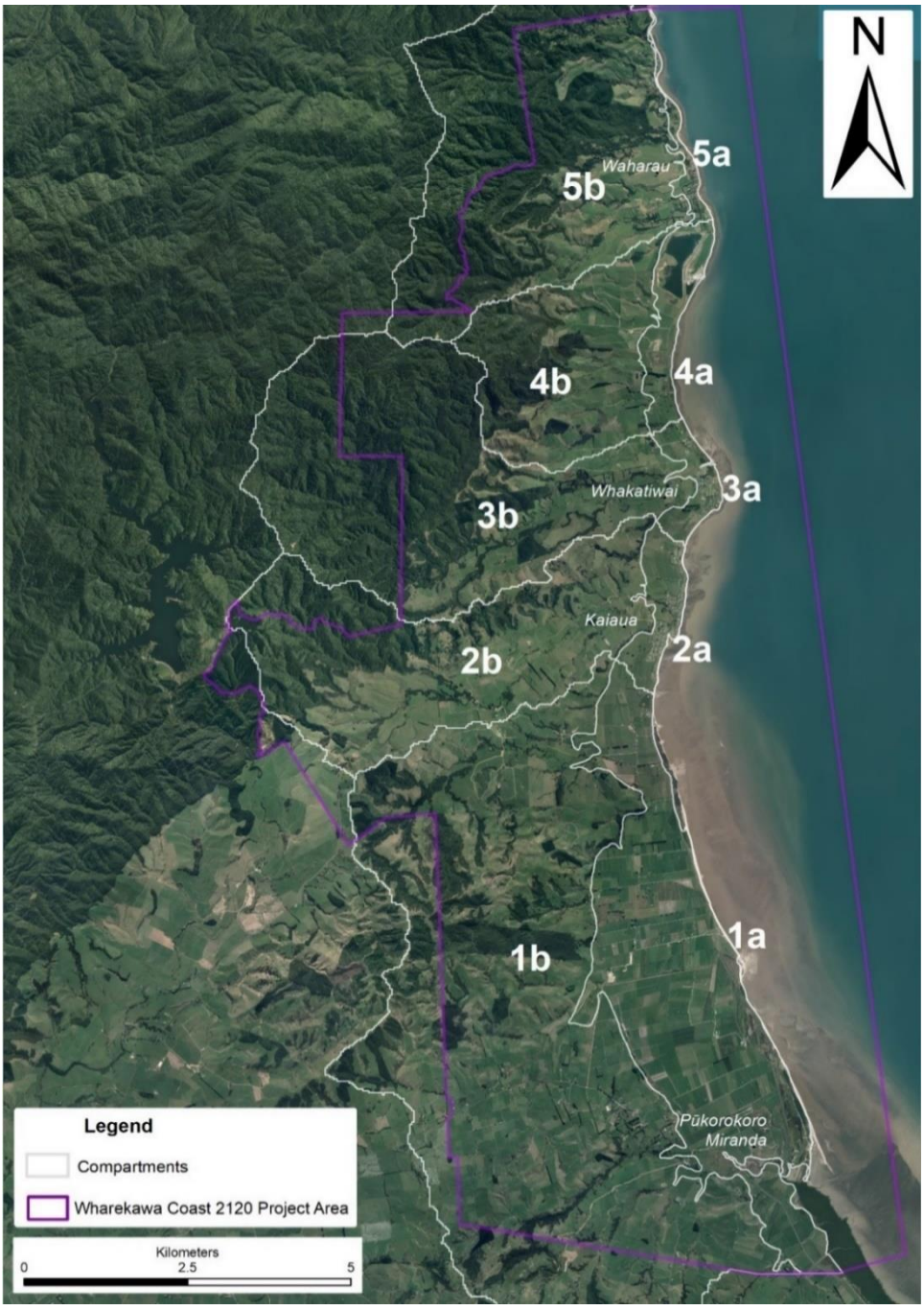

Figure 2 Wharekawa Coast 2120 project compartments and sub compartments

For the Wharekawa Coast 2120 Project, the project area has been divided up into five compartments, each containing a coastal and inland sub-compartment (Figure 2)

Compartments are used to allow for the alignment of information and management options within the similar river and coastal environments. The compartments are derived from upper catchment boundaries, with the division between the inland and coastal compartments at RL 5.0m contour (MVD-53). The compartments are referred to in this report to spatially present the impacts from historical river flooding events across the project area. Not all compartments have documented historical river flooding impacts identified in this report. However, historical events may have occurred that have not been captured in this report.

The township of Kaiaua has previously been exposed to two flood hazard protection studies led by the former FDC, which investigated the freshwater flooding hazard from the Hauarahi Stream. Further, the northern village of Whakatīwai benefits from flood protection installed by FDC in the late 1960s. The Pūkorokoro Miranda rural community benefits from stopbanks along the Miranda and Pūkorokoro Streams, as well as the Taramarie Land Drainage District (TDD). A map of the TDD is available in Appendix 1. The current flood protection schemes and past community consultation work highlight the considerable exposure and risk of the project area to river flooding.

2.2 Flood event registry

Collation of historic river flooding event impact information has identified 16 flood events that have occurred in roughly the last 90 years, which have either occurred from coastal inundation, freshwater stream flooding or both. For each documented flooding and coastal inundation event, a review of the available information provides an understanding into the compartments that have been directly impacted by flood waters, where indirect impacts may also have occurred.

This collection of records therefore allows for an estimated severity rating to be assigned to each event documented. Please note, that the estimated severity rating may not directly reflect the real-life event and are subjective, however, is an estimate based on impact information available from the project area. Estimated severity impacts are assigned based on the below criteria:

- Extensive events: Widespread and serious flooding, affecting property and infrastructure and resulted in long term impacts on people.
- Moderate events: Localised flooding, with impacts restricted to property and farmland (no long-term impacts to people).
- Minor events: Localised little flooding, often may be flooding contained to the stream or the foreshore.

Table 1 below identifies the known flooding events identified through past flood event reports, council documentation and personal accounts/information with the wider community in the project area.

Table 1 Flood event registry for the Wharekawa Coast 2120 project area.

Date	***River flooding***	***Coastal Flooding***	***Known compartments impacted*** *(may have impacted further sub-compartments)*	***Estimated severity rating***	***Source***
January 1938		✓	unknown	Extensive	(Dahm J, 1999)

Date	*River flooding*	*Coastal Flooding*	*Known compartments impacted* *(may have impacted further sub-compartments)*	*Estimated severity rating*	*Source*
March 1966	✓		2A, 3A	Extensive	(Clements L, 2001; Golder Associates 2015; McLeod & Thompson, 2011; Mills T, 6 August 1998; Franklin District Council, 1969).
April 1967	✓		3A	Extensive	(Franklin District Council, 1969)
23 May 1985	✓	✓	2A	Extensive	(Clements, L.A, 2001; Golder Associates, 2015; McLeod & Thompson, 2011; Mills, T, 6 August 1998)
12–14 July 1995	✓	✓	1A, 2A, 3A	Extensive	(Clements L, 2001; Dahm J, 1999; Harrison and Grierson, 1997b; Mills T, 1998; McLeod & Thompson, 2011; Waikato Regional Council, 2021b)
10-12 January 1997 (Ex-tropical Cyclone Drena)	✓	✓	1A, 2A, 5A	Extensive	(Clements L, 2001; Dahm J, 1999; Harrison and Grierson, 1997b; Mills T, 1998; McLeod & Thompson, 2011; Waikato Regional Council, 2021b; Hume T, 2021)
10-14 July 1998	✓		2A, 5A, 5B	Extensive	(Mills T, 1998; Waikato Regional Council, 2021b)
6 August 2006	✓		2A	Minor	(Wotton R, 2006; Waikato Regional Council, 2021b)
July/August 2008	✓	✓	2A	Minor	(Ryan G, 2009; Waikato Regional Council, 2021b)
23 January 2011	✓	✓	Unknown	Minor	(McLeod & Thompson, 2011; Ryan G, 2011; Waikato Regional Council, 2021b)

Date	*River flooding*	*Coastal Flooding*	*Known compartments impacted* *(may have impacted further sub-compartments)*	*Estimated severity rating*	*Source*
28–29 January 2011	✓		1A, 2A, 3A, 5A	Extensive	(Ryan 6, 2011; McLeod & Thompson, 2011; Waikato Regional Council, 2021b)
10-11 June 2014	✓		2A	Unknown	(Grant D, 2014; Waikato Regional Council, 2021b)
7–12 March 2017	✓		2A, 5A	Extensive	(Craig H, 2017; Waikato Regional Council, 2021b)
4–6 April 2017	✓		5A	Extensive	(Craig et al., 2017; Waikato Regional Council, 2021b)
5 January 2018		✓	1A, 2A, 3A, 4A, 5A	Extensive	(Craig & O'Shaughnessy, 2018; Waikato Regional Council, 2021b)
21 March 2022		✓	2a,3a,5a	Minor	(Johnstone J, 2022; Rawiri F, 2022)

Monthly rainfall data obtained from the Watercare Mangatangi Dam rainfall site hosted on Waikato Regional Council, Envirohub, (2021), and the monthly maximum tide level from the Tararu Tide Gauge, identifies clear links between past flooding events outlined above and rainfall/tide level records (Figure 3). Flooding events that have resulted from heavy rainfall such as 1995, 1997, 1998, 2008, 2011, and 2017 events can be identified in Figure 3 below as they spike. However, the graph also identifies other large monthly rainfall accumulations that have not been identified above in Table 1, such as May 2001, February 2004, and June and August 2010, highlighting the uncertainties of the above flood event registry and the incompleteness of the data obtained in this report.

Alternatively, these high monthly totals that do not coincide with recorded flood extents could represent months with continued rainfall across several days or weeks that did not reach a critical intensity to cause over-bank flows within a residential area.
Other events which were the result of both river flooding and coastal inundation are less clearly observed in the historical data, due to reaching a more average monthly rainfall accumulation amount of 200 to 350mm, in conjunction with slightly higher than normal tide levels. Although this highlights the heightened risk of the Wharekawa coastline to combined coastal inundation and river flooding, a large proportion of these events have an estimated severity rating of extensive, considering moderate monthly rainfall accumulations and tide levels.

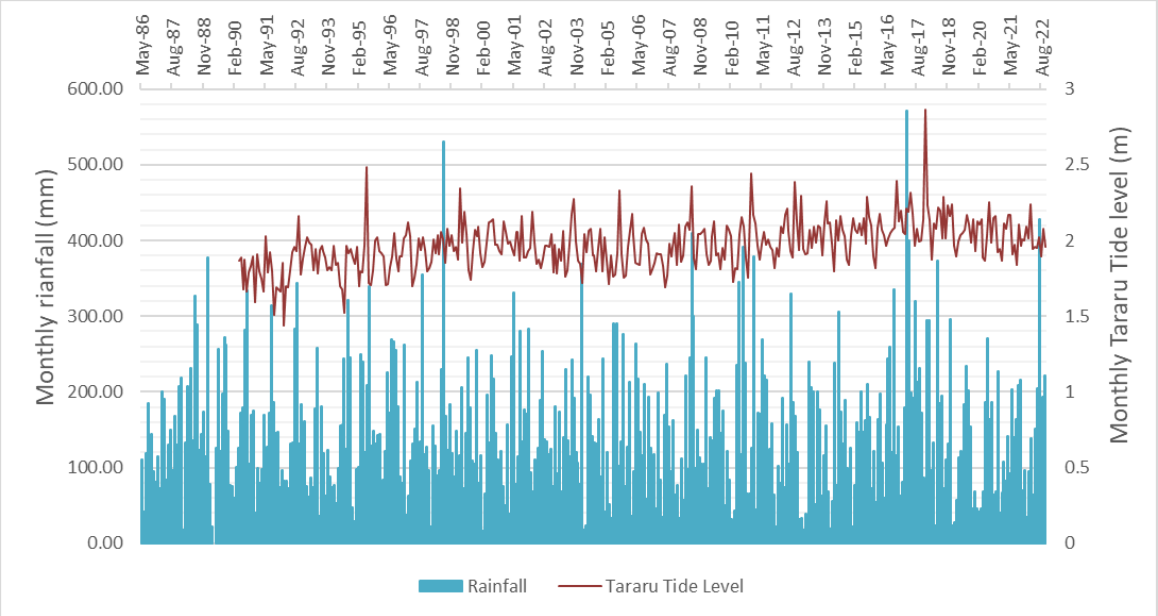

Figure 3 **Monthly maximum recorded rainfall at Mangatangi Dam Rainfall Site from 1986 to present day (blue) and tide level at Tararu Tide Gauge from 1990 to present day (orange) (Waikato Regional Council, 2021b).**

3 Hydrological catchments and hazard drivers

Major stream networks and draining land within the project area are shown on Figure 4.

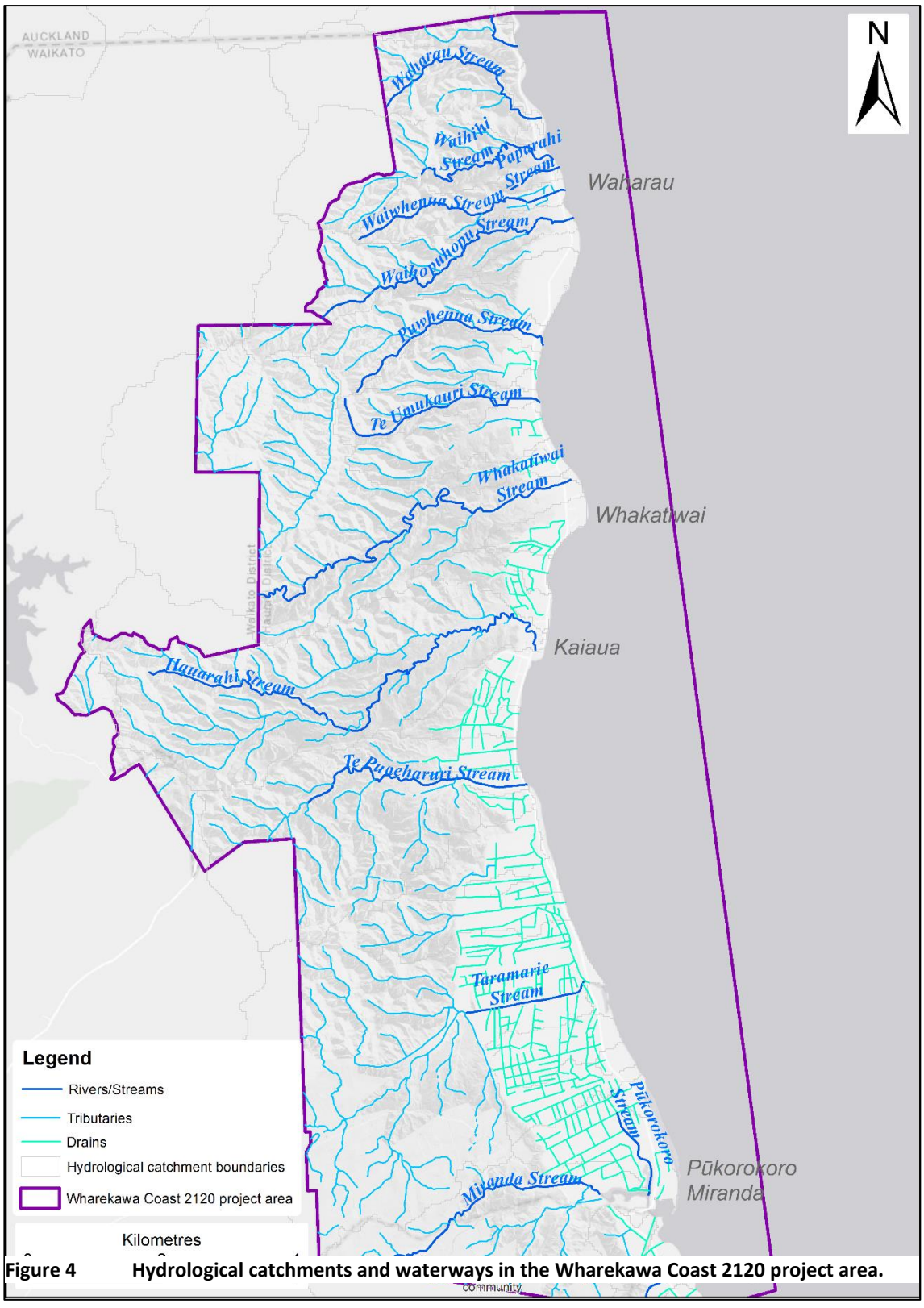

Figure 4 **Hydrological catchments and waterways in the Wharekawa Coast 2120 project area.**

3.1 River/catchment systems

Miranda and Pūkorokoro Streams (1A and 1B)

The Miranda Stream has a catchment size of approximately 1780ha with high producing grassland dominating the low-lying reaches of the catchment, with a mixture of Manuka/Kanuka trees, exotic and indigenous forests sparsely occupying the upper hill catchment. Rural land dominates this catchment, which consists of rolling hills in the upper catchment down to the low lying coastal plain where the Miranda Stream joins with the Pūkorokoro Stream.

A 204ha catchment of flat rural land drains into the Pūkorokoro Stream, where many nearby catchments transport their runoff via channels into the TDD or other stream (Golder Associates, 2015).

Compartment 1A contains an internationally significant coastal landform, comprising a Holocene coastal strand plain accreted by gravel and shell cheniers overlying intertidal muds. These coastal geomorphological features occur in very few similar locations around the world (Hume, T.M, 2021). It also contains part of a nearly 8000-hectare Ramsar site (a wetland of international importance) which is protected under the Ramsar Convention, which is home to thousands of wading birds and shorebirds (Marsh et al., 2022; Golder Associates, 2015).

The TDD covers 720ha of the low-lying rural farmland north of the Miranda Shorebird Centre and south of Kaiaua township (McLeod & Thompson, 2011), which includes 4km of drains, 5km of stopbanks and 14 culverts/floodgates along East Coast Road (ECR) owned by HDC. The objective of this drainage network is to restrict saltwater inundation during high tide events via floodgates along ECR and to reduce the potential for overland flooding. Further south, the Miranda and Pukorokoro stream stopbanks are owned by Department of Conservation (DOC) or private entities and are currently part of the Living Waters Project and in conjunction with DOC and local land owner are looking at reverting the land surrounding the streams back into a natural wetland (Growden et al., 2021).

The drainage district was constructed by the former FDC and currently HDC own the TDD assets, which is now a formal drainage committee of the Council (Golder Associates, 2015; McLeod & Thompson, 2011; Growden et al., 2021). HDC also maintains several floodgates in the Pūkorokoro Miranda area that travel beneath ECR, one north of Rays Rest, and one south of the Shorebird Centre. There are also approximately 3 privately owned floodgates located south of the Miranda Shorebird Centre. It is estimated that the flood control gates in the TDD are approximately 40 to 50 years old, and in many cases limited maintenance has occurred, apart from recent floodgate control upgrades in certain stream outlets (Growden et al., 2021; McLeod & Thompson, 2011).

To the south of ECR in the project area, the Hauraki rail trail is developed on a DOC and privately owned stopbank that HDC has an easement and land use consent over to maintain for the use of the rail trail. HDC owns the stopbanks in the TDD along the Taramarie Stream, while other stopbanks in the area are privately owned (Growden et al., 2021; Living Water, 2022).

