# Safety and Resilience Committee 8 February 2024

Meeting will be held in the Council Chamber at Level 2, Philip Laing House
144 Rattray Street, Dunedin
ORC Official YouTube Livestream

Members:
Cr Gary Kelliher (Co-Chair)
Cr Alan Somerville (Co-Chair)
Cr Alexa Forbes
Cr Michael Laws
Cr Kevin Malcolm
Cr Lloyd McCall
Cr Tim Mepham
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott
Cr Elliot Weir
Cr Kate Wilson

Senior Officer: Richard Saunders Chief Executive

Meeting Support: Kylie Darragh Governance Support Officer

08 February 2024 11:00 AM

## Agenda Topic — Page



1. WELCOME

2. APOLOGIES

No apologies were submitted prior to publication of the agenda.

3. PUBLIC FORUM

No requests to address the Committee under Public Forum were received.

4. CONFIRMATION OF AGENDA

Note: Any additions must be approved by resolution with an explanation as to why they cannot be delayed until a future meeting.

5. DECLARATION OF INTERESTS

Members are reminded of the need to stand aside from decision-making when a conflict arises between their role as an elected representative and any private or other external interest they might have. Councillor interests are published on the ORC website.

Otago Regional Council

# Safety and Resilience Committee
# MINUTES

**Minutes of an ordinary meeting of the Safety and Resilience Committee held in the Council Chamber, Level 2 Philip Laing House, 144 Rattray Street, Dunedin on Thursday 9 November 2023, commencing at 1:00 PM.**

**PRESENT**

Cr Gary Kelliher *(Chairperson)*
Cr Alan Somerville
Cr Lloyd McCall
Cr Tim Mepham
Cr Andrew Noone
Cr Gretchen Robertson
Cr Elliot Weir
Cr Kate Wilson

## 1. WELCOME

Chair Gary Kelliher welcomed Councillors, members of the public and staff to the meeting at 1:00PM Staff present included Richard Saunders (Chief Executive) Gavin Palmer (GM Operations), online Nick Donnelly (GM Corporate Services), Amanda Vercoe (GM Governance, Culture and Customer) Jean-Luc Payan (Manager, Natural Hazards), Ann Conroy (Team Leader Natural Hazards Adaptation) Jamie MacKenzie (Natural Hazards Adaptation Specialist), Simon Robinson (Team Leader Natural Hazards Analysis), Tim van Woerden (Senior Natural Hazards Analyst), online Michelle Mifflin (Manager Engineering), Dr Luke Sutherland-Stacey, Weather Radar New Zealand Limited, Kylie Darragh (Governance Support)

## 2. APOLOGIES

**Resolution: Cr Wilson Moved, Cr Weir Seconded:**

*That the apologies for Cr Lloyd McCall (for lateness), and Cr Alexa Forbes and Cr Kevin Malcolm be accepted.*

**MOTION CARRIED**

## 3. PUBLIC FORUM

None for this meeting.

## 4. CONFIRMATION OF AGENDA

The agenda was confirmed as published.

## 5. DECLARATIONS OF INTERESTS

Chair Kelliher reminded members of the need to stand aside from decision-making when a conflict arises between their role as an elected representative and any private or other external interest they might have and noted that Councillor Declarations of Interests are published on the ORC website.

## 6. PRESENTATIONS

None for this meeting.

## 8. OPEN ACTIONS FROM RESOLUTIONS OF THE COMMITTEE

None for this meeting.

## 9. MATTERS FOR CONSIDERATION

### 9.1. Head of Lake Whakatipu Natural Hazards Adaptation

The report sought to update the Committee on progress towards the development of a natural hazards adaptation strategy for the Head of Lake Whakatipu area.

Gavin Palmer (General Manager Operations) Jamie MacKenzie (Natural Hazards Adaptation Specialist) Ann Conroy (Team Leader Natural Hazards Adaptation) Tim van Woerden, Senior Natural Hazards Analyst and Jean-Luc Payan (Manager Natural Hazards) were present to respond to questions regarding the report. Jamie MacKenzie confirmed that engagement will expand further in the next year.

1:39PM Cr Lloyd McCall joined the meeting.

**Resolution SRC23-109: Cr Noone Moved, Cr Weir Seconded**
*That the Safety and Resilience Committee:*

1. ***Notes** this report.*
2. ***Notes** the Head of Lake Whakatipu natural hazards adaptation work programme and community engagement.*

**MOTION CARRIED**

### 9.2. Otago Rain Radar – Rainfall Analysis and Nowcasting Service

Jean-Luc Payan (Manager Natural Hazards) and Gavin Palmer (General Manager Operations) and Dr Luke Sutherland-Stacey (Rain Radar New Zealand) were present to answer questions on this report which describes developments in the utilisation of the MetService Otago weather radar data to inform the ORC flood response. Dr Sutherland explained the Rain Radar system and applications in detail including the use of high frequency radar pulses which digitize the rain forecast. These maps have been available for some time through Met service. Dr Sutherland-Stacey noted to the Committee that the Otago region has relatively few radars compared to the ideal engineering guidelines.

**Resolution SRC23-110: Cr Somerville Moved, Cr Weir Seconded**
*That the Safety and Resilience Committee:*

1. ***Notes** this report.*
2. ***Requests** that the Chair of the Otago Civil Defence and Emergency Management Group writes to the relevant Minister requesting weather radar coverage for Queenstown-Lakes and Central Otago.*

**MOTION CARRIED**

### 9.3. Clutha Delta Natural Hazards Adaptation

The paper sought to update Council on progress with the Clutha Delta natural hazards adaptation programme. Gavin Palmer (General Manager Operations) and Jean-Luc Payan (Manager Natural Hazards) were present to respond to questions.

**Resolution SRC23-111: Cr Weir Moved, Cr Noone Seconded**
*That the Safety and Resilience Committee:*

1. ***Notes** this report.*

**MOTION CARRIED**

## 10. NOTICES OF MOTION

None for this meeting.

## 11. CLOSURE

There was no further business and Chair Kelliher declared the meeting closed, with Cr Somerville saying a karakia at 2:34PM.

_____ _____

Chairperson Date

| Meeting Date | Document | Item | Status | Action Required | Assignee/s | Action Taken | Due Date |
|---|---|---|---|---|---|---|---|
| 09/11/2023 | Safety and Resilience Committee 2023.11.09 | OPS2326 Otago Rain Radar – Rainfall Analysis and Nowcasting Service | Resolution Release Review | **Requests** that the Chair of the Otago Civil Defence and Emergency Management Group writes to the relevant Minister requesting weather radar coverage for Queenstown-Lakes and Central Otago. | Chairperson Robertson | | 01/05/2024 |

### 8.1. Dunedin groundwater monitoring and spatial observations

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Committee |
| **Report No.** | OPS2326 |
| **Activity:** | Safety & Hazards - Natural Hazards |
| **Author:** | Simon Robinson, Team leader Natural Hazards Analysis<br>Jean-Luc Payan, Manager Natural Hazards |
| **Endorsed by:** | Gavin Palmer, General Manager Operations |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To inform and update the Committee on the findings of a report authored by Geological and Nuclear Sciences Limited (GNS) on South Dunedin and Harbourside groundwater monitoring, spatial observations and forecast conditions under sea level rise.

## EXECUTIVE SUMMARY

[2] This paper presents the latest report on Dunedin groundwater monitoring and spatial observations. The report updates and progresses a GNS report published in 2020[1], to incorporate monitoring and observations over the period 6 March 2019 to 1 May 2023.

[3] Dunedin City has areas of flat-lying coastal land that is situated at, or slightly above sea level. These areas are underlain by a shallow groundwater table. The assets and critical infrastructure in these areas are exposed to both the direct and indirect consequences of a shallow groundwater table. High groundwater levels also potentially contribute to flooding issues in South Dunedin.

[4] The Otago Regional Council (ORC) is focused on hazards posed to affected communities, and any issues these hazards pose to the functioning of the city as a whole. It is important to the ORC to continue to increase knowledge and understanding of the occurrence and severity of the groundwater hazard and how that will be affected by rising sea levels.

[5] In addition to South Dunedin, an extended monitoring network and a longer period of observations has resulted in a more detailed analysis of the Harbourside area of Dunedin in this study. This is an important step as the Harbourside area has its own unique characteristics in relationship to groundwater and forecasted conditions under sea level rise. For this report, Harbourside includes reclaimed land at the head of Otago Harbour and parts of Central Dunedin (Figure 1).

[6] The ORC and partners have invested in monitoring and analysis over a long term (gradually improved since 2008-2009[2]) and have now reached a milestone where the

[1] Cox SC, Ettema M, Mager SM, Glassey PJ, Hornblow S, Yeo S. 2020. Dunedin groundwater monitoring and spatial observations. Lower Hutt (NZ): GNS Science. GNS Science Report 2020/11.

[2] Rekker J, 2011. Groundwater modelling investigation into the effect of sea level fluctuations on the South Dunedin Urban Area, Report to ORC Natural Resources Committee, Report No. 2011/1128, 11 November 2011.

characteristics, extent, and future implications of groundwater in South Dunedin and Harbourside can be better evaluated in a spatial context.

[7] The findings of this report have implications for the South Dunedin and Harbourside areas. Technical staff from the ORC and DCC will use the analyses presented in this report to help inform the next phase of scientific work, while consulting with the community on potential options to mitigate against natural hazards and climate change impacts through the South Dunedin Future programme. The study will also aid in management and adaptation decisions regarding the Harbourside area of Dunedin.

[8] The Dunedin groundwater behaviour is complicated by the influence of urban development on top of the natural environment. The lessons extracted locally by GNS Science, and the ORC are widely applicable in coastal areas around New Zealand and other urban centres throughout the world.

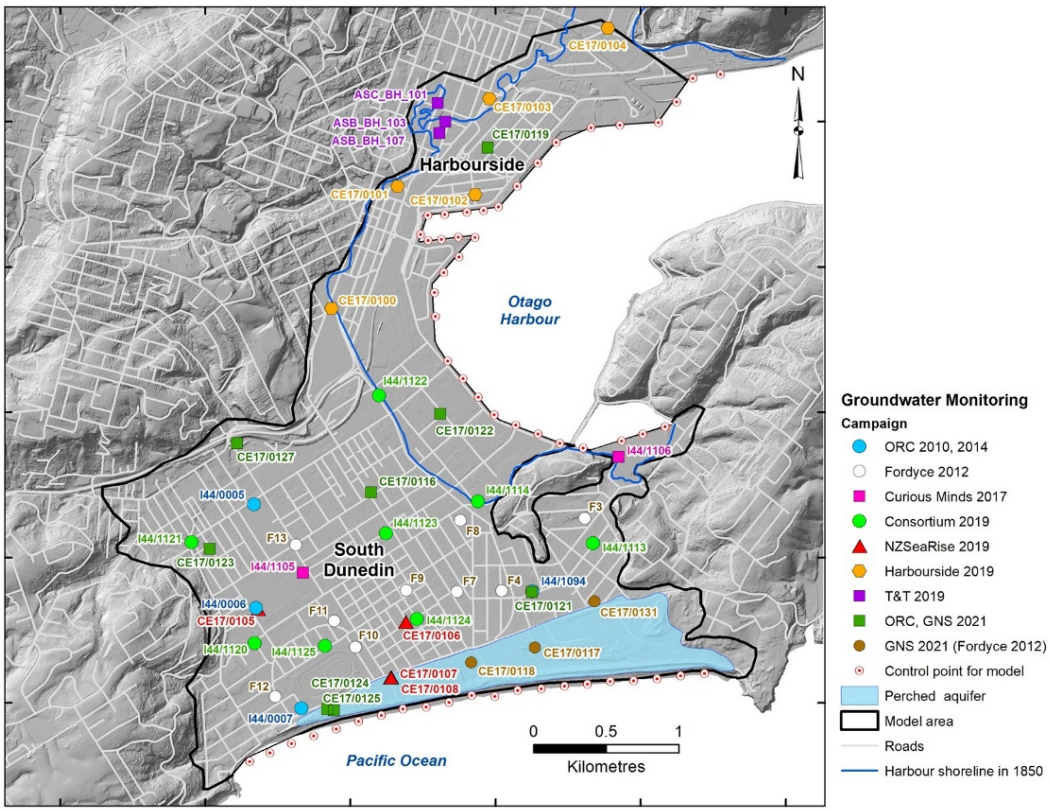


**Figure 1: Groundwater monitoring sites in Dunedin. Piezometers used in this study (coloured by campaign and labelled with installation date) are shown together with an outline of the flat-lying land and model extent, harbour and coastal control points included in interpolations. The figure also shows the interpreted extent of a perched aquifer in the sand dunes at St Kilda (light blue shade) and the position of the harbour shoreline in 1850 prior to reclamation. (Adapted from Cox et al. 2023)**