Hauarahi Stream (2A and 2B)

The Hauarahi Stream enters the western shore of the Firth of Thames through the township of Kaiaua. The catchment area is approximately 1270ha, extending 7km west from the coast to an elevation of 430m into the eastern Hunua Ranges. Approximately one third of the upper catchment remains forested, with much of the lower catchment dominated by rural farmland with a vegetation landcover type of high producing grassland (Grant et al., 2020).

The township of Kaiaua is situated on the lower coastal floodplain of the Hauarahi Stream, where the stream runs through the centre of the township before discharging into the Firth of Thames. The Hauarahi Stream splits the township into northern and southern Kaiaua, each with distinct flood characteristics (Chambers J, 2020; Grant et al., 2020). Historic photographs in Figure 22 in Appendix 3 indicate that the Hauarahi Stream has migrated across its floodplain throughout Kaiaua, therefore it is also likely in the future. Bends in the channels can be seen to be developing and also cut off, with an overall straightening of the stream developing between 1944 and 1960. The historic photos also show the development of properties along ECR in low lying floodplain locations, where ponding is visible in the earlier 1944 photograph (RetroLens, 2018).

Historically, the Hauarahi Stream has experienced many significant flood events which are described in detail in Section 4. Consequently, many buildings in the township have been inundated. During the 1980s to 1990s, a large area of forestry within the upper catchment was cleared to create pastoral farmland as identified in Figure 21 (Appendix 3) potentially increasing catchment runoff volumes (Bosselmann M, 1996). Further details surrounding the impact of land use on flooding is provided in Appendix 2.

The proposal of a flood protection scheme for the Kaiaua township has been requested twice by the community, following the 1985 and 1995 combined coastal and river flooding events (Harrison and Grierson, 1997b). However as described in Section 4 and 5, there is currently no rated flood protection in place along the Hauarahi Stream.

Whakatīwai Stream (3A and 3B)

The Whakatīwai Stream catchment is the largest in the project area at 1670ha extending into the Hunua ranges (McLeod & Thompson, 2011). The catchment has similar vegetation cover to both the Pūkorokoro Miranda and Hauarahi Stream catchments, with a large proportion of the upper catchment being the home to an indigenous forest; the Whakatīwai National Park (Marsh et al., 2022). The land use types in the catchment consist of majority being rural land, with forest conservation in the upper catchments and residential situated on either side of the Whakatīwai Stream on the coast (Marsh et al., 2022). Like the Hauarahi Stream catchment, a large section of the upper catchment was cleared for rural pastoral farming between the 1970s and 1990s as indicated in Figure 20 in Appendix 3.

The Whakatīwai stopbanks are located upstream of the bridge along ECR on both banks and downstream on the southern side (Franklin District Council, 1969; McLeod & Thompson, 2011). HDC currently own the land, however, there are no ongoing ratings present for maintenance on either the stopbanks or the stream itself (McLeod & Thompson, 2011). This flood protection scheme was developed following the two 1960s river flood events which severely impacted the Whakatīwai village (Franklin District Council, 1969), which are described in more detail in Section 4.1. The implications on the stream and stream mouth because of these stopbanks is not considered in this report, however historic photographs (Figure 23 in Appendix 3) indicate the straightening of the stream and the visible implications this had on the shoreline and the Whakatīwai Stream mouth.

The Whakatīwai Stream is of high significance to the local iwi, Ngāti Paoa and Ngāti Whanaunga, as the stream was a major trading route (Mills W, 2021a), with Urupā and wāhi tapu sites located near the foreshore of the Firth of Thames (Franklin District Council, 1969; Ngāti Pāoa & Ngāti Whanaunga, 2008). Historical accounts from local iwi also indicate that the Whakatīwai Stream is reasonably smaller in comparison to historical accounts (Mills W, 2021a). This may indicate long term temporal changes to the natural system in conjunction with human intervention.

Puwhenua Stream (4A and 4B)

No significant recorded events regarding riverine flooding of the Puwhenua Stream were gathered throughout this process. The catchment characteristics for this compartment are equivalent to compartment three.

Waharau Stream (5A and 5B)

The Waharau Stream catchment is smaller at only 410ha in comparison to the larger catchments mentioned above (McLeod & Thompson, 2011). Indigenous forest makes up a large proportion of the upper catchment with similar land use types to the Whakatīwai catchment (Marsh et al., 2022). Sections of the Waharau National Park are also located within this catchment (Marsh, et al., 2022).

Personal accounts from the Wharekawa Coast 2120 Community panel recall proeprties along ECR and the Waharau Stream being flooded during minor events several times a year. This is explored further in the River Management Work programme in section 7.

Other catchments

There are several other hydrological catchments of varying sizes in the project area that contribute to the overall hydrology, however, are not described in this report due to very little to no impacts being identified. Figure 4 indicates the location and complexity of the hydrological setting of the Wharekawa Coastline.

3.2 Fresh water flood hazard drivers

To understand how and why the project area is at risk from river flooding, it is important to consider the driving factors which influence or exacerbate river flooding. In this section, an explanation of different influencing factors which contribute to river flooding is provided, with further details provided in Appendix 2.

3.2.1 How does flooding occur?

River flooding occurs whenever the river discharge from the stream exceeds the local channel capacity, i.e., the volume in which the cross section of the channel can accommodate (Slater et al., 2015). There are several influencing atmospheric, oceanic, and localised catchment conditions that contribute to localised flooding. Further description is provided in Appendix 2.

Heavy rainfall is the most common meteorological process that leads to river flooding. Heavy rainfall in New Zealand occurs due to weather systems such as ex-tropical cyclones, like the 2017 rainfall event that impacted the project area (Craig et al., 2017). When rainfall occurs, it runs into the hydrological system via surface or sub-surface (in-ground) pathways. Several catchment conditional factors are required for runoff, which are outlined in Appendix 2.

3.2.2 The coastal setting and climate change

The impacts of climate change are already increasing the risk of flooding globally, by altering rainfall severity and duration, temperature, and sea levels. Over the long term these processes are forecast to have significant impacts on catchment and coastal geomorphology (Ministry for the Environment, 2020).

The Coastal Processes and Hazards report completed by Hume T (2020) indicates that with 1m of sea level rise along the Wharekawa Coastline, coastal inundation events like the January 2018 event will become a weekly occurrence. Furthermore, raised sea levels will restrict the capacity of coastal river systems discharging runoff to the coast. This change is projected to increase the frequency of overbank river flooding events particularly on low-lying coastal plains, thereby making low lying coastal communities more vulnerable to riverine flooding.

3.2.3 Multi and cascading hazards of river flooding

The concept of multi-hazards, where one hazard occurs at the same time as another, has already been experienced multiple times in the project area. All recorded multi-hazard events in the project area are simultaneous coastal inundation and river flooding events as indicated in Table 1 and in Section 4.0.

There is also the potential for one hazard to influence another. These are known as cascading hazards, where one hazard impacts or initiates another hazard. It is important to consider the potential cascading impact associated with the initial event, as this may pose an extra risk to the communities in the project area. Cascading hazards caused by flooding may include but are not limited to riverbank erosion, aggradation, debris dam development, and dam-break flooding (Robinson & Davies, 2013).

3.2.4 Impact on communities

The impacts of flooding on coastal communities can be dictated by a range of non-meteorological aspects, including the following: (Ministry for the Environment, 2017).

- The locations of development near water courses or on low lying land
- The effectiveness of flood protection assets and the remaining residual risk
- The effectiveness of early warning systems
- The loss of livelihood and economic income
- The impact on critical lifelines located in flood-prone areas such as roads and bridges
- Impact to cultural and ecological aspects that are important to the community, which is particularly relevant to the Wharekawa Coast communities.

4 Historical event impact information

Information in this section is presented in terms of each recorded extreme rainfall event. The impact information may seem incomplete due to gaps in the information gathering process because of accessibility. However, it has been obtained with the best faith of trying to gather a holistic and complete picture of what occurred, based on the evidence provided and contribution from the relevant district council, the panel, and the wider project area communities.

4.1 1960s severe weather events

In the 1960s two major flood events occurred in the Whakatīwai Stream in consecutive years, 28 February to 2 March 1966 and April 1967. Impact information also suggest other major streams in the project area were also impacted. (NIWA, 2018a; Franklin District Council, 1969). These floods resulted in significant damage in the Whakatīwai settlement (Franklin District Council, 1969). The Kaiaua township located 3km south, recorded approximately 35.6cm of rainfall in 12 hours on 28 February 1966 (NIWA, 2018a).

The impacts of these successive events were extensive. The recorded impacts of these events are provided in Table 2. It is not clear in every case which rainfall event caused the stated impact.

Table 2 Impacts recorded from the 1966 and 1967 severe weather rainfall events (Franklin District Council, 1969).

Impact on people	Evacuation in Kaiaua township were required during the 1966 event, where elderly people were evacuated by boat as Kaiaua township flooded (NIWA, 2018a).

Building damage	The Whakatīwai community hall became severely damaged. I*t is unclear if the removal of the hall occurred because of these flooding events*. Most of the houses in the Whakatīwai settlement were inundated. The Whakatīwai village general store was severely inundated with flood waters up to windowsills, major stock loss and significant debris like trees, logs and rubbish being scattered throughout the whole store and campground. One cabin from the Whakatīwai campground (now known as EcoQuest) located downstream of the bridge was washed out to sea, with another three cabins becoming severely damaged and floating off their foundations. Eyewitnesses said the floodwaters were neck deep throughout the camp during the 1966 flood event (Franklin District Council, 1969; NIWA, 2018a). If accurate, this observation would suggest flood levels may have reached a level similar to the edge of seal on the current ECR crossing of the Whakatīwai Stream.
Infrastructure damage	Flooding of the roads on either side of Kaiaua resulted in the township becoming isolated. ECR from Kawakawa Bay to Miranda was severely damaged due to slips and washouts (NIWA, 2018a).
Rural Farmland Damage	Approximately 150 acres of farmland were considered unproductive for 12 months following the events due to extensive silt deposition on the land (Franklin District Council, 1969). There was also extensive farm stock loss as the topography did not provide high ground refuge for stock. In one case only six ewes survived from a flock of 500 (NIWA, 2018a).
Environmental Damage	Erosion in the vicinity of the Whakatīwai bridge threatened to collapse the bridge, due to high flows in the stream. Further extensive erosion was documented across the Hunua foothills and along other streams in the project area (Franklin District Council, 1969; NIWA, 2018a).

No loss of human life was incurred during these flood events. However, the residents of Whakatīwai knew the ability of the stream to rise quickly and were concerned about the risk posed to tourists camping at the Whakatīwai campground in the summer. This initiated an investigation of the flood risk to the Whakatīwai community and assessment of options by FDC in the following years (Franklin District Council, 1969).

Remediation works began in the spring of 1967, including straightening the stream as the flood events had eroded the stream banks in conjunction with the development of the southern stopbank immediately upstream of the bridge (Franklin District Council, 1969). Historical images of the stopbanks and the straightened stream can be seen in Figure 22 in Appendix 3. Due to the urgency of the works, FDC constructed the stopbank to approximately 300mm higher than any eye-witnessed flood level and did not complete a detailed flood assessment. These works were funded using a targeted rate (Growden et al., 2021).

Although the works were completed with urgency, coastal inundation was considered during the design of the stopbank scheme. An approximate 105-hectare ponding area to the north of the stream was designated for coastal floodwaters, as the community recognised the potential for coastal flooding driven by strong easterly winds on a spring tide (Franklin District Council, 1969).
Franklin District Council (1969) determined that an extension of the southern stopbank and construction of a northern stopbank would be required for further farmland and settlement protection, with a further realignment of the downstream channel through tapu land. The construction of the stopbanks was completed, with 300m of stopbank extending upstream on both sides and a further 150m downstream of the southern bank (McLeod & Thompson, 2011).

It is unsure when these upgrades were completed. Currently, these stopbanks are owned by HDC, however they are not managed due to no council ratings in this area.

Further research on the Whakatīwai Stream indicates that no major flooding events have occurred following the construction of these stopbanks signifying the success of the flood protection. Although they have been a success, there is significant importance in maintaining flood defences to preserve the level of service this scheme provides which has not been done for these stopbanks.

4.2 1985 river and coastal flooding event

On the 23 May 1985, heavy rainfall amounts coincided with a high tide resulting in a multi-hazard flood event. A 24 hour rainfall total of 158mm was recorded at the Miranda Hot Spring gauge (Golder Associates, 2015).

This event resulted in a large proportion of properties within Kaiaua township becoming inundated, indicated in the 1998 Kaiaua Flood Protection survey competed by Mills T (1998) from FDC. Further impacts to properties in the Kaiaua township and across the wider project area are likely to have occurred that are not included in Figure 5 below.

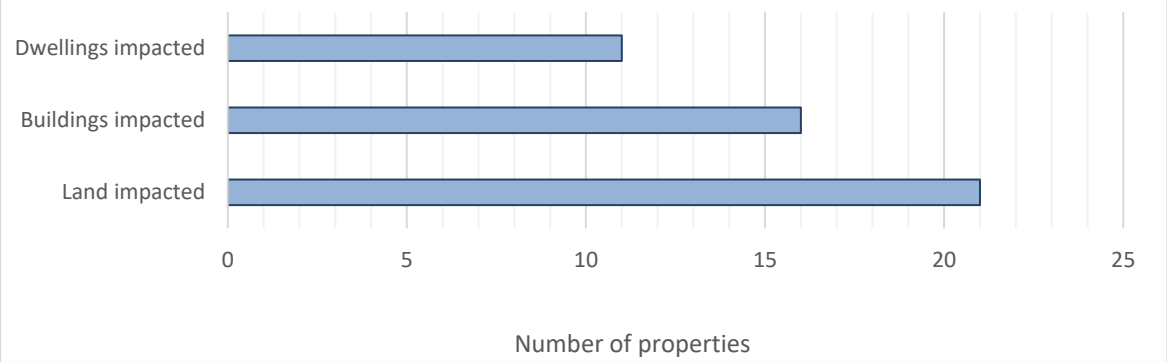

Figure 5 Results from the 1998 Kaiaua flooding survey completed by Mills T (1998) for the May 1985 flooding event. Land impacted refers to the number of properties that documented flooding on their land, and buildings impacted refers to buildings such as sheds

No impact information was available for other assets in the area, impact to properties such as farmland and roading, or across other townships in the project area, however, this does not mean that no impacts occurred.

Following this event, the Kaiaua residents asked FDC to investigate a flood protection scheme for flooding for Kaiaua. A proposed flood protection scheme was developed and presented to the community by FDC. The scheme was ultimately cost-prohibitive and eventually the community decided not to proceed with any flood protection works (Harrison and Grierson, 1997a; Mills T, 1998).

4.3 12 to 14 July 1995 river and coastal flooding event

On 14 July 1995, flooding in Kaiaua township resulted from a multi-hazard event. High tides at RL 2.48m were recorded at the Tararu tide gauge, brought about by a low-pressure system. The Mangatangi Dam rainfall gauge recorded 129.5mm of rainfall during the 12 to 14 July period (Dee K, 1995; Harrison and Grierson, 1997b; Long & Highman, 1995; Dahm & Munro, 2002; Clements L, 2001; Waikato Regional Council, 2021b).

The Hauarahi Stream rose substantially, coinciding with the peak of high tide around 8pm on 14 July (Dahm & Munro, 2002). Residents stated that the peak of the flooding lasted for around 30 minutes, and once high tide passed, the flood waters receded considerably over an hour, particularly in northern Kaiaua (Dee K, 1995).

The known impacts from this combined river and coastal inundation flooding event were concentrated in the Kaiaua township, however, possible impacts may have occurred throughout the rest of the Wharekawa coast. Impacts in Kaiaua township included:

- 36% of the 78 properties that completed Mills T, (1998) flood protection surveys were impacted by either coastal inundation or flooding (Figure 6). It is unclear exactly which properties were impacted by which hazard (Mills T, 1998).
    - One resident, whose property is located on the northern side of Kaiaua, between the Hauarahi Stream and the general store, noted that the flooding on their property was a direct result of overbank flows from the Hauarahi Stream (Dee K, 1995).
- The general store in Whakatīwai was flooded with an estimated 400mm of floodwaters (Long & Highman, 1995).
- Several properties along Puriri Avenue were flooded (Long & Highman, 1995).
- Coastal inundation over ECR in southern Kaiaua was estimated to be extensive based on an eyewitness account (Dee K, 1995).

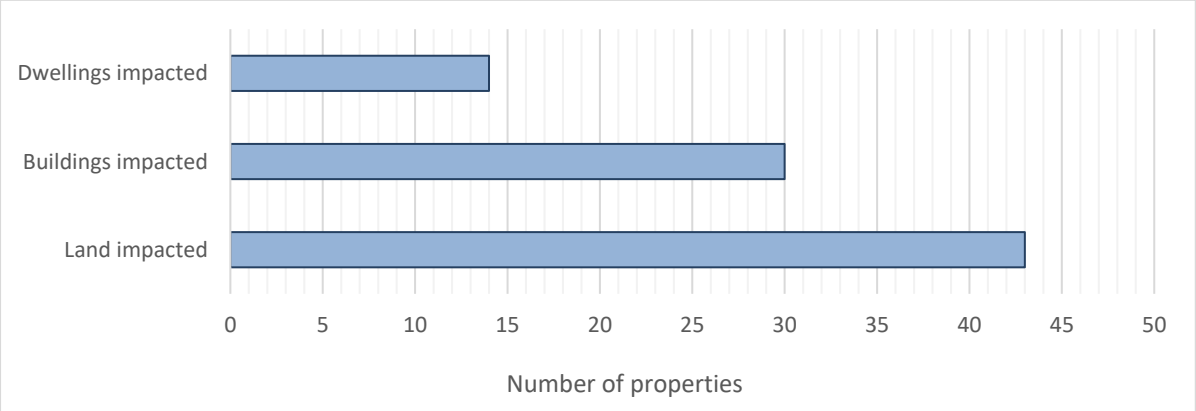

Figure 6 **Results from the 1998 Kaiaua flooding survey completed by Mills T, (1998) for the May 1995 flooding event. Land impacted refers to the number of properties that documented flooding on their land, and buildings impacted refers to buildings such as sheds and garages.**

Following this event, the Kaiaua residents asked once again for FDC to investigate a flood protection scheme for Kaiaua township (Bosselmann M, 1996; Harrison and Grierson, 1997b). In December 1996, FDC accepted a proposal from Harrison Grierson Consultants Ltd. to undertake a flood protection study for Kaiaua (Harrison and Grierson, 1997). More detail about this process can be found in Section 5.1.

4.4 10 to 12 January 1997 Cyclone Drena

Cyclone Drena passed over New Zealand in early January, bringing heavy rainfall and strong winds which coincided with a high tide in the Firth of Thames (Clements L, 2001; Franklin District Council, 1998). Research by Clements, L.A, (2001) indicated that both the 1997 and earlier 1995 events represented a 5% AEP river flood event in the Hauarahi Stream.

Little impact information was found from this flood event, however, unfortunately one fatality did occur (Franklin District Council, 1998) . The cause of the fatality was not mentioned. Waharau Stream-bank erosion was recorded on private property along ECR (Fry P, 1998). This event also resulted in low lying areas in the Pūkorokoro Miranda area becoming inundated, along with properties along ECR in Kaiaua also experiencing flooding due to wave run up and a high tide (Hume T, 2021).

4.5 10 to 14 July 1998 river flood event

On 14 July 1998, RL 2.05m was recorded at the Tararu tide gauge, with 81.5mm of rainfall being recorded at the Mangatangi dam. This followed 203mm of rainfall that had fallen between 8 to 10 July, therefore, resulting in high river levels occurring before and potentially at the same time as the high tide on July 14 (Waikato Regional Council, 2021b).

This event further developed and undermined existing erosion hotspots within the Waharau Stream embankments, which were created during the 1997 event (Fry P, 1998).

From the Kaiaua flood protection survey completed by Mills T (1998), 34% of the 78 properties who completed the survey were impacted by this event as indicated in Figure As shown on Table 1, impact information has been identified for sub-compartments 2a, 5a and 5b, however, it is highly likely that further impacts occurred across other sub-compartments which are not documented.

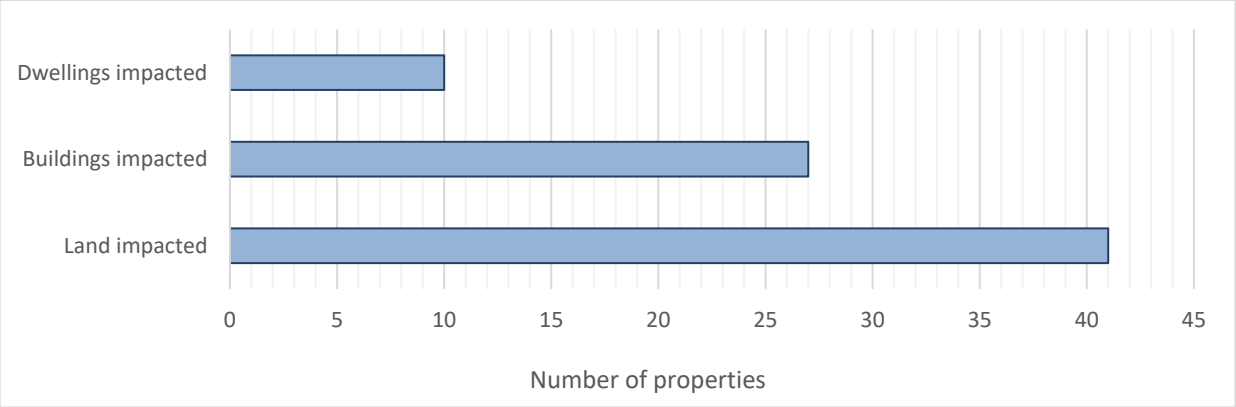

Figure 7 Results from the 1998 Kaiaua flooding survey completed by Mills T (1998) for the July 1998 flooding event. Land impacted refers to the number of properties that documented flooding on their land, and buildings impacted refers to buildings such as sheds and garages.

4.6 6 August 2006 river flood event

There is very little information available about the August 2006 River flood event in the Hauarahi Stream, apart from flood photographs captured by Wotton R (2006) indicating the stream reached a height in which out of bank flooding began to occur behind the fire station. High tide on this day was at 4:45pm at RL 1.28m TVD-53 (Waikato Regional Council, 2021b), passing by prior to the peak flow discharge from the Hauarahi Stream, resulting in very minor to minimal flood impacts as the stream was able to discharge its peak flow (Wotton R, 2006). A 42hr total rainfall accumulation of 123mm was recorder at the Mangatangi dam during this event (Waikato Regional Council, 2021b).

There is no other evidence that other streams in the project area were impacted by peak flows, however, it is possible they might have been.

Figure 8 Flooding photographs of the Hauarahi Stream on 6 August 2006. Both photos are taken in the vicinity of the fire station (Wotton R, 2006).

4.7 July/August 2008

Four weather events occurred over the winter of 2008, where continual widespread rainfall saturated the Waikato region, resulting in flood events from the river systems draining the Hunua Ranges and throughout the Lower Waikato (Ryan G, 2009).

The observed total rainfall depths at Watercare's Mangatangi rainfall site indicated that the catchments of the Hunua Ranges received over the four significant rainfall events are:

Table 3 Observed rainfall totals at the Mangatangi Dam rainfall site during July/August 2008 (Ryan G, 2011).

EVENT	ESTIMATED OBSERVED RAINFALL TOTAL
26–27 JULY	60mm
29–5 AUGUST	200mm
12–19 AUGUST	140mm
24– 25 AUGUST	80mm

The accumulation of the continued rainfall over the already saturated catchments resulted in well above average rainfall accumulation, with the Hunua Ranges receiving almost 300% above average rainfall for July and 220% for August, with an estimated rainfall total of >400mm over the four events (Ryan G, 2009).

Unfortunately, very little information can be found regarding the impacts from these rainfall events for the project area. River and ponding impacts were, however, documented for the nearby catchments of the Waitakaruru stream to the south of the project area and the Mangatangi River in which its headwaters originate in the Hunua Ranges, which experienced significant flood events during events two and four (Ryan G, 2009) coinciding with the largest recorded rainfall depths at the Mangatangi dam rainfall site. Therefore, it is reasonable to assume that the streams within the project area may have experienced overbank flooding during these two events with the possibility of wider flooding impacts.

4.8 January 2011

Two tropical cyclones passed over the Waikato region in January 2011, bringing two separate flooding events which impacted the project area. Ex-tropical cyclone Zelia brought low

barometric pressure around 18 January which coincided with a high tide (Ryan G, 2011; Waikato Regional Council, 2021b).
A small trough then passed over the region on 22 January with 133mm of rain falling at the Mangatangi dam rainfall site, with the peak of high tide occurring at 9:30am on 23 January at RL2.45 (TVD – 52). These two events periodically inundated low lying coastal margins along the western Firth of Thames. (Ryan G, 2011; Waikato Regional Council, 2019b).

Unfortunately, no impact information from the project area is documented for Ex-tropical cyclone Zelia.

Cyclone Wilma then closely followed bringing high rainfall amounts to already saturated catchments overnight on the 28 to 29 January. A total rainfall accumulation amount of 160mm was recorded at the Mangatangi dam rainfall site, reflecting roughly a 50 to 80 ARP rainfall event (McLeod & Thompson, 2011; Waikato Regional Council, 2021b).

Three major catchments in the project area experienced high river flows resulting in ponding, flooding and erosion impacts (Ryan G, 2011; McLeod & Thompson, 2011). Although the main river flooding impacts occurred during Cyclone Wilma, Cyclone Zelia left the catchments saturated with low storage water capacity (Ryan G, 2011). River flooding impacts from Cyclone Wilma are identified below in Table 4.

Table 4 River flooding impacts in the project area from Cyclone Wilma.

Stream:	Impacts:	Resources
Hauarahi Stream	• Hauarahi Stream overflowed its left-hand bank behind the fire station. • The Kaiaua Fire Station and the Pink Shop were flooded. • Significant flooding of properties and dwellings in the Kaiaua township *(unknown number of impacted properties).* • Flooding of the Kaiaua beach front.	(McLeod & Thompson, 2011; Ryan G, 2011).
Waharau Stream	• Lateral erosion on the stream banks occurred downstream of ECR. • The Waharau bridge needed to be checked due to erosion. • Willow and other vegetation growth both upstream and downstream of ECR needed cleaning to clear the stream.	(McLeod & Thompson, 2011)
Whakatīwai Stream	• Significant lateral erosion of the upstream and downstream stopbanks. • Erosion at the Whakatīwai bridge abutments. • Following the event, stopbank and channel straitening occurred however no ongoing ratings were in place for maintenance of these works.	(McLeod & Thompson, 2011).

Stream:	Impacts:	Resources
	   	
Other streams/impacts	• Significant ponding in the TDD. • Several other pipes and open drainage channels were inundated resulting in flooding of basements and garage areas. • Extensive surface ponding in the Rangipo stream area for short periods. • Trees in the Waihopuhopu stream needed clearing both upstream and downstream of ECR.	(McLeod & Thompson, 2011)

4.9 10 to 11 June 2014 Rainfall flood event

In early June 2014, a deepening Tasman Sea low brought heavy rainfall to the Waikato region, causing flooding and in some cases severe flooding damage to parts of the upper Waikato. The most severely impacted areas included the northern tip of the Coromandel, Waihou-Piako, and the Lower Waikato (Grant D, 2014).

Although heavy rainfall and documented impacts were recorded for the above locations, the Mangatangi gauge recorded approximately 175mm of rainfall throughout the event (Grant D, 2014; Waikato Regional Council, 2021b).

By analysing previous heavy rainfall events included in this report, similar accumulated rainfalls in the project area have resulted in minor to moderate impacts.

4.10 Tasman Tempest March 2017 Rainfall Event

The March 2017 rainfall event, also known as the Tasman Tempest, was a series of heavy rainfall bands affecting the northern Waikato region from the 7 to 12 March, with the two most significant events occurring overnight on 7 to 8 March and 10 to 11 March (Craig H, 2017).

The persistence of the rainfall throughout the week played a significant role in worsening impacts, with short gaps not allowing for full clean-up or any significant channel clearing work.

Over the week, the Mangatangi dam rain gauge site recorded a 1% AEP rainfall event (Craig H, 2017). Rainfall totals recorded at the Mangatangi damsite are provided in Table 5 below.

Table 5 Recorded 24 hour rainfall totals throughout the Tasman Tempest at Mangatangi dam rainfall gauge (Waikato Regional Council, 2021b).

Rainfall site	**7th March**	**8th March**	**9th March**	**10th March**	**11th March**	**12th March**	**Total**
Mangatangi	86.6mm	164.8mm	1.2mm	94.9mm	41.3mm	42.0mm	430.8mm

Although no streams in the project area have WRC telemetry recording instruments, the Orere Stream just to the north of the project area recorded a peak river flow of a 1 to 2% AEP event at approximately 2am on the 8 March, and the Mangatangi river recording a 2 to 5% AEP event (Craig H, 2017). As the headwaters of both these streams originate in the Hunua Ranges, it is appropriate to assume that other streams within the project area which also originate in the Hunua Ranges may have experienced similar peak flows.

Craig H, (2017) provided a summary of relative catchment impacts for the event, classifying each catchment as having either a high, medium, or low impact, as shown in Appendix 3. Four catchments in the project area are classified as high.

The impacts from this event included:

- Significant disruption to critical lifelines such as roads, electricity and water supplies, with the Kaiaua township becoming isolated due to flooding along Puriri Ave to a depth of 1.5m and other roads from the early hours of the morning until just before midday on 8 March (Craig H, 2017).
- The flooding resulted in damage to 8 houses in the township, as well as to farmland (Craig H, 2017).
- The Pink Shop was also flooded and was required to close for about a week for clean-up and repairs.
- Minor flooding of the school grounds occurred but the buildings were not affected (Craig H, 2017; Marsh et al., 2022).
- Flooding in Kaiaua township originated from the Hauarahi Stream where the channel capacity was reduced because of mangrove growth. The mangroves have since been removed from the lower reaches of the stream (Munro A, 2021).
- HDC assisted residents with sandbagging to protect properties from flood water.
- During the event, WRC staff were sent to investigate the situation in the project area (Figure 9 and 10) (Craig H, 2017; Knight R, 2017).

Figure 9 **River flooding impacts in Kaiaua from the March 2017 flood event. A. Flooding from Hauarahi Stream in Kaiaua township (Marsh et al., 2022, p.41), B. Flooding on ECR north of the County Bridge (Knight R, 2017) C. Mangroves encroaching Hauarahi Stream on 8 March when WRC staffed visited Kaiaua (Craig H, 2017, p.24).**

Figure 10 **Rural land impacts flooding from the March 2017 rainfall event. A. Flooding of farmland from the Waharau Stream. B. Hauarahi Stream flooding, several hours after the stream was in peak flood, in which the peak flood extent can be seen in the right of the photo by debris deposits. Photos were taken by WRC staff when visited on the 8^{t}of March (Knight R, 2017).**

4.11 Ex-Tropical Cyclone Debbie April 2017 Rainfall Event

Shortly following the Tasman Tempest were two ex-tropical cyclones and a low-pressure system, (Ex-Tropical Cyclone Debbie, Tasman low, and Ex-Tropical Cyclone Cook) making landfall on New Zealand on 4 April, 11 April, and 13 April, respectively. The greatest impacts to the project area occurred during the short-lived Ex-Tropical Cyclone Debbie from 4 to 6 April, bringing further flooding impacts to the already recovering project area (Craig et al., 2017).

The Mangatangi dam gauge recorded a rainfall accumulation of 400mm over April, with 209mm falling during Ex-Tropical Cyclone Debbie (Waikato Regional Council, 2021b). This resulted in the nearby Mangatangi river experiencing a peak flow of 5 to 3% AEP and the Orere river 10 to 5% AEP (Craig et al., 2017).

Despite the relatively short-lived event, it resulted in several impacts, particularly long-lived impacts for the Waharau community.

Table 6 Impacts from Ex-Tropical Cyclone Debbie.

Location	Impacts	Sources
Waharau	• The Waharau community became completely isolated (by road) because to the closure of the Waharau Bridge for safety reasons due to floodwaters undermining the bridge abutments (Figure 11) and a landslide blocking ECR to the north. • Before the bridge closure, residents were given time to self-evacuate (to avoid isolation), with many taking this option due to undermining of the road and bridge structure. • The closure of the bridge highlighted an emergency risk as local fire brigades Ngatea and Mangatangi were unable to help if an emergency were to occur in the Waharau area due to access restrictions. It was fortunate that at this time, the Kaiaua Voluntary Rural Fire Force had a stationary emergency vehicle situated north of the bridge equipped with basic supplies, however nothing sufficient to deal with any larger scale emergency. • Repairs to the bridge were estimated to take two weeks, and clearing the landslide was estimated to take up to a month.	(Craig et al., 2017; Marsh et al., 2022).
Kaiaua	• A telecommunications outage (Spark 3G) was reported at Kaiaua and thought to be associated with the severe weather, nonetheless, actual wind speeds remained significantly lower than forecasted. • Several enquiries were received regarding flooding and damage in Kaiaua. However, staff were unable to attend due to other areas in the HDC requiring more urgent attention.	(Chambers J, 2020; Craig et al., 2017; Marsh et al., 2022).

Figure 11 Eroded bridge abutments at Waharau Bridge following Ex-Tropical Cyclone Debbie on the 4th - 6th April 2017 (Marsh et al., 2022, p.42)

4.12 21 March 2022

This event resulted in relatively small impacts, particularly related to coastal flooding/surge because of a low pressure system rising the tidal level to RL2.23 (TVD-53) (5% AEP event). Coastal impacts from this event are provided in the Coastal Hazards and Processes report developed for the Wharekawa Coast 2120 Project (Hume T, 2021). This event was unusual and important to document because of the variation in the total rainfall accumulation amounts from Kaiaua township, along Kaiaua Road and Mangatangi Dam rainfall site.

Figure 12 Hauarahi stream on the morning of 21 March 2022 in high flow. (Johnstone J, 2022).

Communication from members of the community indicated that rainfall in Kaiaua township was 34mm during the 12hr period, 56mm 3km up Kaiaua Road from the village and 118mm recorded at the Mangatangi Dam rainfall gauge over 12 hours (Waikato Regional Council, 2021b). During this time the Hauarahi Stream waters were constrained to the stream and displayed that the recent works completed on the lower Hauarahi stream (mentioned below in section 4.13.2) was operating effectively.

The difference in rainfall total amounts across the catchment and at the Mangatangi Dam indicates that cold front bringing this heavy rainfall fell primarily at the Mangatangi Dam catchment and not into the Hauarahi stream catchment and resulted in a very isolated event.

4.13 General flooding issues

4.13.1 Pūkorokoro Miranda (sub-compartment 1a)

As identified above, the TDD drainage scheme is designed to provide flood protection to rural land north in central sun-compartment 1a, with national stopbanks along the Pūkorokoro and Miranda Streams benefiting local land owners. Due to ownership confusion and maintenance responsibility over the last few decades driving from the project area changing district councils, the effectiveness of these flood and drainage infrastructures has reduced, however TDD is now regularly maintained by HDC due to a formal drainage district being established (Franklin District Council, 2007; Golder Associates, 2014; Growden et al., 2021).

The floodgates in the Pūkorokoro Miranda area are made from either a simple timber or metal structure depending on ownership, where the rising tide level forces the flapgate to close due to pressure, stopping saltwater from passing underneath ECR road and through to the channel network (Franklin District Council, 2007). Although the overall performance of the floodgates in

the area does provide protection to benefiting farmland, some older not well maintained floodgates do not provide full protection as the culverts protrude further than the timber frame, allowing saltwater to pass upstream during high tide, inundating low lying rural land and reducing soil quality (Golder Associates, 2014).

During site visits to the TDD in 2013, farmers indicated to Golder Associates,(2014) that two to three times a year, approximately 50ha of productive farmland is inundated by freshwater flooding or ponding. It is understood by the community that this is due to the in-effectiveness of the floodgates and the high tide not allowing water to be discharged. However since then, the formal drainage dristrict has been established and regular maintenance of flood gates along ECR owned by HDC has occurred, althought some flooding still remain.

Continual inundation from both freshwater and saltwater has presented an uneconomical risk for farmers near the Miranda/ Pūkorokoro streams, where the overall productivity of pasture land has reduced. Nearby farmers indicate that the cost of buying and spreading fertilizer or regressing these continually inundated areas is not feasible anymore (Golder Associates, 2014).

Figure 13 Photos of a floodgate and culvert underneath ERC and a channel through rural land on an outgoing tide. Note you can see the misalignment of the metal floodgate with the culvert size allowing saltwater to pass through (Mills W, 2021b).

A build-up of mangroves and sediment deposition in the lower reaches of the Miranda Stream has increased local bed elevations, post construction of the Miranda Stream stopbanks (Franklin District Council, 2007). Field observations from Franklin District Council (2007) estimate that the Miranda Stream bed elevation is near the same elevation or potentially higher than the surrounding farmland (Franklin District Council, 2007).

This results in a higher likelihood of stopbank overtopping, as the designed level of service has reduced and no stopbank review has been completed since construction (Franklin District Council, 2007; Golder Associates, 2014; Growden et al., 2021).

Consequently, a historical storm surge event corresponding with high flows in the Miranda Stream overtopped the Miranda Stream stopbanks and ECR, inundating farmland for several days following the event. The deposition of silt and debris from the Miranda Stream and saltwater inundation generated pasture dieback and loss of productivity. Unfortunately, it is unknown what flood event in the flood registry these impacts are associated with (Golder Associates, 2014). Recently, there have been many smaller stream mouths in the sub-compartment that have been dredged by private landowners with guidance from WRC. Where HDC have culverts that run underneath ECR, the council keeps the downstream end of the drains open (Growden et al., 2021).

Figure 14 Existing flood control gates and Pūkorokoro Stream upstream of the gates. Photos were taken on an incoming tide. Note mangroves in the Miranda Stream (top left photo) (Franklin District Council, 2007, p.6).

4.13.2 Kaiaua township

As indicated throughout, the low-lying nature of the Kaiaua township makes it highly vulnerable to flooding. The flooding mechanisms within Kaiaua can be categorised by flooding in the northern and southern extents of the township, each the result from unique ground elevations. These create reoccurring flooding problems and flood hotspots during heavy rainfall and coastal inundation events. During such events, the Hauarahi Stream begins to break its banks in two key locations at a flood level of around 2.1m (TVD-52) (Chambers J, 2020).