## RECOMMENDATION

*That the Committee:*

1) ***Receives** this report by GNS; Dunedin groundwater monitoring, spatial observations and forecast conditions under sea level rise.*

## BACKGROUND

[9] The water table beneath areas of Dunedin is shallow (mostly less than 2m below surface), even during relatively dry conditions.[3]

[10] Groundwater is a largely unseen, and hence poorly understood, contributor to flood and inundation hazard.[4]

[11] Shallow groundwater can cause instability in building foundations and roads, can infiltrate and overwhelm stormwater and wastewater systems, leads to poor public health through dampness and mould issues in housing, increases liquefaction potential, can redistribute underground contamination and can lead to salinity stress or other environmental issues.[5]

[12] Shallow groundwater can also limit the ability of the ground to store rain and runoff, this can result in an increased flood hazard.

[13] In South Dunedin near the coast, shallow groundwater is controlled by sea level. Groundwater levels are expected to rise as sea levels rise, potentially causing greater frequency of flooding and/or direct inundation once it nears the ground surface[6].

[14] The Harbourside area of Dunedin is less susceptible to sea level rise linked ground water inundation, with emergent groundwater modelled to be ubiquitous in South Dunedin before it starts to reach the ground surface in Harbourside.[3]

[15] Mitigation and adaption planning is dependent on a thorough understanding of groundwater and associated hazards.

[16] To better understand the spatial extent, dynamics, and behaviour of groundwater and the hazards it presents in Dunedin, an extensive monitoring system has been established in South Dunedin and the Harbourside area. Initially, shallow groundwater monitoring involved three boreholes installed by Otago Regional Council (ORC) in 2009[7]. Knowledge of groundwater in Dunedin took a major step forward with the installation of additional piezometers in 2019.[8] This drilling was funded by a consortium including ORC, DCC, GNS Science, EQC, Oceana Gold and Canterbury University. The network was again expanded by ORC in 2021. Data has also been collected from a groundwater observation campaign by University of Otago Geography student Emma Fordyce.[9] Observations at bores at

[3] Goldsmith M, Hornblow S. 2016. The natural hazards of South Dunedin. Dunedin (NZ): Otago Regional Council.
[4] Cox SC, Ettema M, Mager SM, Glassey PJ, Hornblow S, Yeo S. 2020. Dunedin groundwater monitoring and spatial observations. Lower Hutt (NZ): GNS Science. GNS Science Report 2020/11
[5] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894
[6] Fordyce E., 2013. Groundwater dynamics of a shallow coastal aquifer. Unpublished MSc thesis, Geography Department, University of Otago
[7] Goldsmith M, Hornblow S. 2016. The natural hazards of South Dunedin. Dunedin (NZ): Otago Regional Council.
[8] Cox SC, Ettema M, Mager SM, Glassey PJ, Hornblow S, Yeo S. 2020. Dunedin groundwater monitoring and spatial observations. Lower Hutt (NZ): GNS Science. GNS Science Report 2020/11
[9] Fordyce E., 2013. Groundwater dynamics of a shallow coastal aquifer. Unpublished MSc thesis, Geography Department, University of Otago

Kings and Bayfield High Schools from piezometers installed during a Curious Minds Science Project are also included in this study.[10]

[17] ORC's groundwater monitoring network now comprises 35 sites across South Dunedin and Harbourside. (Figure 1). Groundwater level, temperature and specific conductance is recorded by automated transducers.

[18] In 2020, a groundwater report (Cox et al. 2020), was produced describing the initial findings from analysis of the monitoring network. The report contained a series of statistical surfaces generated to represent the 'present-day' (2019) water table elevation and depth to groundwater, the response to rainfall recharge and tidal forcing, the available subsurface storage of rain. Depth to water and groundwater inundation was based on a topographic LiDAR survey collected in 2009. An important result from this work was that permeability of the ground and movement of groundwater was not as high as previously thought, meaning the driving force of tides and sea level rise on the groundwater was not as strong as previous assumptions suggested.

[19] In early 2023, following a request from the ORC, a proposal was presented by GNS for an update of the groundwater information for South Dunedin and Harbourside. The update incorporates monitoring and observations over the period 6 March 2019 to 1 May 2023. GNS Science's research for this report was enabled by ORC co-funding to investment and contributions from the GNS Science's Strategic Science Investment Fund (Ministry of Business, Innovation & Employment MBIE), the NZ SeaRise Programme (an Endeavour programme funded by MBIE led by Victoria University of Wellington), and the STRAND Programme (a Royal Society of New Zealand Marsden-funded project led by University of Otago). It acknowledges coastal inundation data supplied by NIWA, tide data from the New Zealand Hydrographic Authority (Land Information New Zealand), and other groundwater observations from Te Whatu Ora / Tonkin & Taylor.

[20] This study will be a critical component in aiding risk assessment and adaptation option decisions considered by The South Dunedin Future Programme (SDF). The SDF programme is a joint initiative between the Dunedin City Council (DCC) and Otago Regional Council (ORC) to develop a climate change adaptation plan for South Dunedin. Outputs from the GNS report will feed directly into the natural hazards, risk assessment and adaptation approaches workstreams of the programme[11].

[21] This study will also be used by technical staff at the ORC and Dunedin City Council to inform future management, risk assessments and adaptation options for the Harbourside area.

[22] The data collected from 2019-2023 groundwater levels are representative (± 70 mm) of median conditions during the past decade, but locally some of the extreme values experienced during the 2015 floods were missed.[12] Continued monitoring to capture

[10] Gore E & Crawford A, 2017. Review of South Dunedin Project: What lies beneath – looking at the changing ground environment in South Dunedin ORC Report A1031062, Report to the 13 September 2017 meeting of the Otago Regional Council Communications Committee

[11] Rowe J, 2023. South Dunedin Future Risk and Adaptation Approaches, Report to ORC Council, Report No. GOV2343, 6 December 2023.

future flood events will add to the understanding of these episodes and their effect on groundwater.

[23] Since publication of the 2020 report, there have been significant developments in available data and science to help constrain groundwater-related hazards in Dunedin. In particular:

1) A new LiDAR survey in 2021, captured by ORC with support from LINZ, details the elevation of land at significantly higher resolution and precision than the survey of 2009.

2) Additional drilling by ORC in 2021 provided new subsurface information and nine new sites were added to the monitoring network. ORC also completed aquifer testing.

3) Some older monitoring sites were relocated, surveyed by differential GPS, and monitoring recommenced from mid-2021.

4) The NZ SeaRise[13] programme published local sea level rise predictions for the coast and harbour, with and without effects of vertical land motion.

5) In 2023, NIWA published studies and updated maps of coastal inundation from extreme sea level rise, including the annual exceedance probabilities at different levels. [14]

6) As part of the NZ SeaRise programme, GNS redeveloped the ORC numerical groundwater model (ModFlow) for South Dunedin (Rekker 2012) and published a scientific paper (Chambers et al. 2023). The model provides probability of groundwater levels under different sea level rise scenarios.

7) There have been nearly three additional years of monitoring of groundwater fluctuations. The period includes intense rainstorms during July-Aug 2022 and one of the wettest months on record in Dunedin, as well as extreme summer and La Nina dry periods and low groundwater.

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[12] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894

[13]The NZ SeaRise: Te Tai Pari O Aotearoa is a five-year research programme funded by the Ministry for Business, Innovation and Employment Endeavour Fund. It brings together 30 local and international experts from Te Herenga Waka-Victoria University of Wellington, GNS Science, NIWA, University of Otago and the Antarctic Science Platform to improve projections of sea-level rise in Aotearoa New Zealand. More information on https://www.searise.nz/

[14] Paulik, R., Wild, A., Stephens, S., Welsh, R., Wadhwa, S. (2023) National assessment of extreme sea-level driven inundation under rising sea levels. Frontiers in Environmental Science, 10, 2633, https://doi.org/10.3389/fenvs.2022.1045743

[3] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894

[24] For the updated report, statistical surfaces were developed to define the present-day geometry of the water table, understand connection with the sea, then forecast the future state under the effects of sea level rise at a site-specific scale.[15] From this the following were calculated:

- Water table elevation
- Depth to groundwater
- Response to rainfall recharge and tidal forcing
- Available subsurface storage of rain infiltration

[25] The empirically based geometric model created for this report was compared against the numerical model created as part of the NZ SeaRise programme.[16]

**KEY FINDINGS AND CONCLUSIONS**

[26] The GNS report concludes that groundwater levels are expected to rise as sea levels rise, causing greater frequency of flooding and/or direct inundation once it nears the ground surface. The 'Loss of storage capacity' and 'Flooding from below' as sea levels rise and the groundwater shoals, will in many places become the principal issues BEFORE direct inundation by the ocean.[1] This can be summarised as:

- As the water table rises with sea level, ability to absorb rainfall into the ground decreases and will exacerbate pluvial (rain-related) flood issues already present.

- Loss of subsurface storage 'leads' emergence of groundwater, which will transition from episodic at nuisance levels to permanent springs and/or flooding.

- Groundwater-related issues should occur well BEFORE coastal inundation, at least locally in Dunedin due to its land elevation.[2]

[27] The study provides a detailed picture of where and when issues will arise, mapped against 10cm increments of sea-level rise (SLR). It is unknown exactly when these amounts of sea-level rise will be attained, as it depends on global warming and efforts to reduce emissions. But estimated timeframes have been provided based on the variety of available emissions scenarios.

[28] In South Dunedin, the report forecasts a marked increase in groundwater emergence and flooding potential at about 50cm SLR, that precedes a step-like inundation from the harbour at 60-70cm SLR (Figure 2).