Flooding in northern Kaiaua is the result of the stream overtopping its banks upstream of the Kaiaua Domain on its true left bank, with consequent overland flow occurring along Puriri and Pohutukawa Ave. Further overtopping may occur downstream, flooding low-lying properties. Recent modelling by Chambers J (2020) indicates that properties in northern Kaiaua tend to

flood approximately 30 minutes before properties in southern Kaiaua. This observation should be verified based on observations from recent river flood events. Overland flows then begin to pond behind the ECR and Pohutukawa Ave intersection before spilling into historic river channels to the north. During extreme rainfall events, or in events with saturated antecedent conditions, overtopping of ECR may occur, causing floodwaters to spill over onto the beach. This process reflects the natural ground elevations and flood profile in northern Kaiaua, as shown in a properties cross-section in Figure 15.

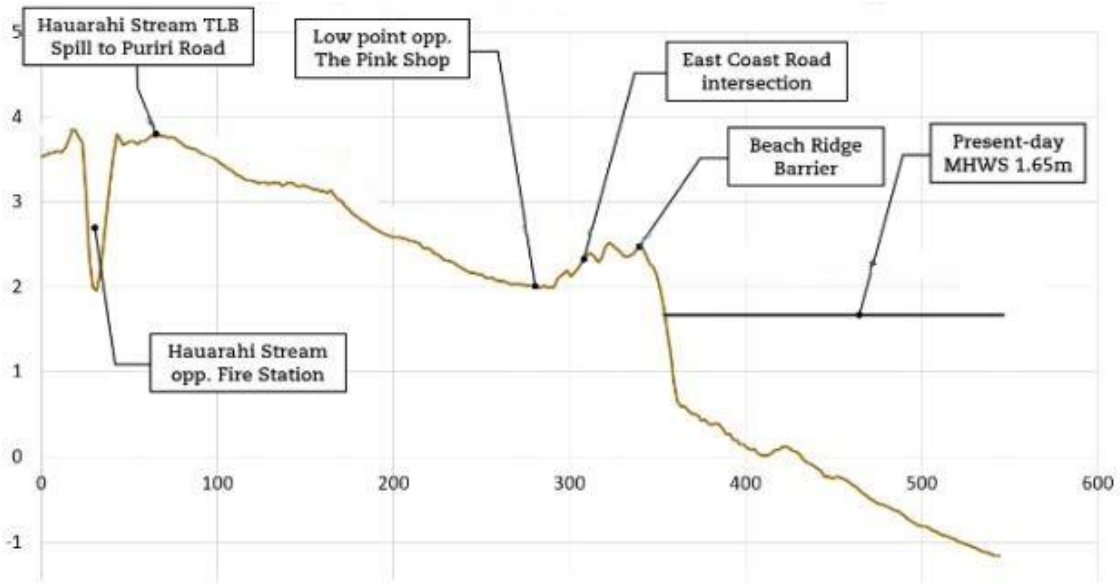

Figure 15 Northern Kaiaua ground elevation cross-section indicating key locations of flooding from overflows from the Hauarahi Stream (Chambers J, 2020, pp.10).

Flooding in southern Kaiaua is the result of the stream overtopping its true right bank to the west of Puriri Ave, travelling down the natural depression of Lipscombe Road, where local ponding can occur to a depth of 0.5m during heavy rainfall events (Harrison Grierson, 1997). Overland flows then travel opposite the community hall and down Kowhai Ave where it is discharged into rural land south of Kowahi Ave approximately 800m from the Hauarahi Stream (Chambers J, 2020). Community observations indicate this commonly reoccurs every 5 years and during severe rainfall events (Harrison and Grierson, 1997b).

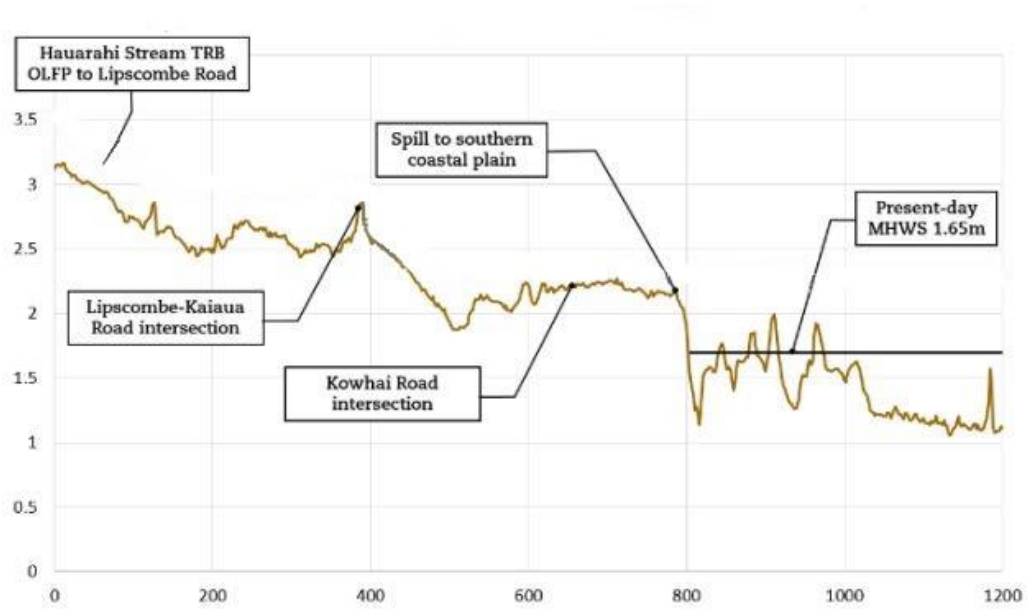

Figure 16 Southern Kaiaua ground elevation cross-section indicating key locations of flooding from overflows from the Hauarahi Stream (Chambers J, 2020, pp.10).

The ECR acts as a barrier that accumulates excess floodwaters on the landward side of the road. This process of runoff accumulation behind ECR road is a common occurrence, as the continual maintenance and build-up of the road to stay above flood levels have resulted in an unintentional localised heightened flood risk for properties along ECR.

Once waters have accumulated behind ECR, it is either transported out to sea via the stormwater network (if they are not backlogged) or over the beachfront (Chambers J, 2020; McLeod & Thompson, 2011; Mills T, 1998; Franklin District Council, 1998; Bosselmann M, 1996).

The accumulation of water within the stormwater system has been witnessed travelling back up tributaries and open drains that lead back into the Hauarahi Stream when discharge into the Firth of Thames is unavailable. Consequently, this also exacerbates flooding of low-lying properties behind ECR (Harrison and Grierson, 1997b; Mills T, 1998).

Current routine river maintenance work has been completed in the lower reaches of the Hauarahi Stream which commenced in 2020, led by HDC where WRC provided technical support. Figure 17 displays the works that have been undertaken to improve river stability and flow performance for small (annual) events, nevertheless these works will not provide flood protection for the much larger flow events such as a 1% AEP. This work was considered important and followed from March 2017 event where mangrove encroachment into the Hauarahi Stream channel by County Bridge was identified as a contributing factor to flooding in the Kaiaua township (Munro A, 2021). HDC has also dredged stream mouths immediately south of Kaiaua township (Growden et al., 2021).

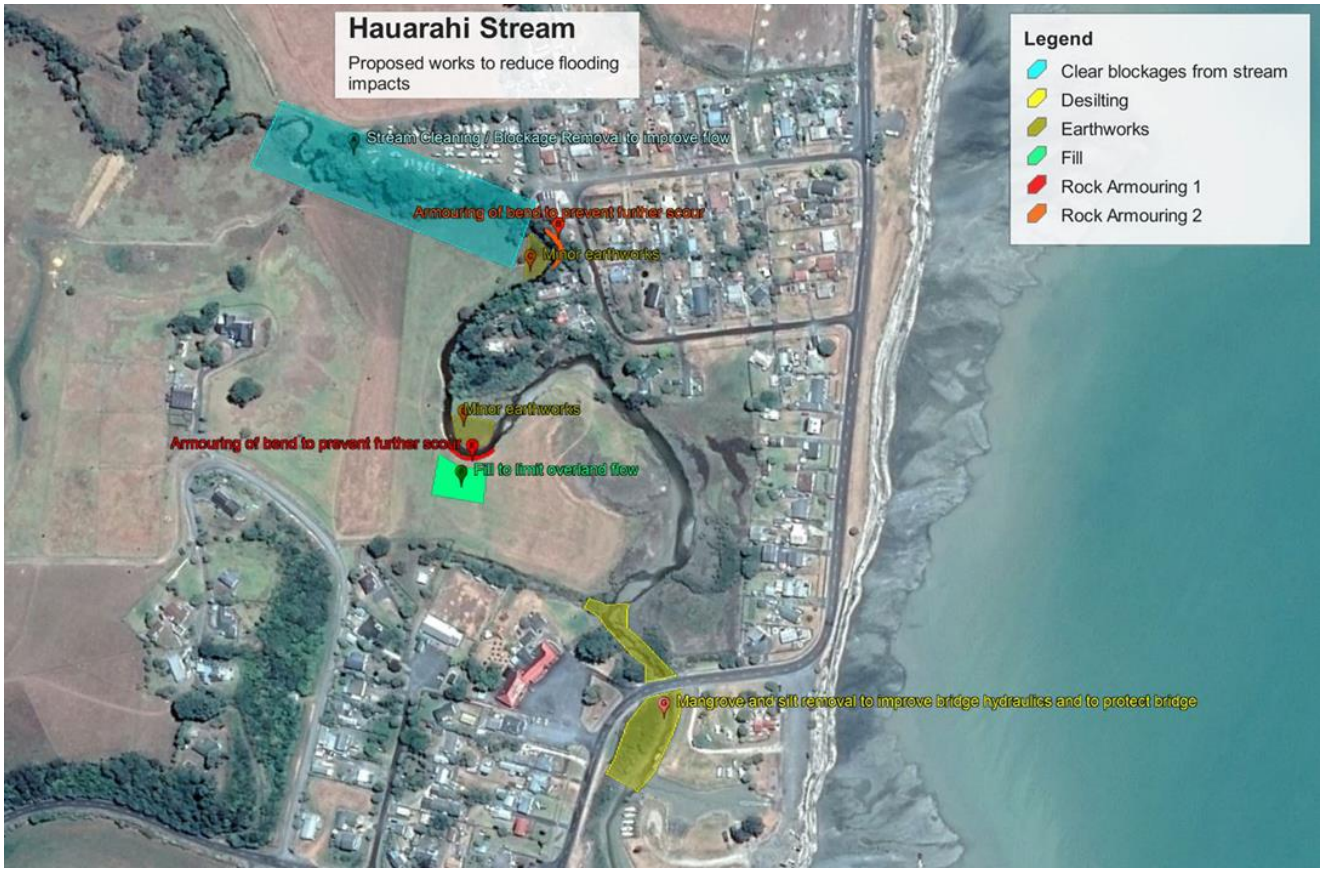

Figure 17 Proposed works on the lower Hauarahi Stream to reduce flooding impacts presented in Kaiaua in 2019 (Munro A, 2021; Hauraki District Council, 2019).

The works on the Hauarahi Stream have been completed in three stages, with stages 1 and 2 completed as allowed under permitted activities limitations. It is understood that these works will benefit both the northern and southern Kaiaua flooding problems. This approach has been adopted based on:

- The works are minor, and it, therefore, does not require consenting, however, fish spawning season in the stream did reduce the months in which in stream works can be completed.
- Providing the community with some reassurance that both councils are willing to act (Munro A, 2021).

4.13.3 Waharau (sub-compartment 5a)

The Waharau Stream has a long history of erosion, both before and after the installation of the Waharau bridge in the 1960s. Before its construction, the Waharau Stream was straightened to minimise the risk of erosion to the Waharau bridge abutments (Auckland Regional Council, 1998). However, the stream continued to meander away from its new path.

This increased erosion resulted in further stream incision with the end consequence being heightened sediment deposition at the mouth of the stream (Auckland Regional Council, 1998). Members of the community then began dredging the mouth of the stream before and after heavy rainfall events, in good faith and within permitted activity levels, in an attempt to reduce the risk of flooding to properties that border the stream.

However, over-dredging resulted in the elevation of the stream mouth becoming too incised, which accelerated erosion of the stream bed and banks further upstream. An investigation by

Auckland Regional Council (1999) concluded this was likely due to the base flow of the stream becoming too low, which consequently increased the velocity in the stream (Auckland Regional Council, 1999).

Anecdotal evidence suggests that HDC has undertaken stream-mouth clearing in the past, however, there is no formal agreement or budget currently in place for this work. This typically occurs before heavy rainfall events, where HDC also dredge and open smaller stream mouths to the north of the Whakatīwai village (excluding the Whakataiwai stream) up to the Waharau Stream, particularly around the Quarry. The streams that have been dredged in the past include the Waharau, Waihihi, Waihopuhopu, Waiwhenua and Puwhenua (Growden et al., 2021).

5 Hauarahi Stream Modelling

The Hauarahi Stream is the only stream in the project area where detailed hydraulic modelling has been completed. Two river flood models have been developed for the Hauarahi Stream. Firstly, a simple 1D hydraulic model was developed by Harrison Grierson to assess flood management options (1997), then more recently a rapid flood hazard assessment was undertaken by Grant D et al., (2020) using DHI software to understand the likely impacts of extreme rainfall and climate change in the present day and at the end of the 21st century. The WRC model was then built upon by Chambers J (2020) to understand the potential impacts of climate change on the community throughout the coming century in terms of Representative Concentration Pathways (RCP) 6.0 and 8.5.

For this report, a brief explanation of the modelling and any actions taken from these models are provided. If you would like to read these reports in further detail, their reference details are provided in the reference list below.

5.1 1997 Kaiaua Township Flood Protection

Following the combined coastal inundation and river flooding event on July 14, 1995, the Kaiaua residents asked FDC once again to investigate a flood protection scheme for the Kaiaua township (Harrison and Grierson, 1997b; Mills T, 1998). In December 1996, FDC accepted a proposal from Harrison Grierson Consultants Limited (HG) to carry out a flood protection study for the Kaiaua township, which was completed in March 1997 and presented to the community in April 1997 (Franklin District Council, 1997; Harrison and Grierson, 1997b).

The scope of the flood protection works was to investigate the overbank flooding from the Hauarahi Stream and to explore flood protection options for Kaiaua township. The scope did not extend to include any coastal inundation or protection options from the Firth of Thames, although consideration was given to the drains, culverts and other watercourses in the flood modelling where backflow is possible (Harrison and Grierson, 1997b).

Due to the Hauarahi Stream and its catchment being ungauged, data from the nearby northern Orere catchment was assumed to be appropriate for the hydraulic model, due to their catchment run-off coefficients and soils being relatively similar. Other data such as rainfall was obtained from HIRDS. The original hydraulic modelling results presented by HG is provided in Appendix 4, which shows the approximate flood extent for a 1% AEP river flood event in the Hauarahi Stream (Franklin District Council, 1997a; Harrison and Grierson, 1997b).

The results of this hydraulic model shadow what has been outlined in Section 4.12.2 above, highlighting the distinctive hydraulic flooding issues that face both northern and southern

Kaiaua. As a result, HG provided flood protection recommendations for both northern and southern Kaiaua separately, as it became clear that one solution would not provide the level of service and protection that the community sought (Harrison and Grierson, 1997b).

Seven flood management options were presented to the community for northern Kaiaua and four for southern Kaiaua, to mitigate the risk of flooding residential properties and dwellings. The options were reviewed by the Kaiaua Resident Rate Payers (KRRP) association, where a decision on which options were to be selected occurred in October 1997. An overview of each management option is provided in Appendix 4 (Harrison and Grierson, 1997b; Leahy A, 1997).

The research, hydraulic modelling and consultation process of this project occurred over a time frame of roughly 3 years, with a very detailed community focused approach. Figure 18 below provides a timeline of the process when key milestones and meetings occurred.

Unfortunately, due to a large proportion of the wider community opposing the flood schemes and management options decided upon by FDC and KRRP, FDC did not see that the development of the Kaiaua Township Flood Protection Scheme was a feasible option for the council to proceed with.

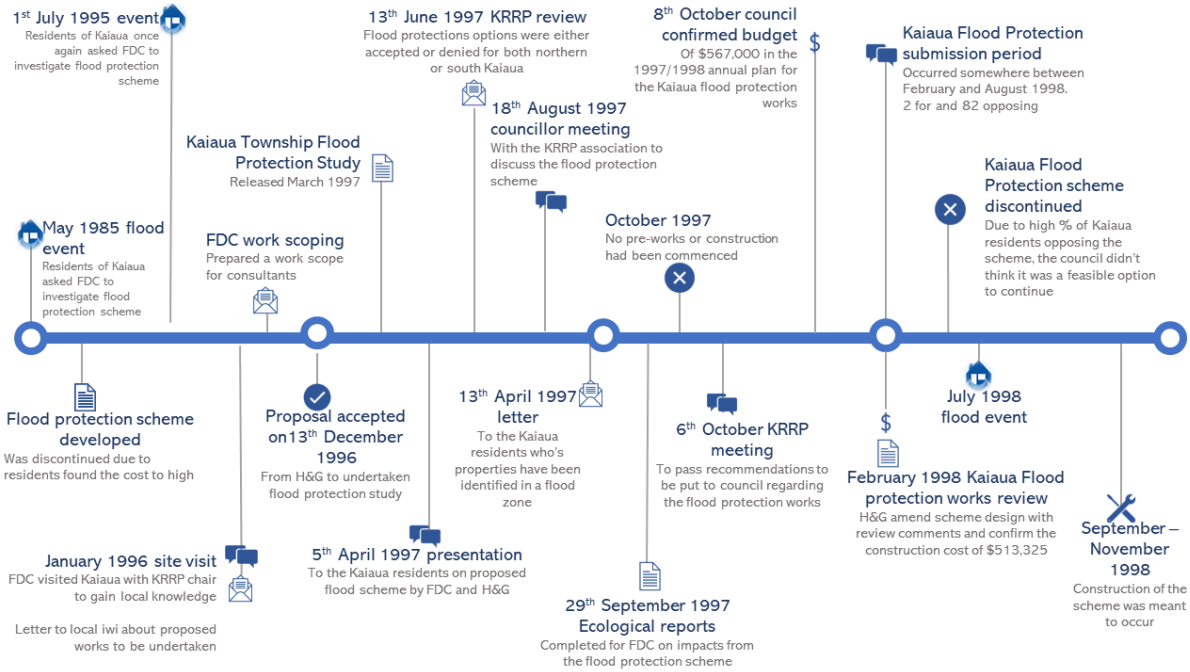

Figure 18 The 1997 Kaiaua Township Flood Protection study timeframe from 1995 – 1998 (Plumpton C, 1997; Mills T, 1997a; Mills T, 1997b; Mills T, 1997c; Franklin District Council, 1997a; Franklin District Council, 1997b).

5.2 Rapid flood hazard assessment of the Hauarahi Stream, Kaiaua

The draft Rapid Flood Hazard Assessment completed by Grant et al., (2020) presents results from a hydraulic model of the Hauarahi Stream, to enable the Wharekawa Coast 2120 TAG and Community Panel to gain a better understanding of the flooding risk from the Hauarahi Stream. This report investigates the flood risk posed to the Kaiaua township for different magnitude events, which also considers the effects of climate change.

Results from this modelling show that the Kaiaua township begins to have minor flooding during a 1-in-2-year ARP (50% AEP) river flooding event. With an increasing magnitude of the event (and the frequency decreasing) the flooding hazard and impacts progressively increase for both the residential township and rural farmland. Modelling also suggests that the increased rainfall because of climate change does not have a large increase in the severity of flooding (Grant et al., 2020).
However, 1 metre of sea level rise results in much of the township being inundated by coastal inundation and thus an increase in the flooding hazard. Although this report focuses on the impacts of river flooding alone, it highlights the importance to consider these hazards simultaneously when investigating the flood hazard and management options along low lying coastal environments (Grant et al., 2020).

The presence of assets and infrastructure located along the Hauarahi Stream does have an impact on the overall flooding mechanisms in the lower reaches of the Hauarahi stream. For example, the County bridge is a constriction location, where the flood risk is increased because the height and width of the bridge is not sufficient to accommodate the larger flood events. Although these have not been considered in this model, it is important to understand the impact of these assets.

Follow the development of this model, updated LiDAR information has become available which does include the recent earthworks that were completed on the lower parts of the Hauarahi Stream. This model therefore needs to be updated to account for these new pieces of data and the results shall indicate whether the recent works have indeed improved the flooding risk for Kaiaua like they intended. The inclusion of the bridge and other assets is likely to be taken into consideration during this update. WRC is currently leading a team to update the existing flood model to better understand the system considering the above and figure out what further work may need to be done.

5.3 Climate-Driven impacts on fluvial inundation hazards in coastal Kaiaua

Chambers J, (2020) completed an assessment on the multi-decadal climate driven impacts on fluvial flooding risk for the Kaiaua community, investigating frequent and extreme rainfall events under two likely climate change scenarios between 2020 and 2120. This reports on the risk posed to the town from river flooding with respect to sea-level rise and indicates timeframes where coastal inundation will exacerbate the current risk associated with river flooding.

Results from this report identify the northern and southern flooding dynamics, along with an insight into the increase in dwellings being flooded above their habitable floor level. For example, under the 2120 moderate RCP 6.0 scenario for coastal inundation, the majority of the dwellings in the town are flooded above their habitable floor level. Depending on the future climate pathway, the results indicate that the depth of flooding experienced by many existing dwellings during a 50% AEP rainfall event in 100 years' time may exceed the depth of flooding experienced during a 1% AEP rainfall event in the present day. This outcome is largely dictated by the influence of raised sea-levels on drainage capacity across the coastal plain (Chambers J, 2020).

Chambers J (2020) report outlines that from 2050 onwards, sea-level rise will be a significant contributing factor towards the present-day flooding risk hazard at greater frequencies (lower magnitudes), where the coastal inundation risk will supersede the river flooding risk. This report

also highlights the importance of considering the risk from coastal inundation in the future, if any flood management options are going to be considered once again for the Hauarahi Stream.

6 Identification of priority work areas that may require further river flood investigation

The findings from this report provide a basis for identifying priority work areas where further flood hazard investigation would be required to provide a more holistic overview of the flooding risk along the Wharekawa Coast. The objective of identifying these flood priority areas is to highlight key streams or communities where the impacts documented in this report are potentially deemed to be too intolerable, and further flood modelling and risk identification may be required. This will enable the Wharekawa Coast 2120 Project TAG and community panel to make the best-informed decision (with the information they hold) when determining adaptation pathways for each compartment.

A priority ranking ID has been assigned to each task, which has been determined using a prioritisation matrix. This matrix table and ID key are provided in Appendix 5. This section has been further reviewed by the Project TAG to provide a comprehensive review of the most appropriate priority ranking ID.

6.1 Identification of priority areas

Table 7 Identification of priority areas where further river flooding investigation is required.

Priority area	Works ID	Work recommendation	Justification	Priority ranking ID
Kaiaua township	1a	Update of Chambers J (2020) and Grant et al., (2020) hydraulic models to include new model inputs.	These two models were completed before the recent routine river maintenance works in the lower reaches of the stream. Furthermore, localised earthworks have taken place on private property within the floodplain near the Hauarahi Stream. Therefore, these models no longer reflect the current state of the lower catchment. Although the flooding risk in Kaiaua is relatively well known from these models, updating them to align with new ground elevations will highlight the positive or negative effects this maintenance work will have on the Kaiaua township flood risk. The process of updating these models is currently underway by WRC obtaining new LiDAR data and considering installing a river flow gauge. HDC is also investigating the potential of developing river cross-sections to better understand the in-channel flooding mechanisms.	HH
	1b	Review of stream bed Elevation and mangrov removal	A study into the current streambed elevations of the Hauarahi Stream would be favourable, particularly understanding the	LL

Priority area	Works ID	Work recommendation	Justification	Priority ranking ID
			positive/negative impacts that the removal of mangroves from the lower section of the stream has had on sedimentation and channel capacity.	
Whakatīwai community	2a	Development of a Rapid Flood Hazard Assessment for the Whakatīwai Stream.	The development of a rapid flood hazard assessment will provide a better understanding of when out of bed flooding may occur, where overland flowpaths may travel, what frequency event will cause the stopbank to overtop and identifying any properties or buildings that may be exposed to river flooding.	MH
	2b	Review of the Whakatīwai stopbanks	A detailed review of the current state of the stopbanks and their performance is also required. As mentioned above, the risk from the stream was considerably reduced post the construction of the stopbanks, however little maintenance other than following the 2011 event has occurred. HDC reporting suggests that the current stopbanks may be in a weakened condition that could raise the potential for a stopbank breach to occur during future high flow events in the stream. Investigation into the impacts that may occur due to stopbank failure is also recommended both with the current condition of the stopbanks and if future works were going to be completed. This review could be coupled with the above recommended Rapid flood hazard assessment to understand where velocity or stress hotspots may be acting on the embankments.	HH
	2c	Whakatīwai Streams impact on critical lifelines	An investigation into different flood frequencies and flood velocities that may impact the bridge abutments is also important, as this community and other north are vulnerable to becoming isolated by road. It is important to understand at what frequencies the bridge may become closed or damaged, as other critical lifelines such as electricity and internet travel along ECR, where bridges are known as hotspots when cables may run underneath the bridge, thus may become damaged during high flow events.	MM
Waharau community	3a	Waharau Stream impacts on critical lifelines	The reasoning for this is the same as what has been identified above for the Whakatīwai community. This is particularly important for this community as they are highly vulnerable to	MM

Priority area	Works ID	Work recommendation	Justification	Priority ranking ID
			becoming isolated, which was highlighted in April 2017.	
	3b	Waharau Stream erosion study	Further understanding surrounding erosion hotspots along the stream and different mitigation options that may be implemented to reduce erosion and build up the stream strength integrity.	LL
Pūkorokoro Miranda Streams	4a	Review of the Pūkorokoro and Miranda Stream stopbanks	A detailed review of the current state of the stopbanks and their performance is also required. There is little information available regarding the performance of these stopbanks since development, however, it can be assumed that they have reduced the localised flooding risk. The current conditions of the stopbanks may be weakened, which may result in heightened residual risk in the future if they were to fail.	LM
	4b	Review of Coastal floodgates along ECR	As identified above in section 4.12.1, the functionality of floodgates that protect farmland from coastal inundation does work, however to a reduced capacity due to infrequent maintenance. It would benefit the Pūkorokoro Miranda rural community, as well as local tourism to review the effectiveness of all floodgates in the area in terms of both coastal and freshwater flooding.	ML
	4c	Review of stream bed elevation and mangrove removal	A study into the current streambed elevations of the Pūkorokoro and Miranda Streams would be favourable, particularly understanding the positive/negative impact that removing the mangroves from the lower section of the streams had on stream sedimentation. This would benefit farmers who farm surrounding the streams to understand the risk of flooding their property on their property.	LL

7 River Management Work Programme

The purpose of this section is to provide short term stream and drainage maintenance and management options that can be completed to reduce the immediate flooding risk across the different compartments. These options have been selected as they can be completed relatively quickly, at a low cost and may help to reduce the immediate risk posed by the streams in the project area.

These solutions are not long-term flooding mitigation options and are not intended to reduce the risk completely. The River Management Work Programme was developed with the intention

to guide future funding options to inform both councils Long Term Plans for 2024-2034, and planning is currently underway.

All streams and water outlets in the project area that drain into the Firth of Thames have been reviewed based on the below criteria, followed by field inspected to determine feasible options.

- Poses a risk to property, infrastructure, community services or the Marae.
- Potential restriction points in the stream – i.e. build-up of sediment/restriction of channel from mangroves or bridges
- Outflow into the Firth of Thames
- The stream flows through low lying properties.

A priority rating has also been assigned to each stream/water outlet where options have been recommended. A classification for a high priority stream meets all the criteria mentioned above, a medium includes properties that are situated further away from the stream but may still be impacted and a low priority stream is one that could overtop, but there is no property/infrastructure nearby, or the stream drains a smaller catchment. These were then sense and field checked and adjusted accordingly.

A range of maintenance and management options have been outlined under six key areas of river management. These areas include:

- Upper catchment stability control through planting, erosion control and pest control
- General river management works including regularly clearing of blockages in streams and culverts, works to maintain channel stability and capacity
- Stream mouth clearance/opening
- Technical Advice to landowners and management techniques
- Assessment of integrity, functionality and stability of existing assets
- Investigation of improvement plans.

The fundamental option that is relevant across all streams and water outlets includes either stream mouth dredging, or culvert clearing/opening, to allow for easy discharge during high flow events. Where land owner responsibility is an option, this is due to flooding being isolated on one rural property.

Streams and culverts identified in the River Management Work Programme are outlined below in Figure 19, where Appendix 7 outlines the complete River Management Work Programme.

Figure 19 Streams and drains included in the River Management Work Programme by compartments.

8 Conclusions

This report clearly identifies the risk to the Wharekawa Coast community from river flooding and outlines the extensive number of historical river flooding events the Wharekawa community have been exposed to. The Wharekawa communities have been open and clear with the councils about their past experiences of river flooding and the risk these events pose to their daily lives. It is hoped that this report was able to capture the most important aspects of river flooding risk for the community, while identifying what councils and the community can do moving forward to improve resilience to river flooding, particularly with the increasing risks from climate change.

It is acknowledged this report will not provide an up-to-date complete picture because of future river flooding events which will occur after publication. However, by working closely with the community in the development of this report an accurate representation of their vulnerabilities to and risks from river flooding is represented. This report provides a River Management Work Programme to address these risks and vulnerabilities in the short term and provides information

and guidance for the development of long-term river flooding options for the Wharekawa Coast community.
The historical impact information shows that all streams in the project area have a long history of river flooding, particularly the Hauarahi and Whakatīwai Streams. The past Kaiaua flood protection studies and recent maintenance work on the Hauarahi Stream illustrate the continual risk this stream poses to the Kaiaua community, particularly during combined coastal inundation and riverine flooding events, where a large proportion of the township's properties have documented impacts from one or multiple events. The construction of the Whakatīwai Stream stopbanks had a positive effect on the community by immediately reducing the flooding risk to the village. However, information on the impacts experienced by the community during the 1960s events highlights the importance of maintaining flood mitigation structures in the project area, as the information provides an understanding of the severity of such impacts prior to the construction of the stopbanks.

The River Management Work Programme is a critical piece of work the community panel's River Flood Focus Group have developed and put forward to the councils, which identifies what can be done in the short term to reduce the risk of river flooding. This work programme has currently been presented to all councils for consideration, and further conversations and discussions will be required for potential inclusion in the councils' next Long-Term Plans. While these discussions are still underway at the time of publication, the implementation of these works will enhance the resilience of these communities to river flooding and provide the instruments to address river flooding issues in the future.

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10 Appendices

Appendix 1 – Limitations and assumptions

Limitations and assumptions have been used throughout this report where modelling has been completed to assess the coastal inundation and river flooding risk in the project area. Limitations and assumptions outlined in the relevant reports have been considered where these reports are referenced. These reports include:

- Coastal Processes and Hazards (coastal inundation, coastal erosion, and tsunami) by Hume T (2020)
- Rapid Flood Hazard Assessment of Hauarahi Stream by Grant et al., (2020)
- Climate Driven Impacts on Fluvial Inundation Hazards in coastal Kaiaua by Chambers J, (2020)
- Natural Hazard Risk Assessment by Marsh et al., (2020) and;
- Kaiaua Flood Protection study by Harrison and Grierson, (1997b).

Appendix 2 –Land Drainage Assets

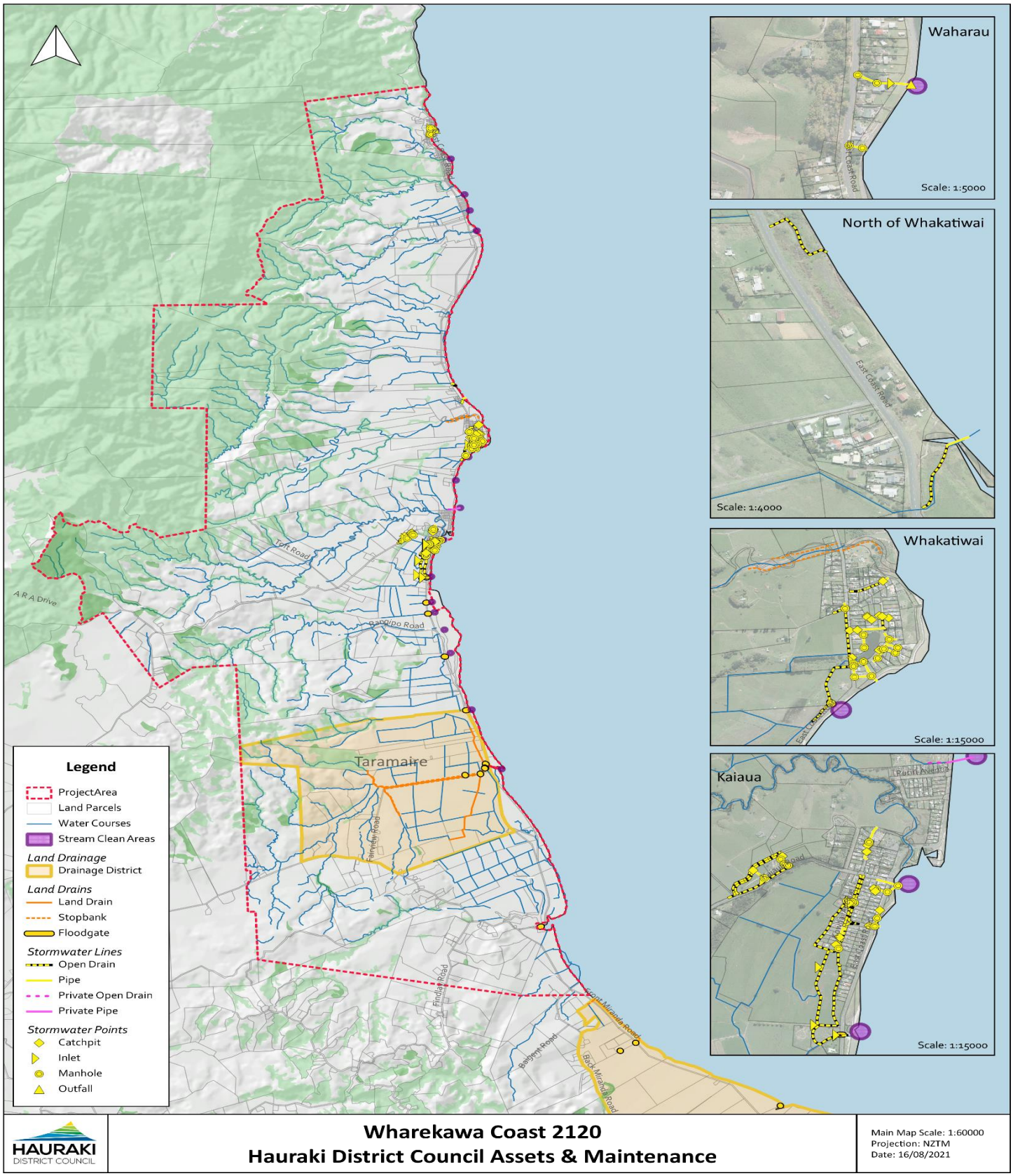


Figure 20 Hauraki District Council Assets in the Wharekawa Coast 2021 project area (Hauraki District Council, 2021).