[29] In the Harbourside area at 60 cm SLR, only the highest storm-surge related conditions (100 and 1000 year Average Recurrence Intervals) appear sufficient to result in emergent groundwater (Figure 2).[17]

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[15] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894

[16] Chambers LA, Hemmings BJC, Cox SC, Moore CR, Knowling MJ, Hayley K, Rekker J, Mourot F, Glassey PJ, Levy RH. 2023. Quantifying uncertainty in the temporal disposition of groundwater inundation under sea level rise projections. *Frontiers in Earth Science* 11: doi: 10.3389/feart.2023.1111065

[17] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894

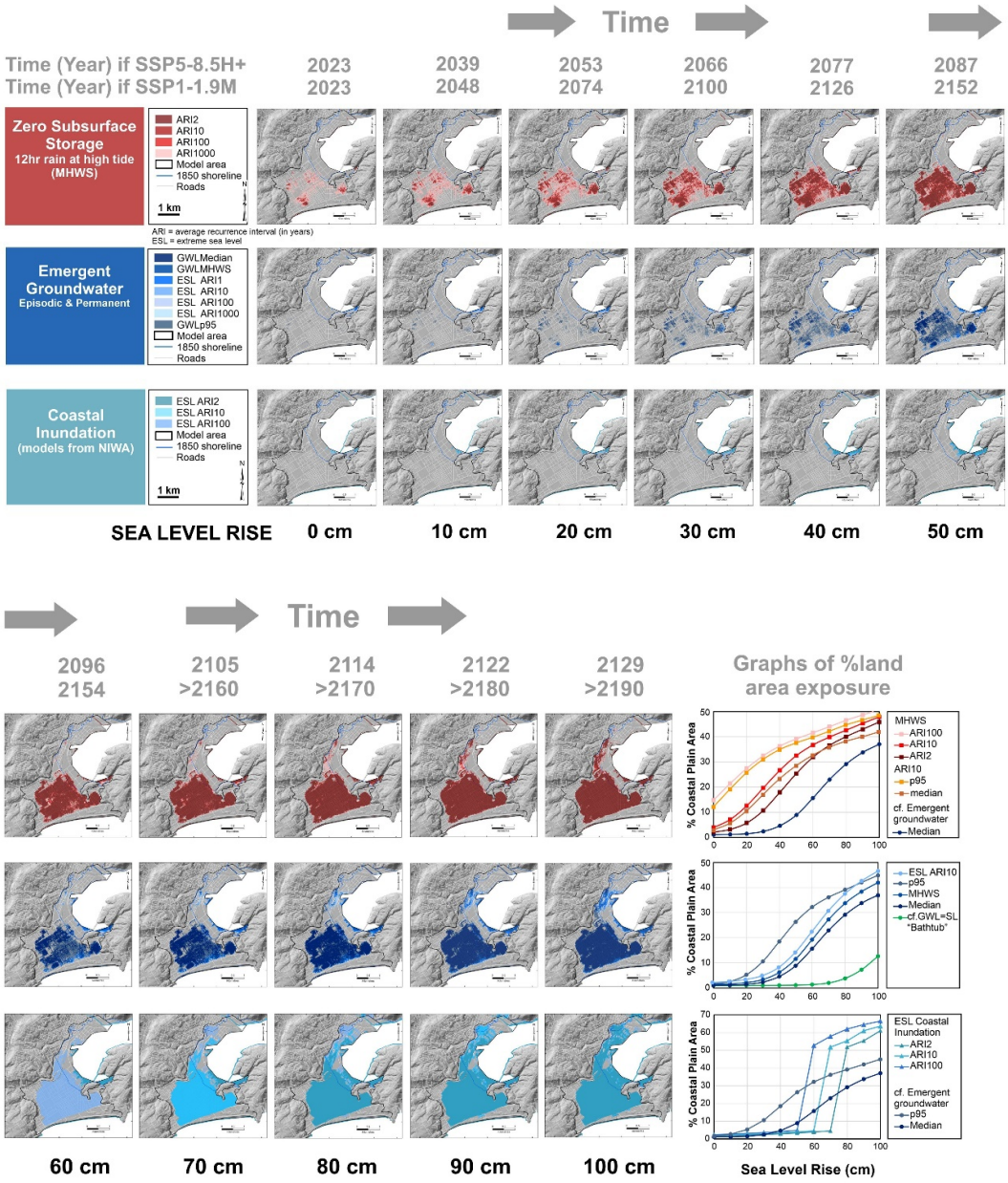


**Figure 2: Maps showing areas of zero subsurface storage capacity, emergent groundwater, and coastal inundation (from NIWA) for various recurrence intervals and increments of sea level rise *(Adapted from Cox et al. 2023)***

[30] The schematic summary below (Figure 3) highlights that the evolution of hazards associated with groundwater are likely to be gradual and will precede a step-like increase in exposure to coastal inundation.[1]

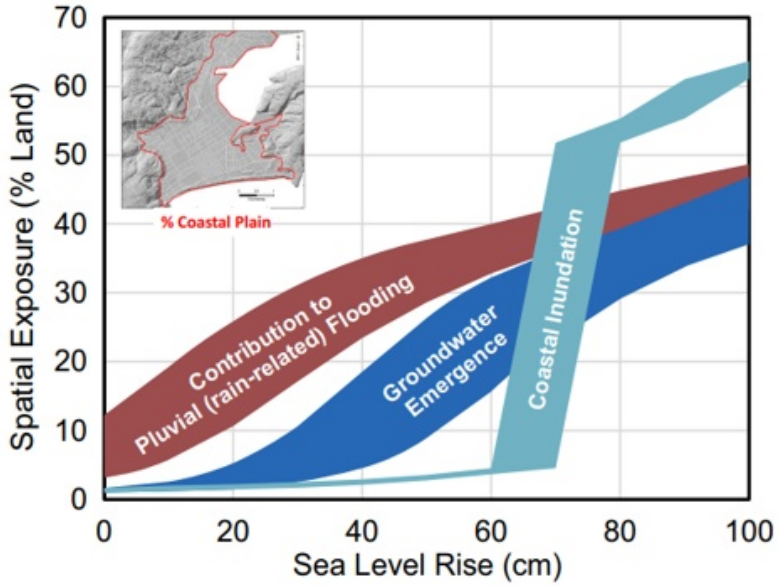


**Figure 3 Summary schematic highlighting that annual- to decadal-scale hazard associated with groundwater is likely to precede coastal inundation, and groundwater's contribution to pluvial flooding is likely to be felt/experienced prior to the emergence of groundwater. Bands show processes with occurrence on annual to decadal time scale that are expected to be problematic and/or damaging. The height bands (at each 10cm increment of SLR) reflects the importance of water table variability (e.g., through tides and seasonal rainfall) for both hazard and risk. *(Adapted from Cox et al. 2023).***

[31] Figure 3 also indicates, and the report concludes, that groundwater's contribution to pluvial flooding may well have been experienced in many places prior to the emergence of groundwater.[18] This has implications for adaptation planning for at-risk areas.

[32] The water table elevation and depth to groundwater fluctuations do not necessarily reflect topography, meaning the lowest areas in elevation do not always have the shallowest groundwater levels.[1] The lowest areas in elevation are not affected more than the highest areas in elevation.

[33] There is a discernible effect by tide and storm surges on groundwater levels, which decays exponentially with distance from the coast, but the effect of rainfall is more pronounced.

## CONSIDERATIONS

### Strategic Framework and Policy Considerations

[34] The information presented and the adaptation approach discussed in this paper reflects Council's Strategic Directions where our vision states: communities that are resilient in the face of natural hazards, climate change, and other risks.

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[18] Cox SC, Ettema MHJ, Chambers LA, Easterbrook-Clarke LH, Stevenson NI. 2023. Dunedin groundwater monitoring, spatial observations and forecast conditions under sea-level rise. Lower Hutt (NZ): GNS Science. 103 p. (GNS Science report; 2023/43). https://doi/org/10.21420/5799-N894

[35] The proposed Otago Regional Policy Statement June 2021[19], states that ORC and territorial authorities are both responsible for specifying objectives, policies, and methods in regional and district plans for managing land subject to natural hazard risk. ORC specifically is responsible for *"identifying areas in the region subject to natural hazards and describing their characteristics as required by Policy HAZ–NH–P1, mapping the extent of those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."*[20]

**Financial Considerations**

[36] The 2023-24 Annual Plan and proposed budget in the draft 2024-34 LTP provides funding towards delivery and implementation of the South Dunedin Futures (SDF) Programme. Part of this funding will be used to continue the groundwater monitoring program and further natural hazards investigations. The South Dunedin proposed budget for the 2024/25 financial year is approximately $500,000. This budget includes ORC's contribution to the SDF programme. The draft 2024-34 LTP also provides funding towards Harbourside monitoring and risk assessment with a proposed budget for 2024/25 of $75,000.

**Significance and Engagement**

[37] This noting paper does not trigger ORC's He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy (He Mahi Rau Rika).

**Legislative and Risk Considerations**

[38] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA.

**Climate Change Considerations**

[39] Dunedin, like many other regions, faces challenges related to climate change. Understanding the dynamics of groundwater is a crucial part of making informed decisions about adaptation strategies to address climate change related issues, such as rising sea levels and increased rainfall.

**Communications Considerations**

[40] A communications plan has been developed following this study. This details how ORC and GNS will work together to provide public information about the groundwater related flood hazards forecast.

[41] Technical staff will support communications staff in preparing supporting content that is easy to understand. This topic is expected to have strong public interest in the Dunedin community so plain language information is needed to help the people to understand the key findings. The report is also expected to have national interest for other parts of New Zealand facing similar challenges in the future.

[42] ORC and GNS will promote this work and the findings to media and will share information with the public through a range of channels, including social media, ORC publications, the ORC website, GNS website and through targeted engagement to stakeholders.

[19] Section HAZ-NH-M1

[20] ORC Natural Hazards Portal: http://hazards.orc.govt.nz

[43] Key stakeholders include: Dunedin City Council, the South Dunedin Future programme, the South Dunedin Community Network, Te Whatu Ora (Southern)/WellSouth, NZ Transport Agency, Ministry for the Environment, Climate Change Commission, Otago CDEM, Port Otago, Ministry of Education, Ministry of Health, University of Otago, Otago Polytechnic and Emergency services.

**NEXT STEPS**

[44] Teams at the DCC and SDF will be briefed on the findings and implications of the study to support their work in the affected areas of Dunedin.

[45] The study will be made publicly available and accessible on the ORC website[21].

[46] Ongoing monitoring will continue to further increase knowledge on the characteristics and spatial extents of the groundwater in South Dunedin and Harbourside. Continued monitoring and observations will also aid in the review of outcomes of implemented adaptation options.

[47] A modelling update will be required at a point where sufficient new monitoring data has been captured.

[48] There will be further development and improvement of datasets of rainfall recharge and groundwater response to a wider number of events, spanning a range of rainfall duration and intensity.

[49] The GNS report notes that the limited data available from the stormwater and wastewater networks "results in considerable epistemic[22] uncertainty in groundwater-related hazard impact forecasting for Dunedin". The report notes that collection and analysis of data from the stormwater and wastewater networks must be recognised as priority. Continued collaboration with DCC and consideration will be given to concurrent monitoring of infrastructure network flows and groundwater level fluctuations at a wider number of sites, to fully understand the groundwater infiltration and the extent to which it might be hazardous compared to problematic, so that adaptation planning and long-term investments in infrastructure can be rationalised.

**ATTACHMENTS**

Nil

[1] https://www.orc.govt.nz/

[22] Relating to knowledge

### 8.2. Clutha Delta Natural Hazards Adaptation

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Committee |
| **Report No.** | HAZ2307 |
| **Activity:** | Governance Report |
| **Author:** | Ann Conroy, Team Leader Natural Hazards Adaptation<br>Jamie MacKenzie, Natural Hazards Adaptation Specialist<br>Tim van Woerden, Senior Natural Hazards Analyst<br>Simon Robinson, Team Leader Natural Hazards Analysis<br>Jean-Luc Payan, Manager Natural Hazards |
| **Endorsed by:** | Gavin Palmer, General Manager Operations |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To update Council on progress with the Clutha Delta natural hazards adaptation programme including engagement planning, and the significant erosion damage at the Koau/Puerua coastal mouth.

## EXECUTIVE SUMMARY

[2] The low-lying plains of the Clutha Delta are exposed to a range of coastal, fluvial, and seismic natural hazard risks. Coastal hazard and flooding hazard risks are projected to be exacerbated by potential impacts of ongoing or projected geomorphic and climatic changes.

[3] Otago Regional Council (ORC) is following the Dynamic Adaptative Pathways Planning approach (DAPP, or 'Adaptation Pathways') as a framework for development of a Clutha Delta natural hazards adaptation programme.

[4] This paper provides an update on activities since the previous committee paper on this work programme, presented in November 2023, including significant erosion damage at the Koau/Puerua coastal mouth.[1]

[5] Engagement planning is underway. The programme is piloting in-development ORC engagement resources, including practice kete/toolkits and templates and is informed by best-practice research and policy.

[6] Engagement planning is following a four phased approach, and this report presents 'Phase 1 - Plan and Prepare', which focuses on understanding the context, scope, audience, purpose and overall level of engagement. The first phase lays the foundation for future phases of engagement planning.

[7] The engagement planning process recommends 'collaborate' as the level of engagement expected to be achieved throughout the programme. This is because it is a highly complex issue, which will require the integration of local knowledge, science and mātauraka Māori to develop solutions. It is anticipated that this programme is of high

[1] van Woerden T, Conroy A and Payan J, 2023. Clutha Delta Natural Hazards Adaptation. Report OPS2341 to the Otago Regional Council Safety and Resilience Committee, 9 November 2023.

interest and significance to affected communities, stakeholders and Council and the purpose of engagement will be to come up with innovative solutions and gain community support for the programme, and ultimately implement successful adaptation actions.

[8] Engagement planning is an iterative and ongoing process and will be updated as the programme progresses, or if there are any notable changes.

[9] Several natural hazard investigations are being scoped or are underway, to inform the programme. These include a natural hazard and engineering investigation at Koau Mouth and Puerua, a flood hazard assessment and a liquefaction hazard assessment.

[10] Both ORC[2][3] and Clutha District Council (CDC)[4] are working on developing climate strategies that will reference the Clutha Delta Natural Hazard Adaptation Programme. This is an opportunity for alignment and collaboration.

## RECOMMENDATION

*That the Safety and Resilience Committee:*

1) ***Notes** this report.*
2) ***Notes** the Clutha Delta natural hazards adaptation work programme and community engagement planning.*
3) ***Notes** the coastal erosion situation at the Koau/Puerua mouth.*

## BACKGROUND

[11] Otago Regional Council (ORC) is leading a programme of work to develop a natural hazard adaptation strategy for the Clutha Delta area.

[12] The low-lying plains of the Clutha Delta are exposed to a range of coastal, fluvial, and seismic natural hazard risks. Coastal hazard and flooding hazard risks are projected to be exacerbated by potential impacts of ongoing or projected geomorphic and climatic changes.

[13] ORC is using the Dynamic Adaptative Pathways Planning approach (DAPP, or 'Adaptation Pathways')[5] (see Figure 1) as a framework for development of a Clutha Delta natural hazards adaptation programme. ORC is already using this approach in natural hazards adaptation planning for the South Dunedin Future and Head of Lake Whakatipu natural hazards adaptation programmes.

[2] Hernandez F and Payan J, 2023. Climate Change Strategy Scoping. Report GOV2329 to the Otago Regional Council, 23 August 2023

[3] Hernandez F, 2023. Regional Climate Strategy Working Group. Report STG2307 to the Otago Regional Council, 22 November 2023

[4] https://www.cluthadc.govt.nz/council/plans-and-strategies/climate-change

[5] Endorsed as best-practice by the Ministry for the Envionment. See: Ministry for the Environment (MfE), 2017. Coastal Hazards and Climate Change: Guidance for Local Government, https://environment.govt.nz/publications/coastal-hazards-and-climate-change-guidance-for-local-government/

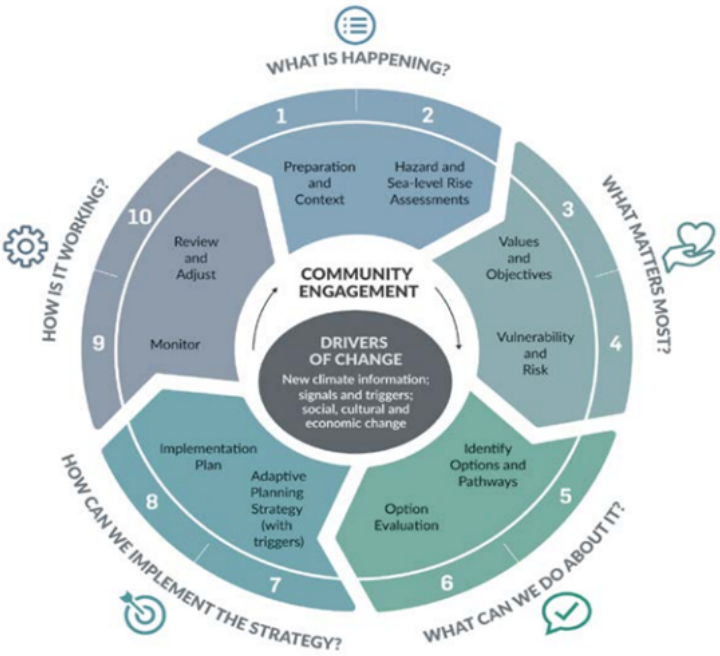


***Figure 1: DAPP ten-step cycle, framed by five key questions and community engagement in the centre (Ministry for Environment, 2017).***

[14] This paper provides an update on activities since the previous committee paper on this work programme, presented in November 2023[6]. That paper summarised the natural hazards context and the proposed natural hazards adaptation work programme for the Clutha Delta.

[15] The work programme is currently in the first phase of the DAPP cycle ("*what is happening?*"), with progress on the scoping or early stages of investigations to increase our understanding of the key natural hazards on the delta, and early engagement planning.

[16] The first iteration of a natural hazards adaptation strategy for the Clutha Delta is proposed to be completed by December 2025. This strategy document will then be used to inform planning for the next LTP cycle (2027-2037).

[17] This paper provides an update on current and proposed programme activities including community engagement planning, and natural hazards investigations.

## DISCUSSION

[18] Development of a natural hazards adaptation strategy for the Clutha Delta area will include comprehensive natural hazards and risk assessments, and the identification and review of adaptation options and pathways approaches (e.g., the PARA framework; Protect, Accommodate, Retreat, Avoid).

[6] van Woerden T, Conroy A and Payan J, 2023. Clutha Delta Natural Hazards Adaptation. Report OPS2341 to the Otago Regional Council Safety and Resilience Committee, 9 November 2023.

[19] Following completion of this project phase to identify and develop a strategy of preferred adaptation options and pathways approaches, the next phase will consist of planning towards implementation of those options and pathways.

[20] Implementation of any larger-scale adaptation options will require significant investment in further investigations, for example these may include feasibility studies, cost-benefit analysis and business case development, investigations of potential funding options, and consideration of environmental, legal, technical, and planning factors. Provision has been made for this in the draft 2024-54 Infrastructure Strategy[7], based on current information. Implementation would be the subject of future decisions of Council.

[21] Scoping for the scheme performance and risk assessments for the Lower Clutha Flood Protection and Drainage Scheme will commence early in 2024 and will be an important component of the natural hazards adaptation programme. This adaptation work programme and the scheme performance and risk assessments will be closely interlinked and intended to complement each other.

[22] Another separate, but closely interlinked, workstream will focus on Emergency Management planning. This can include improving flood warning and preparedness capability and processes.

[23] The adaptation programme will be focused on the core natural hazards concerns (Table 1), but broader aspects such as environmental outcomes (biodiversity/ecology) will be considered as important factors in assessment of adaptation approaches, and the programme will have regard to potential opportunities in these areas.

***Table 1: Key areas of natural hazards focus for the Clutha Delta natural hazards adaptation work programme.***

| | |
|---|---|
| 1. | Balclutha township flooding risks, safety and resilience. |
| 2. | Flooding risk to the wider delta area, including Stirling, Kaitangata and other rural communities (e.g., Paretai, Inch Clutha). |
| 3. | Rising groundwater levels and agricultural sustainability. |
| 4. | Management of the coastal interface and coastal infrastructure and land use. |
| 5. | Seismic hazards, particularly liquefaction or lateral spreading |

## COMMUNITY ENGAGEMENT PLANNING

[24] The November 2023 report to the Safety and Resilience Committee noted that next steps included the development of an engagement and communications plan to guide the first two phases of the adaptation programme (*"what is happening?"* and *"what matters most?"*). This engagement planning process is underway.

[25] It is accepted across literature, research, national and international policy[8] the importance of meaningful, inclusive and accessible engagement in natural hazards and climate change adaptation planning and decision-making processes.

[7] Infrastructure Strategy 2024-2054, Report to 6 December 2023 meeting of Council, Report No. ENG2101.

[8] Notable examples include Aotearoa New Zealand's signing of the United Nations Sendai Framework for Disaster Risk Reduction 2015-2030 and the Ministry for the Environment's National Adaptation Plan.

[26] ORC strategic direction commits to effectively engaging communities to achieve its vision for Otago of *"communities that are resilient in the face of natural hazards, climate change and other risks"*[9]. ORC has set clear commitments to engagement with iwi partners, stakeholders and the community through He Mahi Rau Rika; Significance, Engagement and Māori Participation Policy[10] (He Mahi Rau Rika).

[27] Community engagement is at the centre of the DAPP approach (see Figure 1), recognising that effective engagement is essential for successful natural hazards and climate change adaptation planning and decision-making.

[28] Effective engagement provides numerous benefits for communities, councils and the work programme, including strengthening council-community relationships, incorporating local knowledge and values, enabling people to have a say, increasing a sense of belonging, community and resilience, building staff capability and helping solve complex problems with solutions that are responsive to local issues.

[29] Engagement, as a key part of Clutha Delta adaptation programme, is an opportunity to embed mana whenua and community voices, views and knowledge in the planning and decision-making process.

Engagement Planning Approach

[30] There is no single 'best' approach to engagement as every community and every context is different. The work programme is guided by best-practice principles for community engagement in natural hazards and climate change adaptation contexts and organisation direction.

[31] The programme is piloting new ORC engagement resources, including practical kete/toolkits and templates, currently in development by ORC (as noted in a December 2023 paper to Council[11]). These resources are intended to make up part of an engagement hub which aims to coordinate and assist evidence-based and best-practice engagement efforts across the organisation.

[32] The pilot resources are informed by He Mahi Rau Rika, and best-practice guidance from the International Association for Public Participation (IAP2), Let's Talk About Risk's engagement framework[12] and other academic research.

[33] The process and resources help to ensure we develop a robust engagement plan that commits to meaningful and intentional engagement practices.

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[9] https://www.orc.govt.nz/our-council-our-region/our-council/strategic-directions

[10] https://www.orc.govt.nz/media/12644/he-mahi-rau-rika-significance-engagement-and-maori-participation-policy.pdf

[11] Pettit, K. 2023. ORC's strategic and community engagement, Report GOV2341 to Otago Regional Council, 6 December 2023, https://www.orc.govt.nz/media/15796/council-agenda-public-2023-12-06.pdf.

[12] Let's Talk About Risk Team (Brown, C., Horn, C., Horsfall, S., Kilvington, M). 2023. Natural hazard and climate change risk community engagement: A framework to aid engagement design. Let's Talk About Risk, https://www.resorgs.org.nz/our-projects/risk-and-resilience-decision-making/lets-talk-aboutrisk/.

[34] Engagement planning for Clutha Delta adaptation programme will evolve through four phases, each with multiple steps. Currently the programme is working through the key steps of 'Plan and Prepare' phase (see Figure 2).