Appendix 3 – Hydrological catchment setting and hazard drivers

Catchment and stream historical photographs

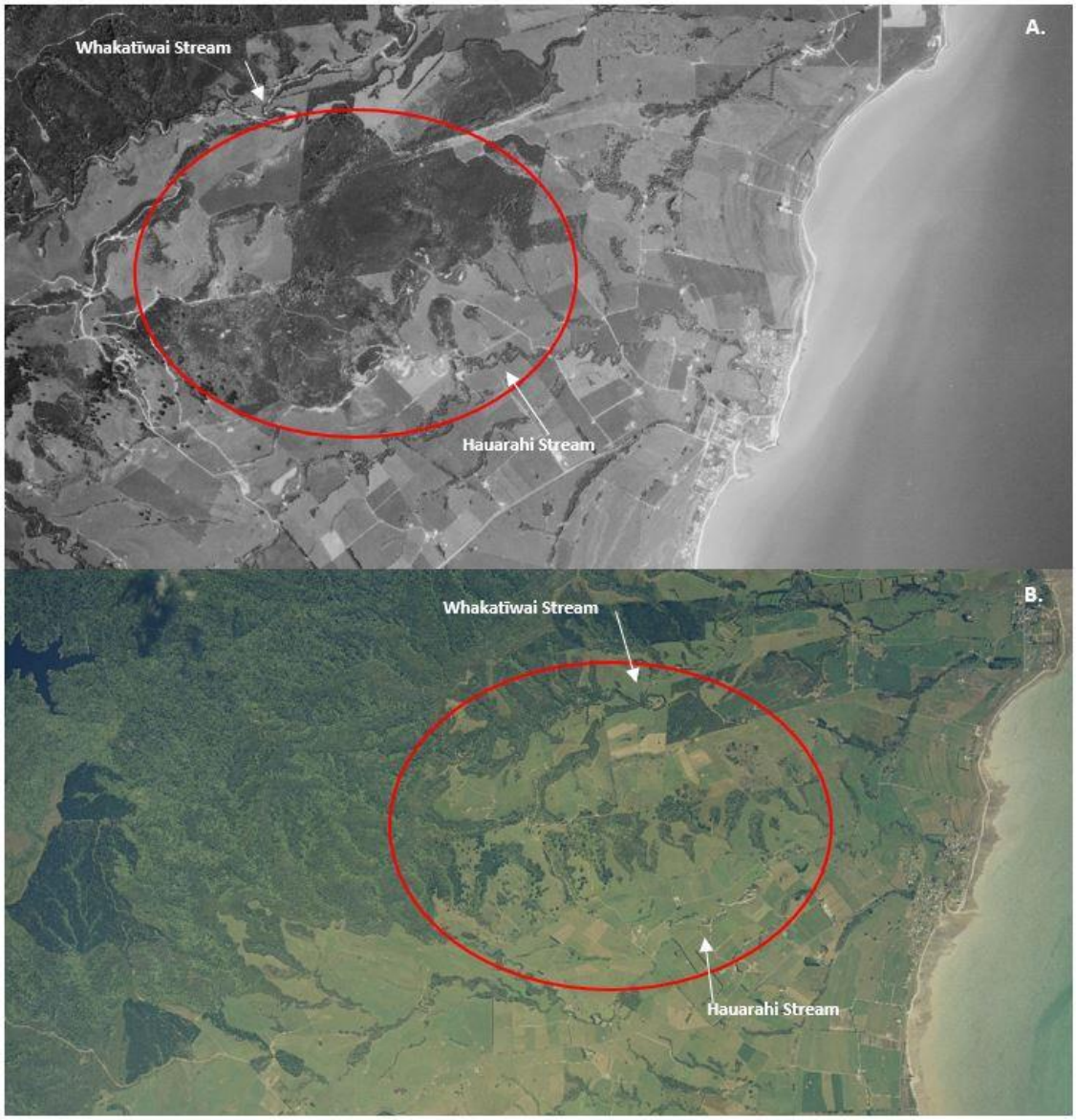


Figure 21 **Land use change in the upper Hauarahi and Whakatīwai Streams between 1977 (image A) and 2004 (image B) (RetroLens, 2018).**

Figure 22 **Migration of the Hauarahi Stream channel through Kaiaua township from the 1940s to 2004. A. 1944, B. 1960. C. 1988. D. 2004 (RetroLens, 2018).**

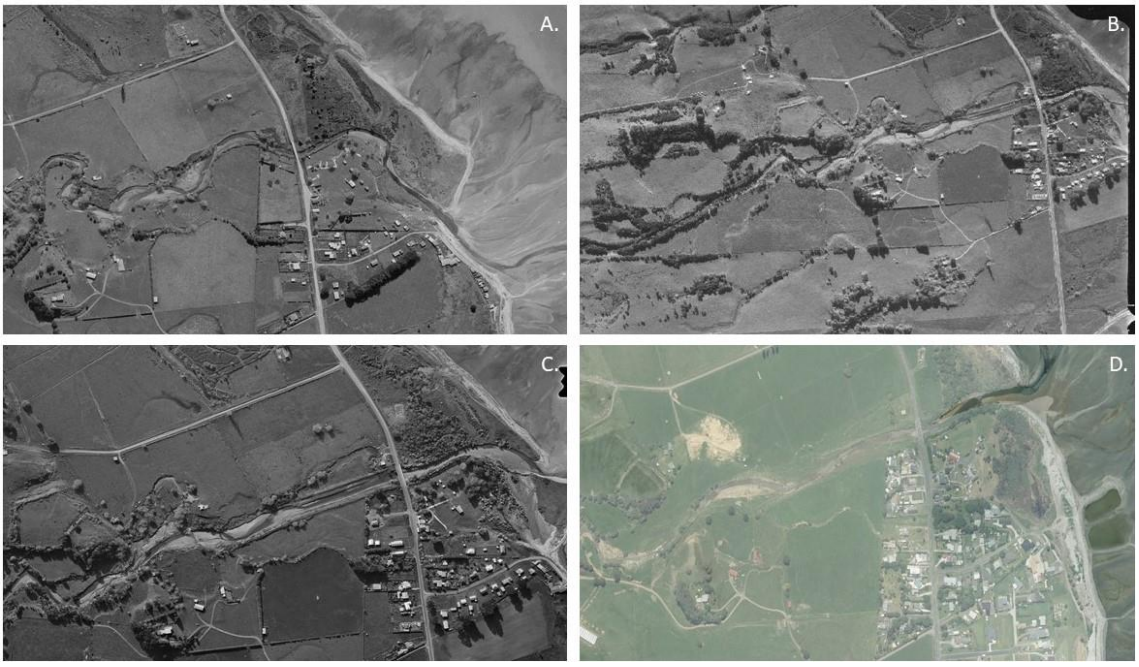


Figure 23 **Whakatīwai Stream evolution from the 1960s to present day. A. 1960. B. 1969. C. 1974. D. 2017 (RetroLens, 2018).**

The straightening of the stream and development of the Whakatīwai stopbanks can be seen in image B, 2 years following the major 1966 and 1967 flooding events. The Whakatīwai spit and beach foreshore is slowly receding overtime to the present day straight stream mouth.

Land use type and soil impacts on flooding

As mentioned above in section 3.1 each catchment has a variety of different land use types and vegetation cover, where less dense vegetation such as grassed farmland allow for easier runoff of accumulated water, compared to the upper reaches of catchments where dense forested vegetation,

when alteration of land use such as urbanisation, deforestation and cultivation all increase flood frequency and severity.

Flood hazard drivers

Weather system processes:

Processes that contribute to localised rainfall occur on several temporal and spatial scales.

- Decadal oceanic/atmospheric processes that influence New Zealand's climate are:
    - El Niño Southern Oscillation, being a band of sea surface temperatures, which are abnormally warmer or colder that influences rainfall, temperature and wind patterns in the southern Pacific that occur every few years (2018b).
    - The interdecadal Pacific Oscillation (IPO) is a large-scale oscillation that influences climate over the Pacific Ocean over a long period. Being in a positive IPO condition increases the perception and mean sea level pressure in certain locations across the Pacific Ocean that fluctuate over a decade (NIWA, 2018d).
    - The Southern Annular Mode (SAM) is a ring of the variable climate surrounding the Southern Pole that extends up to latitudes surrounding New Zealand. During positive SAM conditions, New Zealand experiences higher than normal air pressure which tends to bring relatively lighter wind and storm conditions compared to conditions surrounding the Southern Pole. During Negative SAM conditions, the reverse occurs (NIWA, 2018e).
- Broad scale synoptic processes include: (Schwarz M, 2020).
    - Sub-tropical systems and weather fronts
    - Ex-tropical lows and weather fronts
    - Cold and warm fronts
- Local scale weather systems include: (Noble C, 2020).
    - Localised warming and cooling of the air due to ground and atmospheric conditions.
    - Localised wind conditions due to topography.

Catchment factors contributing to flooding:

When surface run-off occurs, it is a condition of many factors including:

- The amount, intensity and duration of rainfall which is dependent on the weather system.
- The topography
- Extensive vegetation cover in the upper catchment helps to absorb rainfall into the sub-surface. Low vegetation cover in the lower lying reaches of the catchment exacerbates the risk of run-off and erosion (Waikato Regional Council, 2021a).
- Land use of the catchment. Flooding is common in rural areas surrounding watercourses in the Waikato region as land has been cleared for farming production. Urban flooding is also common due to hard structures being in and around watercourses such a stormwater networks, bridges, and buildings.
- Soil characteristics
- Initial conditions of the catchment – this is connected to the above soil conditions of the catchment, being the amount of soil storage capacity of the catchment. For example, if a heavy rainfall event has occurred previously and the soils are still saturated, there is a higher risk of a surface run-off due to the catchment's storage capacity being high (Ministry for the Environment, 2017). Alternatively, if no event has occurred previously and the catchment is relatively dry there is a reduced risk of intense run-off, however still possible.

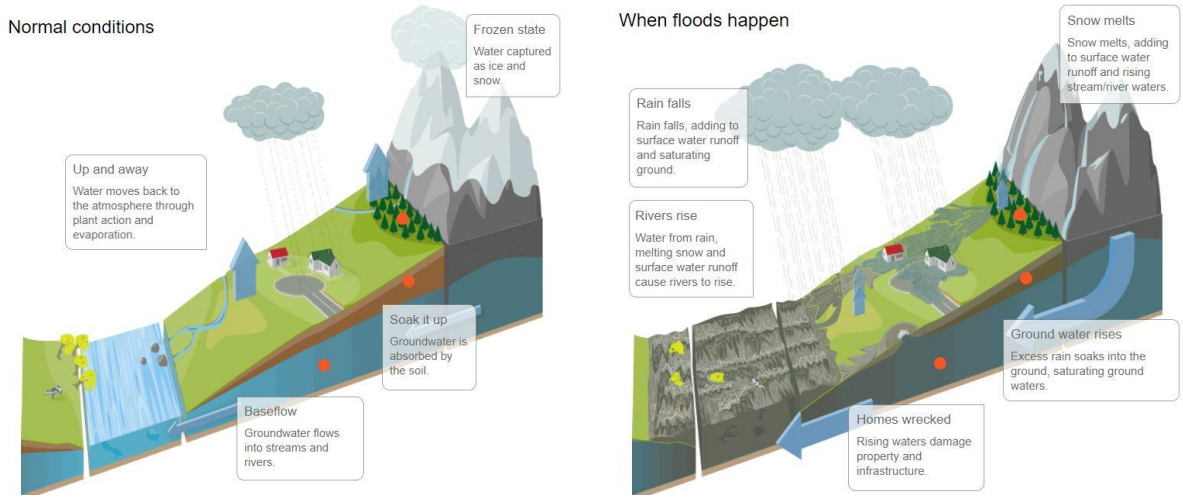


Figure 24 Schematic developed by NIWA to demonstrate the fundamentals of how river flooding occurs, (NIWA, 2018c).

Appendix 4 - Tasman Tempest Catchment impact map

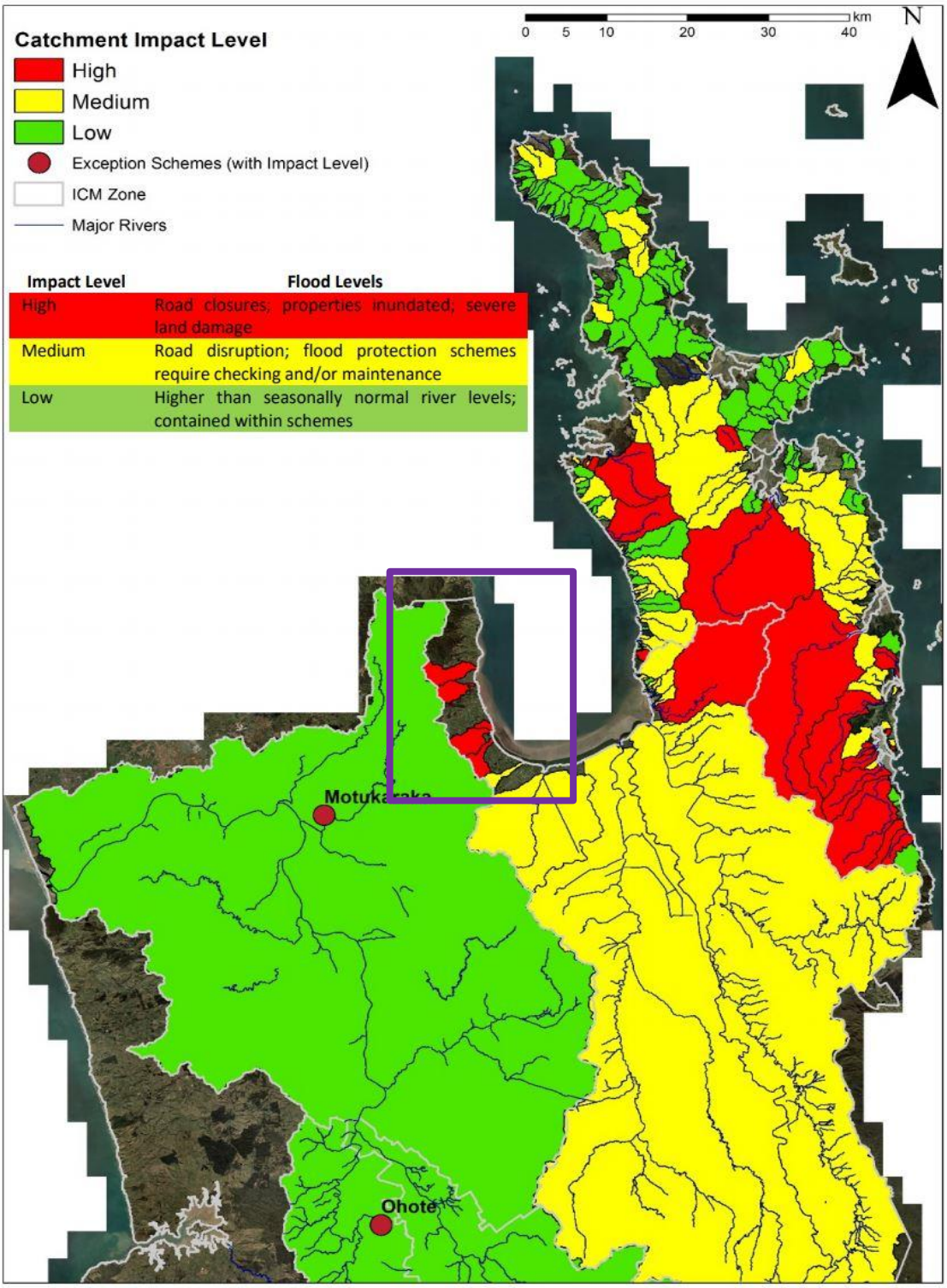


Figure 25 **Catchment impact levels from the March 2017 Tasman Tempest rainfall event (Craig H, 2017, p.17).**

Appendix 5 – Kaiaua township flood protection study

Hauarahi Stream 1% AEP flood model map for Kaiaua township

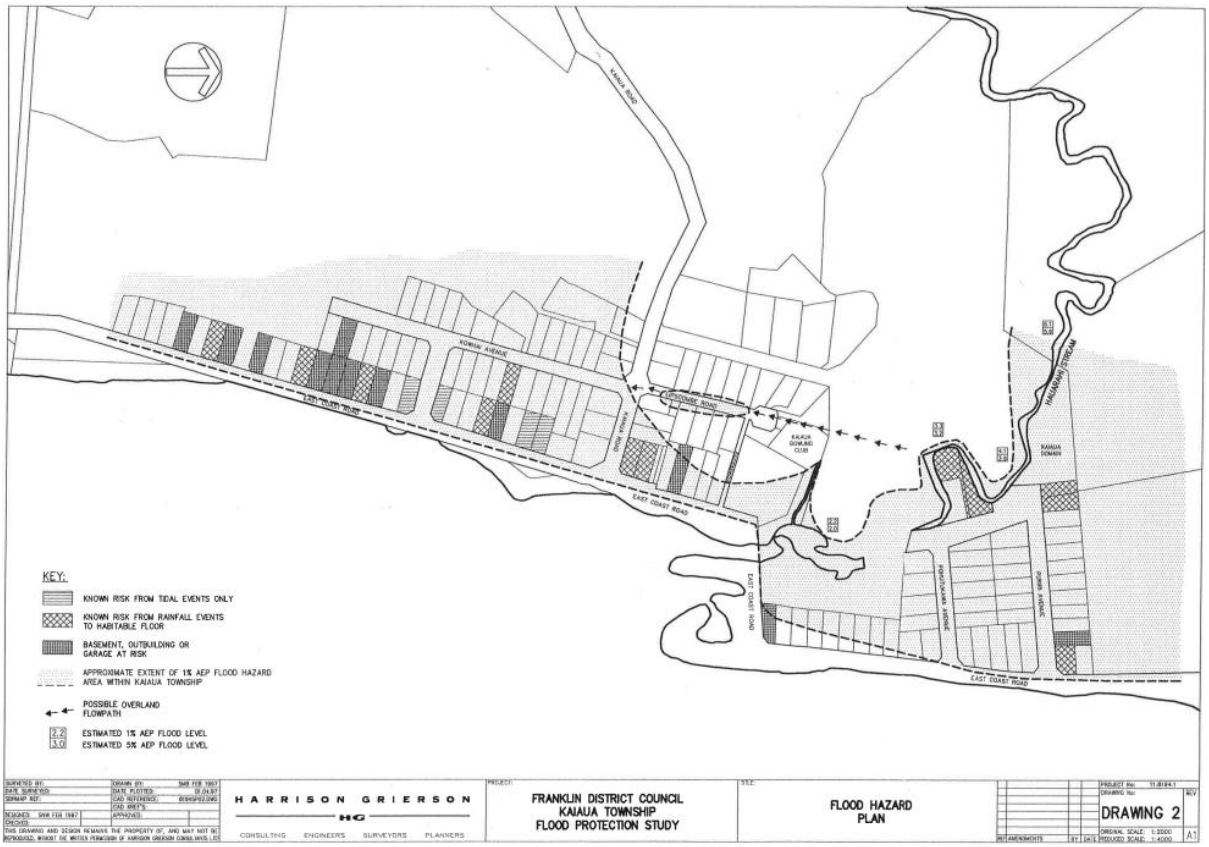


Figure 26 Original Flood Hazard Plan from the 1997 Harrison and Grierson Kaiaua Township Flood Protection study (Franklin District Council, 1997b, p.19).

Flood mitigation options presented for Kaiaua township.