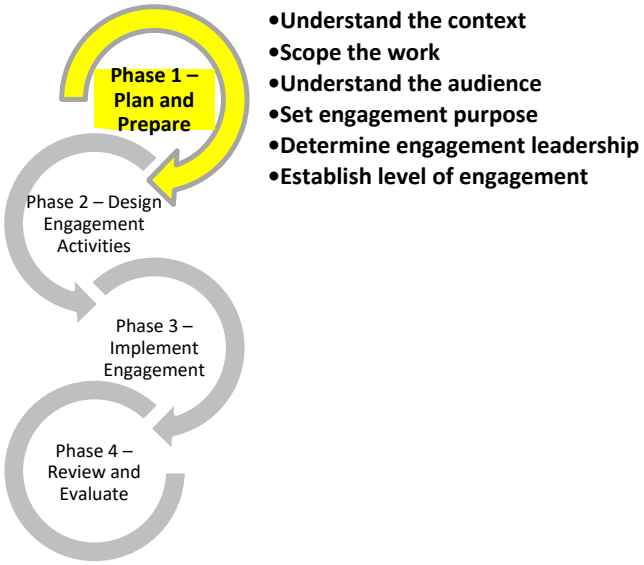


***Figure 2: Engagement planning phases, and key steps for the current "Plan and Prepare" phase.***

<u>"Plan and Prepare" – Understand the Context</u>

[35] Understanding the context helps to situate the work programme within broader international, national and local trends and key social, economic, political and environmental factors. Nationally and globally, there is an increased focus on how to best mitigate risk and build community resilience in the face of complex natural hazards challenges and impacts of a changing climate.

[36] The Clutha Delta, including communities of Balclutha, Stirling and Kaitangata, is predominately Pakeha but has a growing migrant community, largely, to support farming industries. The delta is a highly modified environment and current land-use practices are enabled through the ORC's Lower Clutha Flood Protection and Drainage Scheme. The area has a long history of flooding and various natural hazards have the potential to significantly impact the delta area, including local communities.

[37] Discovery discussions with other ORC teams who are active in the Clutha Delta area are useful to understand community context, identify existing relationships, and opportunities to integrate with other ORC activities. To date, discovery discussions have occurred with Emergency Management Otago, Environmental Implementation, Integrated Catchment Management, Engineering, and Communications. Further discovery is planned for early 2024 with partners and stakeholders.

<u>"Plan and Prepare" – Scope the Work</u>

[38] Scoping is a step that helps to set clear parameters about what is 'on the table' and what is not negotiable for engagement. Example of things that are 'on the table' include values, objectives and aspirations for the future, potential adaptation pathways and how we engage with community and stakeholders.

[39] Non-negotiables identified so far for the Clutha Delta work programme so far include:

- taking a DAPP approach
- informed by the best science and technical guidance available
- informed by community engagement and partnership

"Plan and Prepare" – Understand the Audience

[40] Understanding the audience, or the 'who' of engagement, is a crucial part of working toward an inclusive and accessible engagement process.

[41] The Clutha Delta area comprises a diverse range of affected communities, with a starting list of stakeholders and partners shown in Figure 3. The list will be further developed through the ongoing discovery process. ORC will engage with various communities, stakeholders and partners in different ways at different stages of the programme.

[42] ORC is taking a Te Tiriti partnership approach with mana whenua and an initial discussion with ORC's Senior Advisor – Iwi Partnership and Engagement has taken place to begin considerations of how best for the programme to approach and practice meaningfully partnership with iwi.

[43] ORC has presented and discussed the objectives and scope of the programme with Clutha District Council (CDC), with further discovery discussions on engagement planned for early 2024.

[44] The programme seeks also to collaborate with communities and Emergency Management Otago.

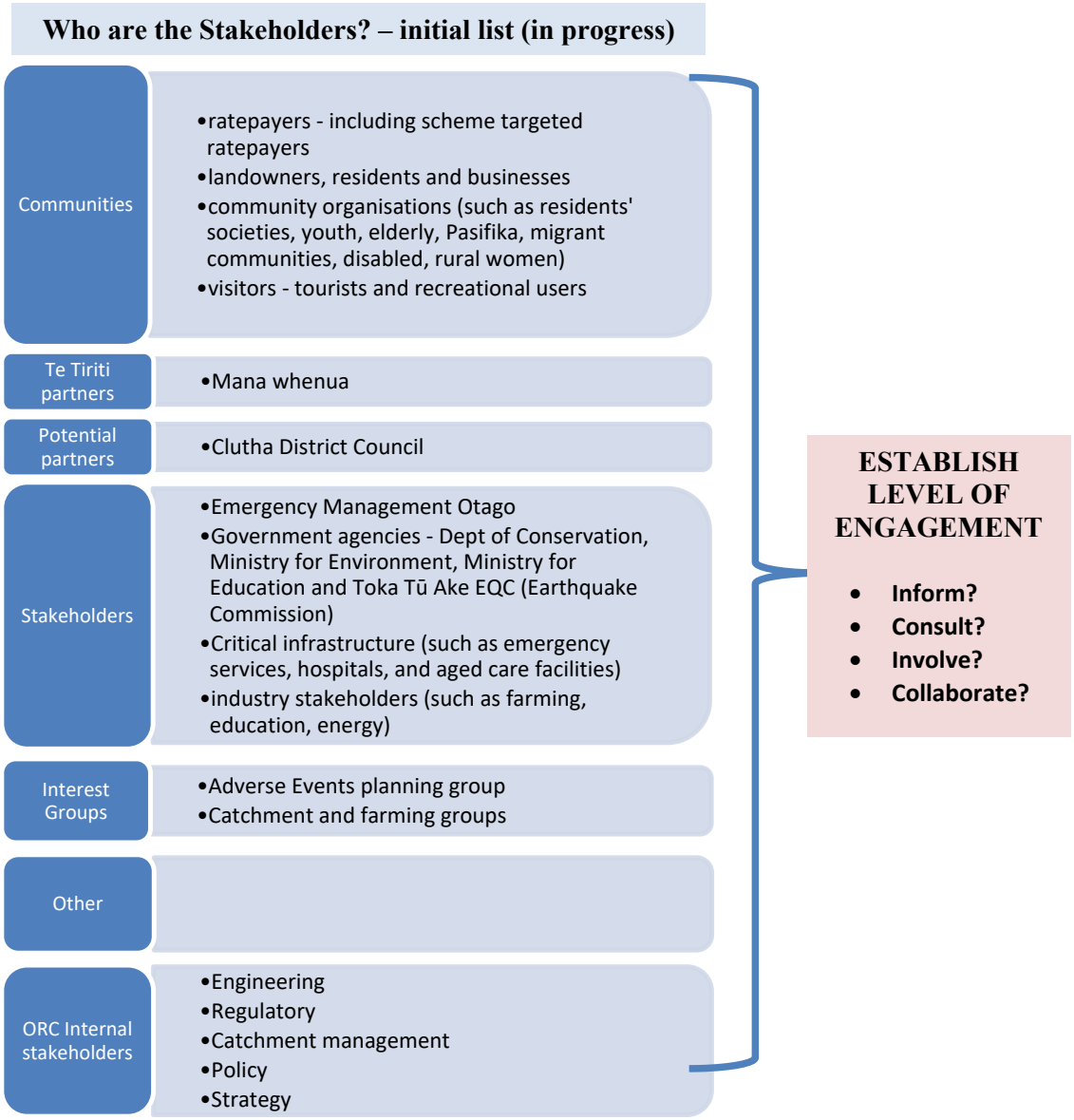


***Figure 3: Understanding the Audience – Who are the Stakeholders?***

"Plan and Prepare" – Set Engagement Purpose

[45] Draft purposes, objectives and goals for the programme community engagement are presented in Table 2.

***Table 2: Draft purposes, objectives and goals of community engagement***

| Purpose | Objectives and Goals |
|---|---|
| **Contribute to decision-making** | For affected communities, stakeholders and partners to meaningfully participate and influence adaptation planning and decision-making processes |
| **Generate innovative ideas and solutions** | To work with affected communities, stakeholders and partners to develop possible adaptation and hazard management approaches that make sense for this place |
| **Build trust and relationships** | To develop relationships and build trust with affected communities, stakeholders and partners in the Clutha Delta area early, well before it is time to make 'hard decisions' |
| **Develop social license** | To build an understanding of what ORC does in relation to natural hazards adaptation and consequently build trust and relationships to undertake council responsibilities in the area. |
| **Build capacity, capability and resilience** | To build community resilience to the impacts of natural hazards events and climate change and support communities to lead adaptation actions from the ground up where possible. |
| **Share knowledge** | To build community understanding and awareness of the risks and potential impacts of natural hazards and climate change. While also, for the council to learn more about mātauraka Māori, local knowledge, values and understandings of place. |
| **Social learning** | For communities and Council to learn more about themselves, including the different values, knowledge and aspirations for the future, and understandings of place they bring to the programme through engagement. |

[46] Engagement will help to build a common understanding of the Clutha Delta area, in collaboration with community, mana whenua, partners and stakeholders. The science and hazardscape of Clutha Delta area is complex; with interactions between multiple natural hazards, a dynamic river and coastal interface, and extensive infrastructure assets. The picture of "*what matters most?*", now and in the future, will incorporate mātauraka Māori and values and objectives of mana whenua; farming community; townships such as Balclutha, Stirling and Kaitangata; residents and businesses.

"Plan and Prepare" – Determine Engagement Leadership

[47] Identifying who leads the engagement process and wider programme is important to set our expectations for who is responsible for leading the engagement and for implementing decisions or actions. The programme is currently led by ORC as ORC is responsible for decision-making and implementation in relation to the Lower Clutha Flood Protection and Drainage Scheme management. Aspects of the programme may

fall under a 'shared leadership and action' model, however shared governance and collaborative partnership agreements are yet to be discussed.

"Plan and Prepare" – Establish Level of Engagement

[48] The last key step of the 'Plan and Prepare' phase is to determine the overall IAP2 spectrum level for the engagement programme (Figure 4). This will depend on the interconnections and outcomes of the context, scope, audience and purpose as discussed above in paragraphs 29-40. Stakeholder analysis will be undertaken to give an indication of where affected stakeholders and communities may sit on the spectrum.

INCREASING IMPACT ON THE DECISION

| | INFORM | CONSULT | INVOLVE | COLLABORATE | EMPOWER |
|---|---|---|---|---|---|
| PUBLIC PARTICIPATION GOAL | To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions. | To obtain public feedback on analysis, alternatives and/or decisions. | To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered. | To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution. | To place final decision making in the hands of the public. |
| PROMISE TO THE PUBLIC | We will keep you informed. | We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision. | We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision. | We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible. | We will implement what you decide. |



***Figure 4: IAP2 spectrum of public participation.***

[49] The engagement planning process recommends 'collaborate' as the level of engagement because it is a highly complex issue, which will require the integration of local knowledge, science and mātauraka Māori to develop solutions. It is anticipated that this programme is of high interest and significance to affected communities, stakeholders and Council and the purpose of engagement will be to come up innovative solutions and gain community support for the programme, decisions made and implementing successful adaptation actions.

[50] Effective community engagement identified in adaptation literature and best-practice points to engagement practices that sit on the collaboration or empowerment end of the spectrum. Recognising that engagement at this end of the spectrum is more resource intensive.

[51] The recommended engagement level signals the highest level of public participation expected to be achieved throughout the programme. The spectrum level may change throughout the programme and across stakeholders. Furthermore, not all aspects of the programme will require the same level of engagement and we will be able to use engagement levels below collaborate where appropriate.

## NATURAL HAZARDS INVESTIGATIONS

[52] The November 2023 paper to the Safety and Resilience Committee noted as next steps several natural hazards investigations for the Clutha Delta area which were in progress or planned. This section provides an update on progress towards completion of those studies.

[53] The investigations noted here are targeted for completion by December 2024.

[54] These investigations will be externally peer reviewed to provide assurance of the robustness of findings.

[55] All investigation findings will be made publicly available, and opportunities given for discussion of findings with community, partners/stakeholders and councillors.

Koau Mouth and Puerua Investigations

[56] A natural hazard and engineering investigation project focusing on the Koau mouth of the Clutha River/Mata-Au and Puerua-Paretai area is being undertaken by Jacobs (NZ) Ltd.

[57] The project is being carried out in response to the coastal erosion event of July 2023, which was described in the August 2023 paper[13] to the Safety and Resilience Committee.

[58] Assessments are being undertaken to allow for thorough consideration of the potential benefits and challenges in potential infrastructure management decisions, and is structured around three key focus areas;

a. Understanding coastal processes and the July 2023 coastal erosion event.
b. Modelling and drainage performance studies.
c. Engineering Investigations.

[59] Periodic aerial imagery is being acquired to allow observation and interpretation of geomorphic coastal changes in the Koau mouth area (e.g. Figures 5 to 7). These figures clearly show the Puerua channel near the outfall culverts being infilled because of coastal retreat processes.

[13] Paterson B and Mifflin M, 2023. Programme Update; Climate Resilience, Flood repairs and Projects. Report OPS2324 to the Otago Regional Council Safety and resilience Committee, 10 August 2023.


***Figure 5: Aerial imagery showing the Koau Mouth of the Clutha River / Mata-Au in January 2020 and July 2023.***

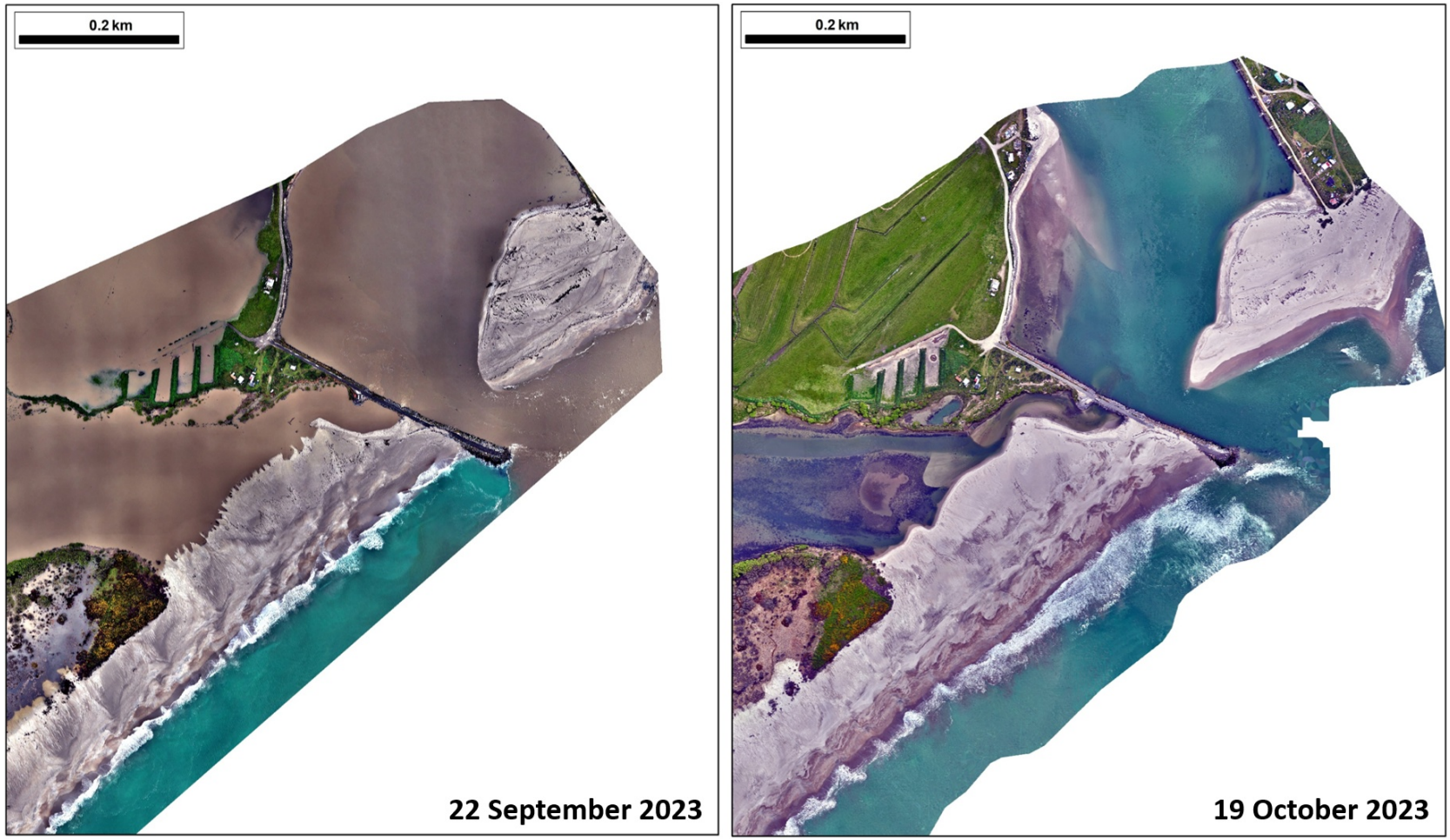


***Figure 6: Aerial imagery showing the Koau Mouth of the Clutha River / Mata-Au in September and October 2023. The September 2023 image was captured with the Clutha River at a flow of about 1300 $m^3/s$ (measured at Balclutha).***


***Figure 7: Aerial imagery showing a closer view of the Koau Mouth training line and Puerua estuary in July and October 2023.***

Management of the impact on Infrastructure located at Koau Mouth and Puerua River.

[60] The management of the infrastructure impacted by the coastal erosion event of July 2023 (Figures 8 to 10), has been to stabilise the existing training line structure and monitor the behaviour of the culverts remaining in the training line. Where the culverts have sediment accumulation, the response will be to remove the sediment to allow the drainage scheme to function.

[61] Observations have shown that there is an increased level of surface water when the coastal effects are increased, such as wave action and higher tides. This impacts the drainage function of the gravity flow outfalls and the culverts through the training line.

[62] The response since the July 2023 coastal event, which is on-going is considered tactical maintenance and will remain in place until further investigations are completed that will inform the options that the infrastructure and functionality of the flood protection and land drainage scheme will need to consider.

[63] Tactical maintenance includes increased inspections by Engineering staff, weekly and biweekly, where the weather and coastal behaviour is considered as having the potential for increased erosion impact. The inspections inform planning for immediate response to 'hold the line' with the training line structure and ensure the remaining culverts have functionality. Holding the line means the infrastructure is being maintained as-is, with what is remaining of the assets, until further investigations and information will inform the longer-term adaptation of the infrastructure form and function. Tactical response incudes replacing rock armouring (using existing rock that is dislodged from tidal action where possible) and maintaining the open egress to the culverts. A stockpile of rock material is also kept on site. Engineering is also carrying out monthly drone surveys of the area to inform any accelerated erosion so that appropriate response can also be planned (Figures 11 to 14). The monthly surveys are also assisting with the Puerua investigation work.

[64] The cost of the tactical maintenance and repairs is also subject to partial funding from Contact Energy where it complies with respective Contact Energy held consents. The Engineering team have been claiming under these consents to date with successful contributions from Contact Energy as it complies with the relevant consent conditions.

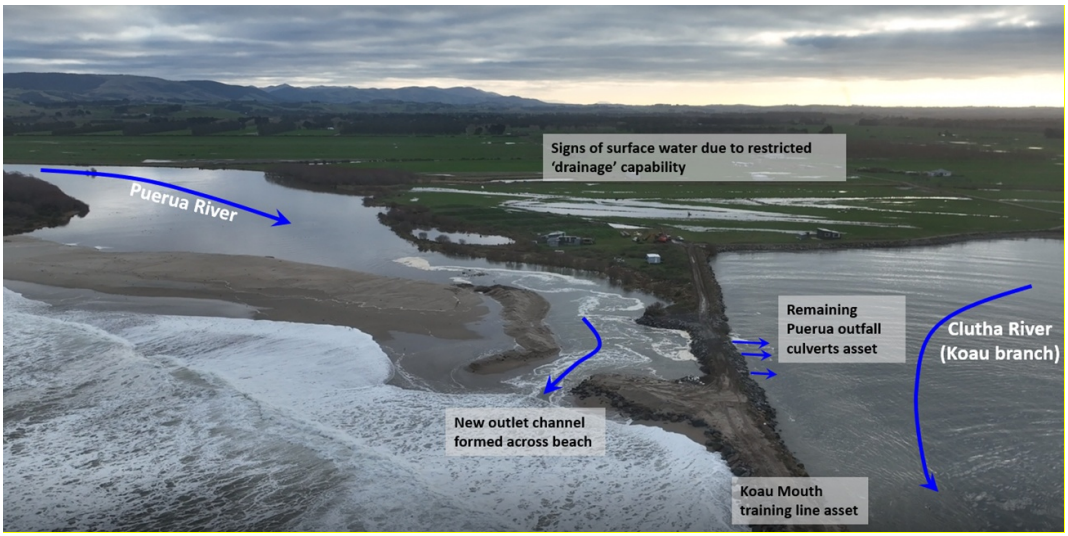


***Figure 8: Imagery showing the infrastructure impacted by the July 2023 event, the Koau training line and culverts, October 2023.***

***Figure 9: Imagery showing the Koau training line (holds culverts) and the progression of the sand deposition, 19 January 2024.***