Table 8 1997 Harrison Grierson flood management options for Kaiaua township (Harrison and Grierson, 1997a; Harrison and Grierson, 1997b)

	Management Option	Description	Advantage	Disadvantage	Cost of construction	Considered/ rejected
Northern Kaiaua	**Stopbanking of Hauarahi Stream**	Stopbanking would contain the peak flows of water and direct flow through the normal channel and would also contain some channel straightening during construction. This option would protect the township from flooding but would direct waters across the farmland north of the general store. This option would also increase the capacity of the channel from 20 m^3/s to 30 m^3/s.	High level of protection, visible community-based facility, reduced flows to southern Kaiaua, protections both dwellings and property	Costs, ($410,000) Does not protect from the tide, cost If damage in event of failure, construction difficulties	Northern stopbank - $406,3000 central Stopbank - $36,000 Sea shore stopbank - $26,650	✓
	Diversion of Hauarahi Stream Flood Flows	Diversion of flows before it reaches the township boundaries,	High level of protection, visible community-based	Does not protect from the tide, cost of damage in event of failure,	$300,000	✓

	Management Option	Description	Advantage	Disadvantage	Cost of construction	Considered/ rejected
		more protection would be gained. This option involves the diversion of the flood flows over the 20 – 30 m^3/s contained within the main channel. The option would also require Stopbanking along the northern bank in Kaiaua west of the Domain. The option also includes upgrading the culvert underneath ECR and raising the road.	facility, lower cost than stop banking, protections both dwelling and property, reduces flows through southern Kaiaua	construction difficulties, effect on adjacent farmland, reformation of each coast road, keeping outlet open and available in extreme events, resource consent		
	Detention Storage Basin in Upper Catchment	With Stopbanking of the stream increasing the stream capacity to $30m^3/s$, a detention basin with the storage capacity of 300 $000m^3$ would be required in the upper catchment to ensure that the channel banks are not overtopped.	A high level of protection protects both property and dwelling, reducing flows to southern Kaiaua	Does not protect from coastal, cost of damage in event of failure, construction on farmland not directly affected, no ideal site identified	$300,000	X
	House Raising	The raising of existing habitable flood levels above the expected flood level. Modelling suggests that 4 houses and one shop are known to have flood levels that are at risk of being flooded	Protects dwellings from the tide, targeted at those most affected, most economical in terms of capital cost	Does not protect property, individual protection not community facility, no direct benefit for southern Kaiaua	$130,000	X
	Purchase and removal of Flood Prone Buildings	Purchasing of flood prone properties and the removal of at-risk buildings. Modelling suggests that this option would include the removal of 6 flood prone buildings, which upon removal the vacant sections could be resold with requirements for appropriate construction of any new buildings.	completely reduces the risk by removing at risk building, allows for possible redevelopment in future	Distribution to owners, individual protection not community facility, high cost	$500,000	X
	Restrict Future Development	The continued implementation of building controls within the 1% AEP flood extent should ensure that no future developments are placed at flood risk.	Low cost, protects buildings from tide and the risk is manageable	Does not protect existing properties and may have a longer-term impact on community development	-	X
	Improve Hydraulic Efficiency of Main Channel	Any clearing of vegetation cover would have to be accompanied by an extensive lining of the channel banks to prevent further erosion. Radical reforming of the main channel would also be required with no certainty that the 1% AEP flows could be contained within the channel banks.	Improve Hauarahi Stream channel	Cannot pass design flows, practically channel erosion	-	X

	Management Option	Description	Advantage	Disadvantage	Cost of construction	Considered/ rejected
		For these reasons, this option was not investigated any further				
Southern Kaiaua	**Stopbanking of Flood Prone Properties**	Development of low stopbanks directly behind the properties on Kowhai Ave and ECR. A stopbank is also considered along the southern banks of the stream with the purpose to prevent the occurrence of overland flows down Lipscombe Ave.	High level of protection, visible community-based facility, protections both dwellings and property, allows filling of land behind stopbank in future	Costs, ($130,000) does not protect from the tide, cost If damage in event of failure, construction difficulties.	$130,000	✓
	House Raising	The raising of existing habitable flood levels above the expected flood level. Modelling suggests that 5 houses and the petrol station are known to have flood levels that are at risk of being flooded.	Protects dwellings from the tide, targeted at those most affected, most economical in terms of capital cost	does not protect property, individual protection not community facility, no direct benefit for southern Kaiaua	$160,000	X
	Purchase and removal of Flood Prone Buildings	Purchasing of flood prone properties and the removal of at-risk buildings. Upon removal, the vacant sections could be resold with requirements for appropriate construction of any new buildings.	completely reduces the risk by removing at risk buildings, allowing for possible redevelopment in future.	Distribution to owners, individual protection not community facility, high cost	$650,000	X
	Restrict Future Development	The continued implementation of building controls within the 1% AEP flood extent should ensure that no future developments are placed at flood risk.	Low cost, protects buildings from tide and the risk is manageable	Does not protect existing properties and may have a longer-term impact on community development		X

Appendix 6 – Prioritisation matrix for section 6

Table 9 **Prioritisation matrix for identification of priority areas that may require further investigation**

Degree of community exposure	**Impact on community resilience/knowledge if impact recommendation is completed**			
		High	**Medium**	**Low**
	High	HH	HM	HL
	Medium	MH	MM	ML
	Low	LH	LM	LL

Appendix 7 – River Management Wok Programme

Complete River Management Work Programme

Table 10 River Management Work Programme for Compartment Five (Waharau)

Stream/watercourse	Priority	River Management Work Programme	Comments
Waharau stream and tributaries	High	Existing Asset: 1x bridge along ECR a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, maintaining channel capacity, **ensuring stability of channel (erosion control)** c. To ensure performance under flood conditions, **structural integrity and stability of the asset (Waharau Bridge) on this stream.** Ensuring the **bridge is not undermined with erosion** around structure and blockages are removed to ensure it performs as designed. d. **Stream mouth opening** prior to a big event e. Improvement plan - **investigation of issues and upgrade requirements of the existing systems** and **assets (bridge)** to improve performance and reduce maintenance costs.	Erosion of the left bend upstream of the bridge now has rock armouring. Further erosion above the rock armouring is occurring and may collapse during the next big event. This has altered the energy flow in the stream and is causing further erosion on the right abutment of the bridge. Repairs occurred following 2017 event. NZTA indicates repairs and further investigation is required to the right bridge abutment. Water can still get behind the poles installed in the abutment and erosion can already be seen risking the collapse of the bridge during a high flow event. Waharau stream mouth is always moving and therefore the mouth gets blocked with sediment. Manually opened once a year by Hauraki District Council), or when there is a big event the water flows out itself. This stream has ecological significance. The Community Panel would like clarification around the councils current maintenance guidelines for this stream. **This stream requires gravel maintenance and bridge adjustment maintenance.**

Stream/watercourse	Priority	River Management Work Programme	Comments
Waihihi stream and tributaries	Medium	Existing Assets: 1x bridge along East Coast Road a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, **maintaining channel capacity**, ensuring stability of channel via rock armouring (erosion control) c. To ensure performance under flood conditions, structural integrity and stability assessment of the asset (Waihihi Bridge) on this stream to ensure the bridge is not undermined with erosion around structure, and blockages are removed to ensure it performs as designed. d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g the **bridge is out of alignment with the stream and an erosion issue is reported by NZTA**).	The natural meander of the stream is slowly migrating the stream to the south away from the bridge (6m) therefore, erosion control is required. **Rock armouring is required** to ensure the stream flows towards the bridge. Erosion of the left hand bank upstream of the bridge will escalate in the next big flood event. The stream mouth is partially closed and used as a swimming hole for locals in summer. However, **during winter it becomes blocked up** and may begin to flood nearby houses. This also creates water quality issues, and it smells for nearby residents. The stream mouth requires opening prior to a big event (open to the south and place sediment on the south side of the stream mouth to ensure blockage doesn't reoccur). The beachfront is an area of cultural significance as this beach was the landing location of the local tribes arriving in the Waikato. The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Waiwhenua stream	Medium	Existing Assets: 1x bridge along East Coast Road a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, **maintaining channel capacity**, ensuring stability of channel (erosion control as required)	Ensure access to the boat ramp south of the stream. Private resident rock armoured the stream just upstream of the mouth about 15 years ago, as a result, the stream has got wider and deeper and coastal processes continually block the stream mouth. Blockage of the stream mouth occurs quickly due to

Stream/watercourse	Priority	River Management Work Programme	Comments
		c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the bridge is not undermined with erosion around structure, and blockages are removed to ensure it performs as designed. d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	coastal processes. The stream mouth requires opening prior to a big event (open to the south and place sediment on the south side of the stream mouth to ensure blockage doesn't reoccur). The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Waihopuhopu stream	Medium	Existing Assets: 1x bridge along East Coast Road a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the bridge is not undermined with erosion around structure, and blockages are removed to ensure it performs as designed. d. Stream mouth opening required prior to a big event e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	Hauraki District Council own the two parallel properties downstream of the bridge (council reserve). **Stream mouth requires opening** prior to a big event (open to the south and place sediment on the south side of the stream mouth to ensure blockage doesn't occur again). The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Paparari stream	Low	Existing Assets: 1x culvert under East Coast Road, 2x private dams	Assets are a combination of both private landowner

Stream/watercourse	Priority	River Management Work Programme	Comments
		Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on any privately owned assets on their property due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the culvert is not undermined with erosion around the structure, and blockages are removed to ensure it performs as designed. d. Stream mouth opening e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work as this stream drains from 2 private dams. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property. The Paparari stream does not have a large catchment and drains two dams on a private property. The Paparahi stream has been dry (ephemeral) for at least the last 2 years since development of the dams. The stream only flows during large rainfall events.
Auwharewhare stream and unnamed tributary	Low	Existing Assets: 1x culvert underneath East Coast Road. a. Upper catchment stability control b. Stream management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) c. To ensure performance under flood conditions, structural integrity and stability of the assets on this stream. Ensuring the culvert	This stream is of cultural and historical significance that will need to be considered. Local iwi will need to be consulted when any works are planned and/or undertaken (Historical Kauri Mill location, urupa for Spanish Flu victims) No real concern around opening on the beachfront as this gets blown out during a big event, but clearance may be required prior to big events to ensure no water backs up.

Stream/watercourse	Priority	River Management Work Programme	Comments
		is not undermined with erosion around structure, and the culvert is managed, and blockages are removed to ensure it perform as designed. d. Culvert and discharge location opening is required to ensure continual clearance e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	
Murphy's Culvert	Low	Existing Assets: 3 x Culverts a. **To ensure asset performance under flood conditions an assessment of suitable culvert size is required.** b. **Management of blockages to ensure they are removed, and culverts perform as designed.** c. **Discharge outlets clear** d. **Improvement plan** - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs – e**.g investigate size of culverts, pathways of culverts.**	Coastal inundation pushes the rocks up and makes a mound on the coastal side, and the road is higher than the properties – therefore the properties are located in a bowl and susceptible to flooding. Murphy's Culvert splits into 3 drains and culverts, (one under the road, one to the south and to the north and then under the road) currently only 1 is open and working. Ensure accompanying culverts are appropriate for the amount of water discharge and working with the flow of water not against.

Figure 27 River Management Work Programme for Compartment Five (Waharau) stream locations

Table 11 River Management Work Programme for Compartment Four (Wharekawa)

Stream/watercourse	Priority	River Management Work Programme	Comments
Okarea Drain	Low	Existing Assets: 1x Culvert Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on privately owned assets on their property, due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) - to communicate with the landowner b. Drain management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) - to communicate with the landowner c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the culvert is not undermined with erosion around the structure, and blockages are removed to ensure it performs as designed. d. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	Ensure access to the boat ramp north of the stream. Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works, as they would only benefit from the works on their property.
Puwhenua stream	Low	Existing Assets: 1x bridge along East Coast Road. a. Upper catchment stability control (e.g planting, stability control, pest control) b. River management work - **removal of blockages, maintaining channel capacity**, ensuring stability of channel (erosion control as required)	This stream floods approximately 3 times a year as nearby land is very low due to the quarry. The floodwaters pond and this results in the road becoming flooded. Floodwaters don't impact traffic and will usually drain over a 24hr period.

Stream/watercourse	Priority	River Management Work Programme	Comments
		c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream including the following: I. Ensuring the bridge is not undermined with erosion around the structure. II. Blockages are removed to ensure the bridge performs as designed. d. Stream mouth opening e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	The farmland on the coastal side of the road is all located in the stream's floodplain. **Culvert clearing and general stream management like vegetation spraying and clearing is required.** The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Waimoho Stream	Low	Existing Assets: 2x culverts along East Coast Road Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on any privately owned assets on their property, due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) - to communicate with the landowner b. River management work - removal of blockages, **maintaining channel capacity**, ensuring stability of channel (erosion control as required) - to communicate with the landowner c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. **Ensuring the culverts**	Assets are a combination of both private landowner responsibility and council responsibility. This is the rohe boundary between Ngāti Paoa and Ngāti Whanaunga. Upstream of the culvert, there is only one landowner who would receive benefit from this work as this stream drains their property. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works, as they would only benefit from the works on their property. **Two very large, blocked culverts underneath East Coast Road and the stream mouth is blocked.** Because of this the **road floods to the south and the paddocks to the north** (not affected as much as the road).

Stream/watercourse	Priority	River Management Work Programme	Comments
		are managed and blockages are removed to ensure it performs as designed. d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Farm drain (1363 East Coast Road)	Low	Existing Assets: 1x Culvert Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on any privately owned assets on their property, due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) - to communicate with the landowner b. River management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) - to communicate with the landowner c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. **Ensuring the culverts are managed and are the correct size and blockages are removed to ensure it performs as designed.** d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work as this stream drains their property. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property.

Stream/watercourse	Priority	River Management Work Programme	Comments
		improve performance and reduce maintenance costs.	
Te Umukauri Stream	Low	Existing Assets: 1x Culvert and 2x private dams Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works and any privately owned assets on their property, due to the stream only running through their property. a. **Upper catchment stability control** (e.g. planting, stability control, pest control) - to communicate with the land owner b. River management work - **removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required)** - to communicate with the landowner c. To ensure performance under flood conditions, **structural integrity and stability of the dams that discharge into this stream**. Ensuring the **dams are not undermined with erosion around the structures and is managed and blockages are removed** to ensure it performs as designed. d. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream**. Ensuring the culvert is not undermined with erosion** around the structure, and is the correct size and blockages are removed to ensure it preforms as designed. e. **Stream mouth opening**	Assets are a combination of both private landowner responsibility and council responsibility. **Two private dams on private property** require technical advice from council to **ensure the performance and integrity of these dams** under flood conditions to **reduce the risk of dam failure**. Historical sand dune used to be along the beachfront and provide protection from coastal inundation events. However, a resident 20+ years ago removed this sand dune to sell properties and now this area is constantly flooded. The Community Panel would like clarification around the council's current maintenance guidelines for this stream.

Stream/watercourse	Priority	River Management Work Programme	Comments
		f. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	

Figure 28 River Management Work Programme for Compartment Four (Wharekawa) stream locations

Table 12 River Management Work Programme for Compartment Three (Whakatīwai)

Stream/watercourse	Priority	River Management Work Programme	Comments
Whakatīwai stream	High	Existing Assets: 1x bridge, 3x Hauraki District Council stopbanks a. Upper catchment stability control (e.g. planting, stability control, pest control). b. River management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required). c. **To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Manage flood way in ensuring conveyance, maintaining the structural integrity and performance of the stopbanks. Ensuring the bridge is not undermined with erosion around the structure and blockages are removed to ensure it performs as designed.** d. Stream mouth opening (blockage due to Whakatīwai gravels). e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. gravel management) f. Investigate option for reopening the historic riverbed and redirecting the stream via this channel.	There are a high number of properties that are at risk of flooding if stopbank failure occurrs. Of cultural significance due to the urupa in front of beachfront properties, to the south of the stream mouth. An area of high significance and valued by the community, so is to be protected from rising seas. **Option suggested by community is to reopen the historic river bed and redirect the stream via this channel (to the south in front of the properties).** This will have little to no impact to the urupa as the urupa is located on the banks of the old stream. Reopening the old stream bed may also generate a second defence for coastal inundation as flood waters would enter the stream and be discharged back out to sea for the smaller more frequent events. The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Whakatīwai Village drains and Whakatīwai pond	High	Existing Assets: Multiple open drains, private and council pipes, stormwater points of catchpits, manholes and an outlet.	23 properties surround the stormwater pond.

Stream/watercourse	Priority	River Management Work Programme	Comments
		a. **To ensure performance under flood conditions, structural integrity and stability of all assets in the Whakatīwai village. Ensuring the infrastructure is not undermined with erosion around structures and blockages are removed to ensure it performs as designed. Ensuring open drains are sprayed and cleared.** b. **Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. investigate Whakatīwai pond inlet and outlet and drains capacity to ensure it is suitable to accommodate the required inflow and outflow).**	One Hauraki District Council culvert runs through 4 Rua One Road (there is no building on this property) out to the coast. Overflow flow path to the north of the stormwater pond, via an old water course runs through properties which join both open drains and pipes. The Community Panel would like clarification around the council's current maintenance guidelines for this stormwater system.
Moemoepo stream	Medium	Existing Assets: 1x Culvert Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on any privately owned assets on their property, due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) - to communicate with the landowner b. River management work - **removal of blockages, maintaining channel capacity**, ensuring stability of channel (erosion control as required) - to	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property. **Stream spraying and dredging** is required on both sides of the road as the vegetation is overgrown and the stream is not visible. **Stream mouth opening is required. Culvert may also need clearing**. This combination results in the

Stream/watercourse	Priority	River Management Work Programme	Comments
		communicate with the landowner c. To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the culvert is not undermined with erosion around structure, **and blockages are removed to ensure it performs as designed.** d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	properties and the road beginning to flood and it can take up to 2 weeks to drain. This occurs on the roadside of 1277 East Coast Road as there is an old water channel through this property. The Community Panel would like clarification around the council's current maintenance guidelines for this stream
Kaiaua Marae stream	Low	Existing Assets: 1x culvert a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required) c. **To ensure performance under flood conditions, structural integrity and stability of the asset on this stream. Ensuring the culvert is not undermined with erosion around structure, and blockages are removed to ensure it performs as designed.** d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and	This stream is of cultural significance due to the Kaiaua Marae bordering the stream. However, very little flooding occurs here, just a small amount of farmland surrounding the stream gets flooded. Floodwaters travel to the south via a meandering channel on the coastal side of road. Vegetation spraying and clearing of the stream and stream mouth opening is required. Significant urupa from this stream down to Whakatīwai Stream. The Community Panel would like clarification around the council's current maintenance guidelines for this stream.

Stream/watercourse	Priority	River Management Work Programme	Comments
		assets to improve performance and reduce maintenance costs.	
Culverts and drains between Kaiaua school and Whakatīwai	Low	Existing Assets: 4x culverts a. To ensure performance under flood conditions, structural integrity and stability of these culverts and drains including: ensuring the culvert is not undermined with erosion around the structure, blockages are removed to ensure culverts perform as designed, drains are sprayed and cleaned regularly, and investigate the shortening of culverts into the sea to increase discharge volumes. b. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. blockages by shellfish in culvert, such as installing grates or one way valves, reduce culvert length on beachside of the road to allow discharge across the tidal sequence, investigate increase in drainage capacity).	All culverts are blocked from shells, gravel and sand and are only allowing a very small percentage of water from the drains to discharge in the ocean. Investigate the shortening of the culvert pipes into the sea which will increase water discharge volumes. The Community Panel would like clarification around the council's current maintenance guidelines for these streams and drains.

Figure 29 River Management Work Programme for Compartment Three (Whakatīwai) stream locations

Table 13 River Management Work Programme for Compartment Two (Kaiaua)

Stream/watercourse	Priority	River Management Work Programme	Comments
Hauarahi stream	High	Existing Assets: 1x bridge along East Coast Road, several open drains and culverts, associated stormwater points and boating club a. Upper catchment stability control (e.g. planting, stability control, pest control). Councils to provide technical advance and communicate to landowners. b. River management work - removal of blockages, maintaining channel capacity, stream spraying of overgrown vegetation, ensuring stability of channel (erosion control as required). c. To ensure performance under flood conditions, structural integrity and stability of the assets along the Hauarahi stream and in the township. Ensuring the bridge and associated stormwater infrastructure is not undermined with erosion around structures and blockages are removed to ensure it performs as designed. d. Stream mouth opening. e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and	Any works that occur on land north of the Kaiaua Village are required to have local iwi engagement during both the discussion and implementation phases as this land is iwi owned. Specific locations where works are needed: • Domain area: - Stream clearing and spraying upstream of the Kaiaua Domain - Remedial clearing works upstream of the Kaiaua Domain particularly around sharp bends - Ensuring channel capacity around Kaiaua Domain - Investigate old swale to the north of Kaiaua Village as an option to reduce floodwaters and travel through the culvert by the Pink Shop • Upstream - Wharekawa 5a/4a blocks: - Some willow removal works may be required in the future to ensure stream blockage is reduced - Spraying of stream banks to kill off any wild willow and vegetation to keep stream open. Cleared material from the Hauarahi Stream needs to be spread out in a way that assists with the management of coastal erosion. Investigate proposed caravan park and its impact on and from localised flooding (work is already underway on this, led by Hauraki District Council). Recommend that focus is given to the other streams in the

Stream/watercourse	Priority	River Management Work Programme	Comments
		reduce maintenance costs.	Project Area over the Hauarahi Stream as it has already had works completed on it.
Matawhero Stream	Low	Existing Assets: 1x culvert a. **To ensure performance under flood conditions, structural integrity and stability of this culvert and drains. Ensuring the culvert is not undermined with erosion around the structure, and blockages are removed to ensure it performs as designed. Drains are sprayed and cleaned regularly.** b. **Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. blockages by shellfish in culvert, such as installing grates or one-way valves, reduce culvert length on beachside of the road to allow discharge across the tidal sequence, investigate increase in drainage capacity).**	Hauraki District Council discharge into this stream from stormwater points. This is located in a rural zone, and Hauraki District Council have an obligation to maintain it. 75% of culverts currently blocked with seashells, rocks and sand resulting in a backup of water around Pink Shop and houses. Investigate one-way valve system and shortening of the existing culvert pipes into the sea which will increase water discharge volumes. The Community Panel would like clarification around the council's current maintenance guidelines for this stream.
Small unnamed drain at 831 and 845A East Coast Road	Low	Existing Assets: 1x stormwater pipe, 2 outlets and 2x floodgates Council to communicate and provide technical advice to the landowner. It is the landowner's responsibility to maintain and manage works on any privately owned assets on their property, due to the stream only running through their property.	This drain and associated drainage assets are part of the Kaiaua township stormwater system network. Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is

Stream/watercourse	Priority	River Management Work Programme	Comments
		a. To ensure performance under flood conditions, structural integrity and stability of the assets on this drain. **Ensuring the assets are not undermined with erosion around the structures, and blockages are removed to ensure it performs as designed.** b. **Stream mouth opening** c. **Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. investigate alignment and capacity of floodgates to ensure they are operating correctly).**	the landowner's responsibility to complete works, as they would only benefit from the works on their property. Investigate one-way valve system and shortening of the existing culvert pipes into the sea which will increase water discharge volumes.