***Figure 10: Section of the Training line with the remaining culverts, 19 January 2024.***

***Figure 11: The seaward end of the Training line, 19 January 2024.***

***Figure 12: Training line and Koau Mouth, 19 January 2024.***

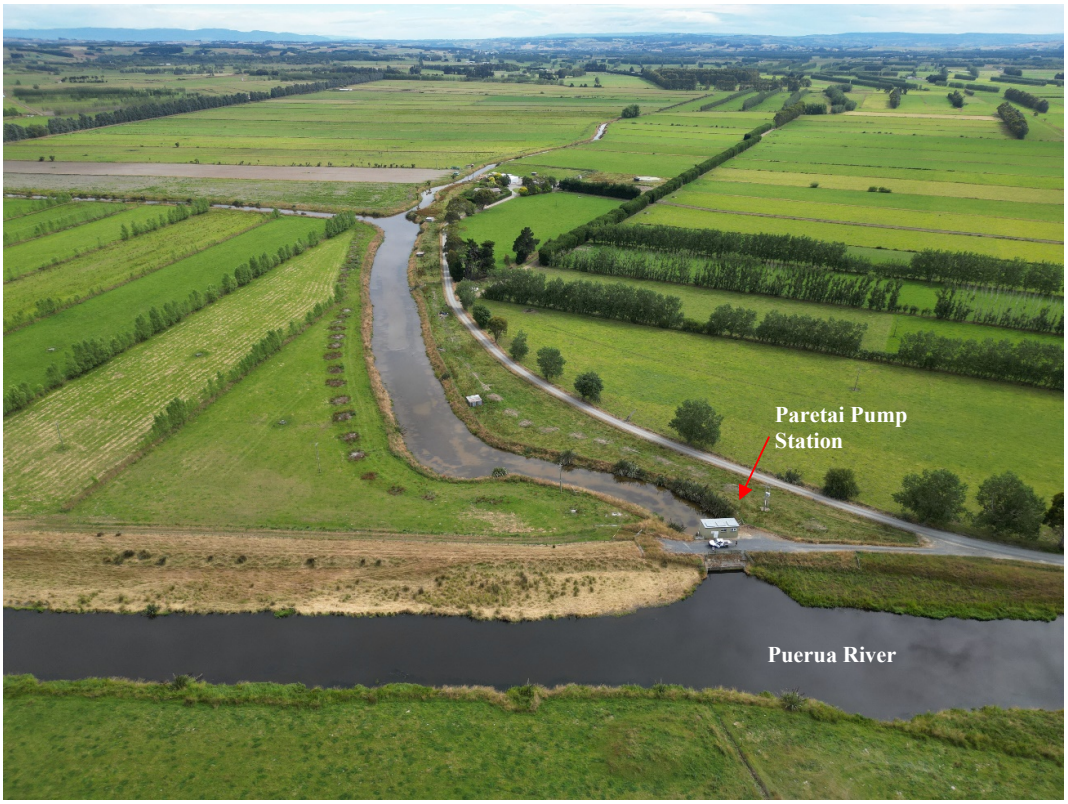

***Figure 13: Paretai Pump Station which manages drainage flows into the Puerua River, 19 January 2024.***

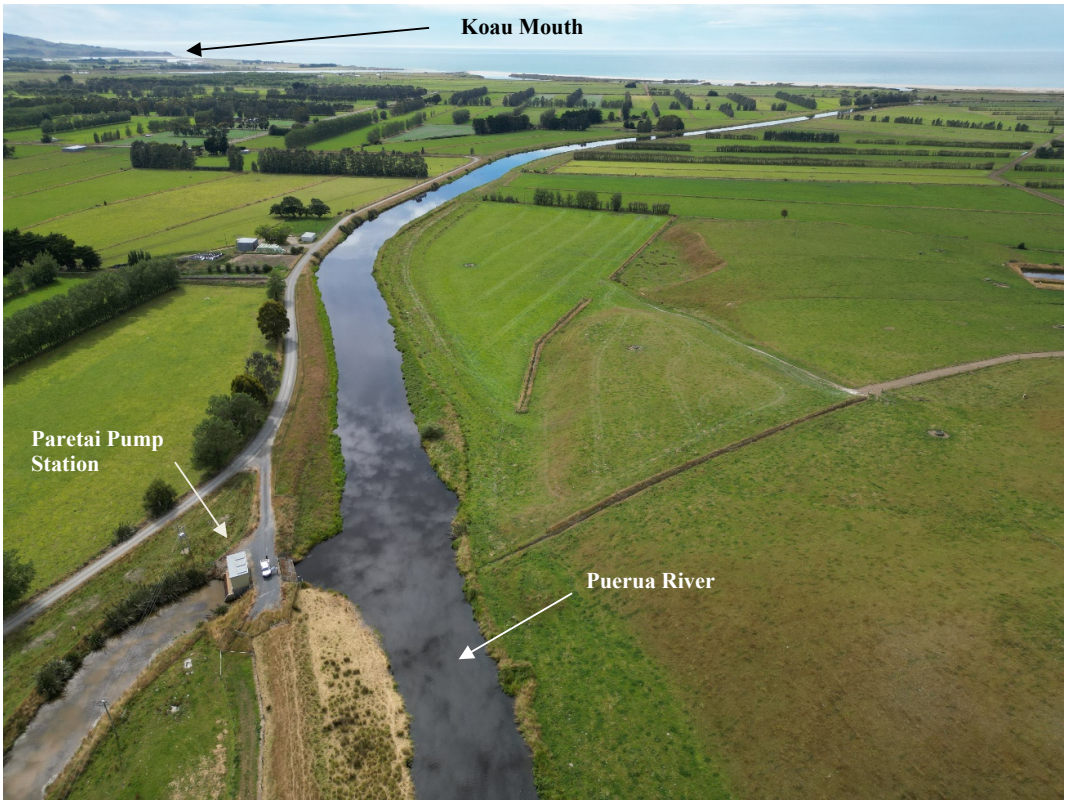


***Figure 14: Paretai Pump Station in foreground showing the Puerua River and Coastline, 19 January 2024.***

[65] The Draft 2024-54 Infrastructure Strategy[14] sets out capital expenditure for significant programmes of work which have been incorporated for adaptation of scheme infrastructure within the Lower Clutha Flood Protection and Drainage Scheme. A project to investigate and undertake adaption works to infrastructure is included in the capital expenditure as 'Puerua Outfalls Culvert Training Line' Adaptation. The Draft 2024-34 Long-Term Plan, and Draft 2024-54 Infrastructure Strategy provision for ongoing tactical maintenance and Infrastructure adaptation. The amount for operational tactical maintenance on the training line and Puerua outfall culverts is provisioned at $307,000 with capital expenditure provisioned at $1.49M, which will be informed by the investigation works carried out in the current Annual Plan (FY 2023/2024) that are described above.

[66] The investigations will result in a significant decision point for Council in Year 1 of the 2024-34 Long-Term Plan.

<u>Flood Hazard Assessment</u>

[14] Infrastructure Strategy 2024-2054, Report to 6 December 2023 meeting of Council, Report No. ENG2101.

[67] A comprehensive hydraulic modelling study and flood hazard assessment for the Clutha Delta is planned. The project findings will be used to further develop ORC's flood hazard mapping and understanding, to inform evaluation of the flood protection scheme performance, and to guide Emergency Management planning for flooding events.

[68] Initial scoping for the flood hazard assessment has been completed. The proposed scope will include hydraulic modelling of the Clutha River/Mata-Au and significant tributary catchments, for a range of flow magnitudes including a "maximum credible" event.

[69] Modelling scenarios will consider the effects of climate change on river flows, the impacts of sea level rise, and potential breaches of floodbank structures.

Liquefaction hazard assessment

[70] A high-level liquefaction hazard assessment is planned for the Clutha Delta. The project findings will be used to inform the local community, ORC, and other project partners/stakeholders of the potential risks posed by these hazards.

[71] The findings will provide an indication of potential impacts from a major earthquake on the flood protection and drainage infrastructure on the Clutha Delta. The potential cascading impacts on flood hazard and drainage may be significant for Balclutha and the wider delta area, for example through damages to floodbank structures or pump stations, or by causing widespread land subsidence.

[72] Initial scoping for the liquefaction hazard assessment has been completed. The proposed scope will include collection of new geotechnical data, analysis of key liquefaction hazard descriptors such as the Liquefaction Severity Number (LSN), and description of interpreted liquefaction land damage and consequences for different return period events. Scoping was informed by external technical advice on potential assessment approaches to ensure the study most effectively achieves its purpose.

[73] The first preparatory activities for this assessment are in progress, such as the compilation of existing geotechnical datasets from local geotechnical consultants so they can be utilised in analysis.

[74] Procurement of consultant expertise for collection of geotechnical data and analysis is expected to commence in early 2024.

## CONSIDERATIONS

### Strategic Framework and Policy Considerations

[75] The information presented in this paper reflects ORC's Strategic Direction to achieve its vision, for Otago *"communities that are resilient in the face of natural hazards, climate change and other risks".*

[76] The proposed Otago Regional Policy Statement June 2021[15], states that ORC and territorial authorities are both responsible for specifying objectives, policies and methods in regional and district plans for managing land subject to natural hazard risk. ORC specifically is responsible for" identifying *areas in the region subject to hazards and describing their characteristics as required by Policy HAZ–NH–P1, mapping the extent of*

[15] Section HAZ-NH-M1

*those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."*[16]

**Financial Considerations**

[77] The budget in the 2023/24 Annual Plan provides for some of the forward work programme described in this paper. The budget for the 2023/24 financial year for the Clutha Delta natural hazards adaptation programme is approximately $300,000 (professional services and staff time).

[78] The remainder of the forward work programme is included in the draft 2024-34 Long-Term Plan (LTP) budget, which provides funding towards delivery, implementation and monitoring of the Clutha Delta natural hazards adaptation strategy. The total proposed budget for the 2024/25 and 2025/26 financial year is $600,000.

**Significance and Engagement**

[79] This noting paper in itself does not trigger ORC's He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy (He Mahi Rau Rika).

[80] Engagement planning to inform the work programme requires consideration of He Mahi Rau Rika, as the Clutha Delta adaptation programme is likely to have potentially significant impacts on communities. It should be noted that each stage and aspect of the engagement process will be designed to be consistent with He Mahi Rau Rika.

**Legislative and Risk Considerations**

[81] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA and the Soil Conservation and Rivers Control Act 1941.

**Climate Change Considerations**

[82] Climate change and sea level rise are key factors influencing natural hazards in the Clutha Delta area. These factors will be considered in natural hazard and risk assessments, particularly for flooding and coastal hazards.

[83] The adaptation programme will be referenced in the upcoming climate change strategies for ORC and CDC.

**Communications Considerations**

[84] The development of a communications plan is underway. The programme team are working with the Communications team to ensure alignment and that communications and engagement planning are integrated and complement and build off each other.

**NEXT STEPS**

[85] A high-level timeline for natural hazards and risk investigations, engagement activities and development of an adaptation strategy, is given in Table 3.

***Table 3: High-level timeline for natural hazards and risk investigations, engagement activities and development of an adaptation strategy, for the Clutha Delta programme.***

| | Programme Milestone | Community Engagement |
|---|---|---|
| **2023** | **December** - Scoping completed for all new natural hazards | Early engagement planning and discovery |

[16] ORC Natural Hazards Portal: http://hazards.orc.govt.nz

| | | |
|---|---|---|
| | investigations | |
| **2024** | **December** - All new natural hazards investigations completed | Engagement planning<br><br>Focus areas for community engagement activities in 2024<br>• "what is happening?"<br>• "what matters most?"<br>• Updates about technical studies and programme progress |
| **2025** | **June**<br>• Natural hazard risk assessment completed<br>• Adaptation option assessments completed<br><br>**December** - Natural hazard adaptation strategy (first iteration) completed | Focus areas for community engagement activities in 2025<br>• "what can we do about it?"<br>• Pathways, triggers and thresholds<br>• Updates about technical studies and programme progress<br>• Draft strategy review cycle |

[86] Scoping for the scheme performance and risk assessments for the Lower Clutha Flood Protection and Drainage Scheme will commence early in 2024 and will be an important component of the natural hazards adaptation programme. This adaptation work programme and the scheme performance and risk assessments will be closely interlinked and intended to complement each other.

[87] The three current natural hazards investigations (Koau Mouth and Puerua investigations, flood hazard assessment and liquefaction hazard assessment) are scheduled to be completed by December 2024. Following this a natural hazard risk assessment will be required. It is expected this assessment would include detailed assessments of the main natural hazard risks in the delta area, and include consideration of the changing future risk profile, and of residual risks for the scheme areas.

[88] ORC is taking a Te Tiriti partnership approach with mana whenua and an initial discussion with ORC's Senior Advisor – Iwi Partnership and Engagement has taken place to begin thinking about how best for the programme to approach and practice meaningfully partnership with iwi.

[89] Further advice from ORC's Senior Advisor - Iwi Partnership and Engagement will help guide the programme's approach to meaningful Te Tiriti partnership. Early discussions with mana whenua, initially through Aukaha and Te Ao Marama Inc, will be an important step for the work programme to develop relationships and identify opportunities for partnership and participation in programme governance, management, and delivery.

[90] ORC will have further discussions with CDC in early 2024 to confirm their preferred level of involvement in the programme and how they wish to collaborate on key workstreams, such as community engagement planning.