Figure 30 River Management Work Programme for Compartment Two (Kaiaua) stream locations

Table 14 River Management Work Programme for Compartment One (Pūkorokoro Miranda)

Stream/watercourse	Priority	River Management Work Programme	Comments
Miranda/Pūkorokoro streams	High	Existing Assets: 1x bridge, 3x stopbanks, 1x rail trail Council to communicate and provide technical advice to landowners, Living Waters Project, Department of Conservation and Waikato District Council on options to improve land drainage and overall flooding. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - **removal of blockages (mangroves), maintaining channel capacity, ensuring stability of channel** (erosion control as required) c. To ensure **performance under flood conditions, an assessment of the structural integrity and stability** of the assets on this stream is needed. d. **Manage flood way in ensuring conveyance**, maintaining the **structural integrity and performance of the stopbanks** (private owner). e. Ensure the **bridge is not undermined** with erosion around the structure. That the bridge is upgraded if necessary and blockages are removed to ensure it performs as designed.	The Pūkorokoro/Miranda Bridge along East Coast Road sits within the Waikato District Council boundary and as a result, **any communication regarding the bridge should be addressed with Waikato District Council**. The Miranda and Pūkorokoro Streams stopbanks lie within the Living Waters' project (a collaboration between the Department of Conservation and Fonterra). The Hauraki District Council have a land drainage proposal with the Department of Conservation to use the stopbanks south of the bridge for the Hauraki Rail Trail, which requires Hauraki District Council to maintain these coastal stopbanks. **Flooding is dominant in the upper part of the catchment, particularly around Findlay Road**. **This area was the most flooded and impacted for the project area during the 2018 coastal inundation event.** The flooding issue in this area, is the inability of water ponded to successfully drain. **Mangroves are overgrown and built up with silt which has restricted the channel capacity both underneath the bridge and downstream of the bridge.** Removal of the left hand banks of silt and mangroves will allow for increased channel capacity during flood events. By reducing the mangroves on the right stopbank but keeping some there, it will help reduce sea swell action and flooding for the properties to the south of the stream. The river at the point of

Stream/watercourse	Priority	River Management Work Programme	Comments
		f. **Stream mouth opening (blockage due to chenier ridges).** g. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e**.g. investigate alignment and capacity of floodgates to ensure they are operating correctly).**	the bridge should be 30m wide, however it currently is 9m. **Work includes spraying of the mangroves** first to investigate what is required to be removed, **then removal of mangroves right out to the Firth of Thames is required.** The structural integrity of the bridge needs to be investigated and fixed. **Improving drainage capacity in this area, through removing the mangroves and silt, will ensure the stream has suitable capacity to drain, and will reduce a large percentage of flooding issues in the Pūkorokoro/Miranda area.** Waikato Regional Council has already developed a detailed plan suggesting the above. For any works to be considered upstream of the bridge, a collaborative approach is required with the Living Waters Project and DOC.
Small unnamed watercourse at 773 East Coast Road	Low	Existing Assets: 2x floodgates Council to communicate and provide technical advice to landowner. It is the landowner's responsibility to maintain and manage works on assets on their property due to the stream only running through their property. a. To **ensure performance under flood conditions, structural integrity and stability of the assets on this drain. Ensuring the assets are not undermined with erosion around the structure, and blockages are removed**	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property.

Stream/watercourse	Priority	River Management Work Programme	Comments
		to ensure it performs as designed. b. Stream mouth opening c. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (e.g. **investigate alignment and capacity of floodgates to ensure they are operating correctly).**	
Te Puaeharuri Stream	Low	Existing Assets: 1x bridge along East Coast Road Council to communicate and provide technical advice to the landowner. It is the landowner's responsibility to maintain and manage works on assets on their property due to the stream only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - **removal of blockages, maintaining channel capacity, ensuring stability of channel (erosion control as required)** c. To ensure **performance under flood conditions, structural integrity and stability of the asset on this stream**. Ensuring that the **bridge is not undermined with erosion** around the	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property.

Stream/watercourse	Priority	River Management Work Programme	Comments
		structure, and **blockages are removed to ensure it performs as designed**. d. **Stream mouth opening** (blockage due to chenier ridges) e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	
Unnamed watercourse at 673 East Coast Road	Low	Existing Assets: 2x floodgates Council to communicate and provide technical advice to the landowner. It is the landowner's responsibility to maintain and manag works on assets on their property due to the stream only running through their property. a. To ensure **performance under flood conditions, structural integrity and stability of the assets on this drain**. Ensuring the **assets are not undermined with erosion** around the structure, and **blockages are removed** to ensure it performs as designed. b. Stream mouth opening c. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property.

Stream/watercourse	Priority	River Management Work Programme	Comments
Unnamed drain at 545 East Coast Road	Low	Existing Assets: 1x floodgate Council to communicate and provide technical advice to landowners and the Taramarie Land Drainage District on options to improve land drainage. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - **removal of blockages, maintaining channel capacity, ensuring stability of channel** (erosion control as required) c. To ensure **performance under flood conditions, structural integrity and stability of the assets on this drain. Ensuring the assets are not undermined with erosion** around the structure, and **blockages are removed** to ensure it performs as designed. d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs **(e.g. investigate alignment and capacity of floodgates to ensure they are operating correctly).**	This stream is part of the Taramarie Land Drainage District, which already has a current process for land drainage in place. Therefore, these are recommendations to the Land Drainage Committee.
Taramarie Drainage District	Low	Existing Assets: 17x floodgates, 1x bridge, 2 stopbanks and a number of drains	This stream is part of the Taramarie Land Drainage District, which already has a current process for land drainage in place. Therefore, these are

Stream/watercourse	Priority	River Management Work Programme	Comments
		Council to communicate and provide technical advice to landowners and the Taramarie Land Drainage District on options to improve land drainage. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - **removal of blockages, maintaining channel capacity, ensuring stability of channel** (erosion control as required) c. To ensure **performance under flood conditions, structural integrity and stability** of the assets on this stream. **Manage flood way ensuring conveyance**, maintaining the **structural integrity and performance of the stopbanks**. Ensuring the **bridge is not undermined with erosion** around the structure, and **blockages are removed** to ensure it performs as designed. d. **Stream mouth opening (blockage due to chenier ridges)** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs (**e.g. investigate alignment and capacity of floodgates to ensure they are operating correctly).**	recommendations to the Land Drainage Committee.
Waiwarawara stream and unnamed watercourse at Coxhead property and 761 Front Miranda Road	Low	Existing Assets: 1x culvert underneath East Coast Road and 1x bridge Council to communicate and provide technical advice to landowner. It is the	Hauraki District Council maintain the stopbanks along the front of the property due to the rail trail, therefore have responsibility to maintain the stopbank.

Stream/watercourse	Priority	River Management Work Programme	Comments
		landowner's responsibility to maintain and manage works on any privately owned assets on their property, due to the drains only running through their property. a. Upper catchment stability control (e.g. planting, stability control, pest control) b. River management work - **removal of blockages, maintaining channel capacity, ensuring stability of channel** (erosion control as required) c. To ensure **performance under flood conditions, structural integrity and stability of the assets** on this drain. **Ensuring the assets are not undermined with erosion** around the structure, and **blockages are removed** to ensure it performs as designed. **Hauraki District Council to manage flood way ensuring conveyance, maintaining the structural integrity and performance of the stopbanks.** d. **Stream mouth opening** e. Improvement plan - investigation of issues and upgrade requirements of the existing systems and assets to improve performance and reduce maintenance costs.	Assets are a combination of both private landowner responsibility and council responsibility. Upstream of the culvert, there is only one landowner who would receive benefit from this work. Council to provide adequate technical advice to the landowner and it is the landowner's responsibility to complete works as they would only benefit from the works on their property.

Figure 31 River Management Work Programme for Compartment One (Pūkorokoro Miranda) stream locations

Appendix 8 - Council responsibilities

Hauraki District Council and Waikato Regional Council provided the below information sheet to the Wharekawa coast community to help them understand the roles and responsibilities for each council.

WHAT DO REGIONAL AND DISTRICT COUNCILS DO?

In terms of flood management, Waikato Regional Council (WRC) is responsible for the overall management of the region's rivers and their catchments. This includes land management and soil conservation, river management, and flood control and management. Hauraki District Council (HDC) is one of the few district councils in NZ that own and maintain a land drainage system. For more detail on this refer to the information provided below that was prepared prior to the Hauarahi Stream works being agreed to, that clarifies which council does what in this area.

OVERVIEW

Regional councils generally are involved in environmental resource management, flood control, air and water quality, pest control, public transport, and sometimes regional parks and bulk water supply.

District councils (also called territorial authorities) are responsible for local services such as roads (not State Highways), water reticulation, stormwater, wastewater, rubbish collection, libraries, parks, recreation services, local regulations, community and economic development, and town planning (adapted from https://www.lgnz.co.nz/localgovernment-in-nz/local-government-basics/).

Here's a link to another website (Te Tari Taiwhenua Department of Internal Affairs) that describes the roles further:
http://www.localcouncils.govt.nz/lgip.nsf/wpg_URL/About-Local-Government-LocalGovernment-In-New-Zealand-Councils-roles-and-functions

Both regional and district councils have responsibility for some areas of work like natural hazard management.

PLANS

Both regional and district councils are required to:

- prepare long term plans (LTPs), annual plans and budgets in consultation with their communities.
- report annually on their performance (Annual Report).
- prepare long term infrastructure and financial strategies including funding, financial management and investment policies.

These are all required by the Local Government Act 2002. Councils have other responsibilities under other Acts such as the Resource Management Act 1991 (RMA), Building Act 2004 and Biosecurity Act 1993.

Plans required to be prepared under the RMA are:

- Regional Policy Statement
- Regional plans
- Regional coastal plan
- District plan.

The following links are to the HDC and WRC Local Governance Statements which outline in detail what the councils do:
https://www.hauraki-dc.govt.nz/assets/council_documents/governance-stmt.pdf
https://waikatoregion.govt.nz/council/about-us/local-governance-statement/

WHAT DOES HAURAKI DISTRICT COUNCIL DO?

The following outlines more about what HDC does in the areas of land transport, land drainage and stormwater.

LAND TRANSPORT

- Local roads and footpaths
- Bridges
- Road safety
- Amenities
- Contribution to public transport
- Cycleways

LAND DRAINAGE

Collecting water runoff from rural areas and redirecting it

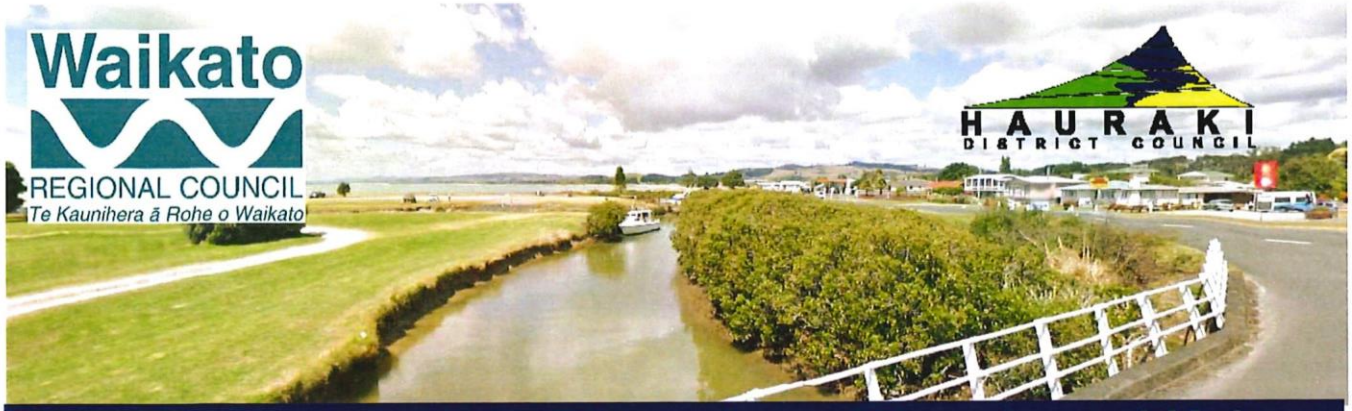
STORMWATER

Collecting or channelling excess rainwater that runs off urban properties and roads

LAND TRANSPORT - The land transport activity includes the maintenance of our sealed and unsealed roads, bridges, streetlights, and road drainage. It also includes the clearing of roads after weather events such as slips or flooding, footpaths, road safety and some public transport coordination, street cleaning, vegetation control for improved visibility for users and mobility purposes, and noxious weed control on road sides.

LAND DRAINAGE - The activity involves collecting runoff from the rural catchment areas of the District and leading it to the primary flood protection assets which discharge it directly to river or sea outlets. Additional drainage assets include stopbanks, floodgates and pumps. Land drainage services are provided in four drainage districts – Western Plains, Eastern Plains, Paeroa Rural and Taramaire. Flood protection is provided by the Waikato Regional Council's river schemes except in the northwest part of the District (Waitakaruru to Pūkorokoro / Miranda) where it is provided by the Hauraki District Council. Flood protection assets include stopbanks, floodgates and pump stations that provide direct protection from river and tidal flooding.

STORMWATER - The stormwater activity involves collecting and disposing of excess rainfall runoff from urban areas using various drainage systems. These services are provided in Paeroa, Waihi, Ngatea, Turua, Kerepehi, Whiritoa, Mackaytown, Karangahake, Waikino and Kaiaua. Stormwater assets include open drains, piped network, manholes and pump stations which operate in combination to remove surface water runoff. All stormwater systems eventually discharge into the Waihou or Piako Rivers, with the exception of the Kaiaua and Whiritoa systems which discharge directly to sea.



Flood management in Pūkorokoro-Miranda and Kaiaua

In the Waikato region there are rural areas that are low lying, very wet, and have limited natural drainage outlets. In some of these areas, such as the Hauraki Plains, networks of drains, stopbanks, pump stations, floodgates and detention dams have been developed over time to support pastoral farming and to alleviate flooding. The level of protection is decided by the community, who pays for it via a targeted rate.

What is Waikato Regional Council responsible for?

Waikato Regional Council is responsible for the overall management of the region's rivers and their catchments, including the effects of flooding and erosion. It does this in partnership with local communities.

Waikato Regional Council has three main work programmes:

- land management and soil conservation
- river management
- flood control and management.

What is land management and soil conservation (often referred to as catchment management)?

Land management includes appropriate land use, stream protection, erosion control and soil conservation.

Soil conservation works, such as native planting, help to minimise erosion on hill slopes and along river and stream banks. Work can also include retiring erosion-prone land from grazing, constructing debris dams and erosion control structures.

Waikato Regional Council staff are able to provide expert advice to property owners on best land management practices.

What is river management?

A river's flow and course can be affected by bank erosion and the build-up of debris, silt or gravel. River management works help to keep rivers flowing on course, and include:

- protecting and stabilising riverbanks, through fencing and planting and coordination of works along river banks
- controlling bank erosion, for example by using rock protection, groynes or other riverbank stabilisation works
- removing blockages
- undertaking river training works – ensuring the flow paths of rivers are kept on course
- undertaking gravel and sand management.

Waikato Regional Council provides assistance to landowners for the purpose of minimising erosion, sedimentation and flooding risks on their land.

What is flood control and management?

Flood control schemes have an important job. They protect people, productive farmland, telecommunications links and roads by helping to minimise the risk of flooding. Protection is achieved through a network of stopbanks, pump stations, floodgates and detention dams.

Waikato Regional Council is responsible for the provision and maintenance of the major flood control schemes throughout the Waikato region. Some of these areas are managed in conjunction with district councils. Hauraki District Council owns and maintains a land drainage system of 650km of drains, stopbanks, pump stations and floodgates in the Hauraki Plains for example.

What is Hauraki District Council responsible for?

District councils are generally responsible for:

- stormwater management
- the supply of town drinking water:
  - In the Pūkorokoro-Miranda and Kaiaua area, Hauraki District Council provides drinking water up to the Miranda Hot Springs. There is currently no town drinking water supply in Kaiaua, or north of the township.
- provision of sewer systems.
  - Hauraki District Council provides wastewater services in most urban areas, but this service is not currently provided in Kaiaua township
- controlling land for development and subdivision
- implementing the Building Act.

Hauraki District Council is one of only a few district councils in the country to own and maintain its own land drainage system of 650km of drains, stopbanks, pump stations and floodgates.

What am I responsible for?

Landowners are responsible for rivers and streams flowing through their property. Landowners can help look after the health of waterways by:

- managing stock to keep them out of rivers and other waterways
- planting vegetation to protect and stabilise river banks
- maintaining vegetation to prevent waterway obstruction
- managing animal and plant pests.

What level of protection am I currently paying for in my rates?

Waikato Regional Council rates

The Pūkorokoro-Miranda and Kaiaua areas are not currently covered by any targeted flood and river management funding.

This meant Waikato Regional Council staff were only able to provide information and advice following Ex-Tropical Cyclones Debbie, Cook, and the Tasman Tempest in March and April 2017, despite receiving multiple calls from local landowners for assistance.

Hauraki District Council rates

Residents in all Hauraki townships currently pay a general rate for stormwater services while those in areas needing flood protection pay a small targeted rate for land drainage. This is based on land value and covers cleaning flood gates and maintaining drains. There is no provision in these rates to undertake any meaningful flood protection or storm water infrastructure work in the Pūkorokoro-Miranda and Kaiaua area.

Are the current water management services enough?

The relentless rain that fell over a matter of days in March and April 2017 raised river levels to record heights, and caused extensive flooding, slips and road closures in the Pūkorokoro-Miranda and Kaiaua area.

The heaviest rainfalls recorded in March were in the Hunua area, which feeds the Pūkorokoro-Miranda and Kaiaua catchments. These levels reached over 1% annual exceedance probability (AEP) – this means there's a 1 in 100 chance of an event of this magnitude in any given year.

Waikato Regional Council, Hauraki District Council, and private landowners have separate and overlapping roles and responsibilities for the management of water resources so it's important we all work together to decide what level of water management and flood protection is desirable and how this might be funded.

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