[91] The programme governance and management structure will be confirmed, once the collaborative and partnership arrangements with mana whenua, CDC, and EMO are defined through further discussions.

[92] The next steps of engagement planning will be the development of Phase 2 – Design Engagement Activities. The aim for this stage is to determine the different stages of engagement needed across the programme, determine engagement objectives, plan risk management, select and design methods and plan evaluation.

[93] Engagement planning is an iterative process and so we will likely revisit the engagement planning tool as the programme moves forward into a new stage, or if there are any notable changes. This accounts for how the approach and level of community engagement may change, such as from the problem definition phase, to assessing adaptation options, or when implementing decisions made, or based on feedback from community, stakeholders or partners.

[94] Next steps include the development of strategic and operational objectives to guide the direction of the programme and will be informed by engagement with partners, communities and stakeholders.

**ATTACHMENTS**
Nil

### 8.3. Head of Lake Whakatipu Natural Hazards Adaptation

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Comm |
| **Report No.** | HAZ2306 |
| **Activity:** | Governance Report |
| **Author:** | Ann Conroy, Team Leader Natural Hazards Adaptation<br>Tim van Woerden, Senior Natural Hazards Analyst<br>Jamie MacKenzie, Natural Hazards Adaptation Specialist<br>Simon Robinson, Team Leader Natural Hazards Analysis<br>Jean-Luc Payan, Manager Natural Hazards |
| **Endorsed by:** | Gavin Palmer, General Manager Operations |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To update the Committee on progress towards development of a natural hazards adaptation strategy for the Head of Lake Whakatipu area.

## EXECUTIVE SUMMARY

[2] The Otago Regional Council (ORC) led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing well, with three significant technical studies in progress and aiming for completion in early 2024.

[3] The three technical studies, 1) socio-economic impact assessment, 2) natural hazard risk assessment, and 3) flood protection and nature-based solutions feasibility assessment, will contribute to the robust information base for evidence-based decision-making.

[4] Community is at the centre of the Dynamic Adaptive Pathways Planning (DAPP) and their feedback is being considered in ORC's development and scheduling of the work programme. The community has conveyed a strong preference for receiving findings of two finalised technical studies (natural hazard risk assessment and socio-economic impact assessment) prior to engagement focused on pathways development.

[5] In response to the community feedback, ORC has changed the sequence of engagement activities and is proposing to deliver the completed (first iteration) strategy by November 2024, rather than by June 2024. A draft of the strategy document is likely to be available for community/public consideration and feedback in Q3 2024.

[6] The Strategy will include Action Plans that describe adaptation responses that are underway or in progress. Actions that are ORC responsibility will either continue as business-as-usual (e.g. river management), or continue investigations to confirm feasibility and/or support a business case for implementation (e.g. nature based solutions). This ORC work is independent of the publishing timeline for the Strategy.

## RECOMMENDATION

*That the* Safety and Resilience Committee:

1) ***Notes** this report.*
2) ***Notes** the Head of Lake Whakatipu natural hazards adaptation work programme and community engagement.*

## BACKGROUND

[7] The area at the head of Lake Whakatipu (Whakatipu-Wai-Māori) is exposed to multiple natural hazard risks, including those due to seismic events, flooding and slope-related processes. This risk setting is compounded by a changing climate and landscape-scale geomorphic change.

[8] ORC, in collaboration with project partners, is leading a programme of work to develop a natural hazard adaptation strategy for the head of Lake Whakatipu area.

[9] The 2021-2023 Long-Term Plan (LTP) targets for the adaptation strategy are shown in Table 1.

***Table 1: 2021-2023 Long-Term Plan (LTP) targets for the Head of Lake Whakatipu natural hazards adaptation strategy.***

| 2021/22 TARGET | 2022/23 TARGET | 2023/24 TARGET |
|---|---|---|
| **The Head of Lake Whakatipu natural hazards adaptation strategy progresses as per annual work plan.** | The Head of Lake Whakatipu natural hazards adaptation strategy progresses as per annual work plan. | The first Head of Lake Whakatipu natural hazards adaptation strategy completed by 30 June. |

[10] The adaptation project approach and work activities completed are outlined in the papers previously presented in 2021-2023.[1-5] Quarterly update papers to the Safety and Resilience Committee will continue through until the delivery of the strategy in November 2024.

[11] This paper is focused on updates about the development of the natural hazards adaptation strategy and adjustments to the key programme milestones in 2024, based on community feedback.

[12] Updates for other current and planned activities in this work programme are included as Paragraphs 24-51. These include community engagement activities; socio-economic impact assessment; natural hazard risk assessment for Glenorchy and Kinloch; feasibility assessment for floodplain hazard management approaches for the Dart-Rees floodplain (including nature-based solutions); and Buckler Burn flooding hazards.

[1] 1. van Woerden T & Payan J, 2021. *Natural Hazards Adaptation in the Head of Lake Wakatipu*. ORC Report HAZ2105, Report to 27 May 2021 meeting of the Otago Regional Council.
2. van Woerden T & Payan J, 2022. *Head of Lake Wakatipu flooding and liquefaction hazard investigations*. ORC Report HAZ2202, Report to 9 June 2022 meeting of the Otago Regional Council Data and Information Committee.
3. van Woerden T & Payan J, 2023. *Head of Lake Whakatipu floodplain and liquefaction hazard intervention assessments*. ORC Report OPS2256, Report to the 10 May 2023 meeting of the Otago Regional Council Safety and Resilience Committee.
4. Conroy A, van Woerden T, MacKenzie J & Payan J, 2023. *Head of Lake Whakatipu Natural Hazards Adaptation*. ORC Report HAZ2301, Report to 10 August 2023 meeting of the Otago Regional Council Safety and Resilience Committee.
5. MacKenzie J, Conroy A, van Woerden T & Payan J, 2023. *Head of Lake Whakatipu Natural Hazards Adaptation*. ORC Report OPS2340, Report to 9 November 2023 meeting of the Otago Regional Council Safety and Resilience Committee.

[13] Figure 1 shows an overview of key activities in the Head of Lake Whakatipu natural hazards adaptation work programme, with the programme currently focussing on the second and third phases *"What matters most?"* and *"What can we do about it?"* and building towards delivery of a first iteration of the strategy document by November 2024. Figure 1 updates the similar figure presented in the previous committee papers.

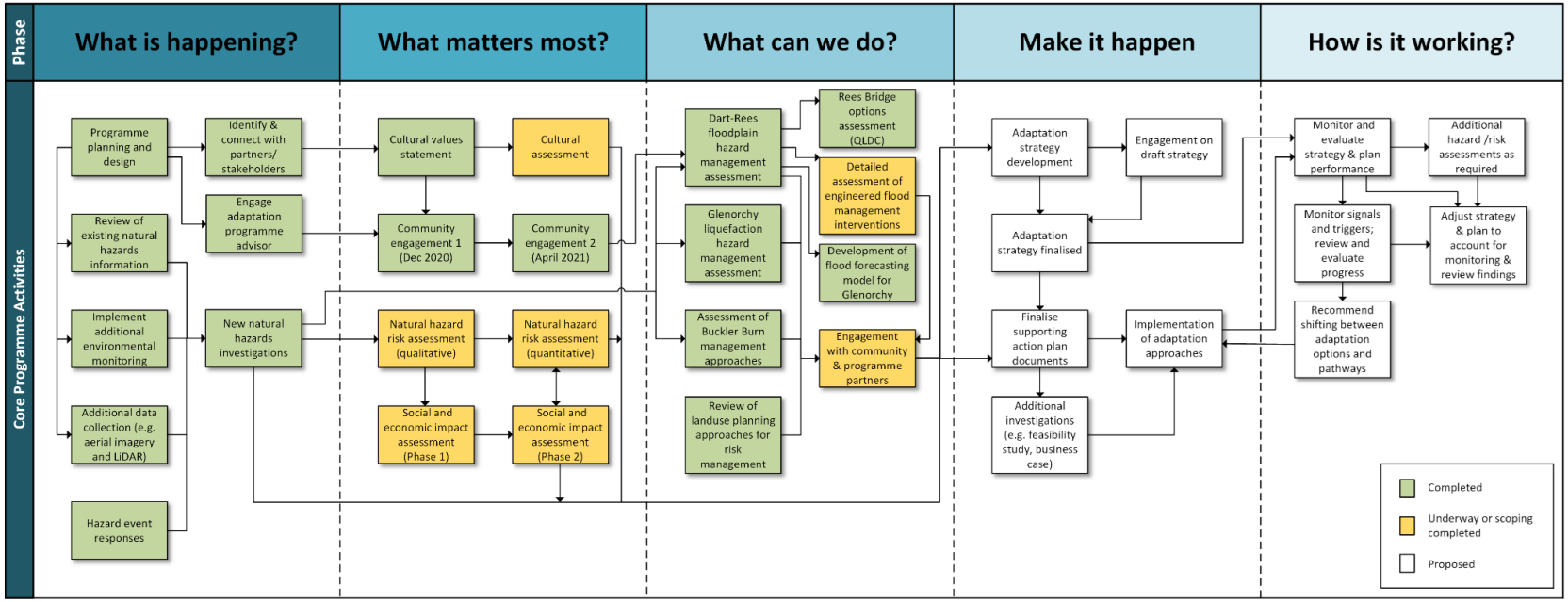


***Figure 1: Head of Lake Whakatipu programme overview of key activities. This diagram updates from the previous (November 2023) committee paper.***

## DISCUSSION

[14] The ORC-led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing well, with three significant technical studies in progress and aiming for completion in early 2024.

[15] In response to community feedback (details in paragraph 27), ORC has changed the sequence of engagement activities and is proposing to deliver the completed (first iteration) strategy by November 2024. A draft of the strategy document is likely to be available for community/public consideration and feedback in Q3 2024.

[16] The Strategy will include Action Plans that describe adaptation responses that are underway or in progress. Actions that are ORC responsibility will either continue as business-as-usual (e.g. river management), or continue investigations to confirm feasibility and/or support a business case for implementation (e.g. nature based solutions). This ORC work is independent of the publishing timeline for the Strategy. Actions to be delivered by other organisations will be agreed as part of consultation with those organisations.

### ADAPTATION STRATEGY DEVELOPMENT

[17] As noted above, ORC has adjusted the delivery schedule for the first iteration of the adaptation strategy in response to community feedback requesting to see the results of the risk assessment and socio-economic impact assessment first, before proceeding with other engagement activities.

[18] The natural hazard risk assessment and socio-economic impact assessment (Phase 1) are underway. These technical assessments are expected to be finalized in Q2 2024.

[19] The revised sequence of key programme activities with Council and community is as follows:

- Presentation of technical assessment results (Q2 2024)
- Adaptation pathways discussion (end of Q2 2024)
- Draft of strategy document released for feedback and comment (Q3 2024)
- Finalised strategy document presented to Council (November 2024)

[20] A screening assessment of the potential cultural significance of a long-list of possible adaptation responses at the Head of Lake Whakatipu is being undertaken separately by Aukaha to incorporate a Te Ao Māori worldview into decision-making processes.

[21] Adaptation strategy development is currently focussed on drafting potential pathways, including suitable signals, triggers, and thresholds, to support community discussion and input (Figures 2-4).

[22] Signals are indicators of change, and triggers are decision points that prompt a move to another pathway, before a harmful adaptation threshold is reached. Signals, triggers, and thresholds can include those based on the physical environment (e.g., riverbed levels, flood heights), as well as social aspects (e.g., community outcomes), policy changes, and economic factors (e.g., funding constraints or opportunities).

[23] Community values and desired outcomes are a key part of adaptation pathways development and also provide a means to measure success.

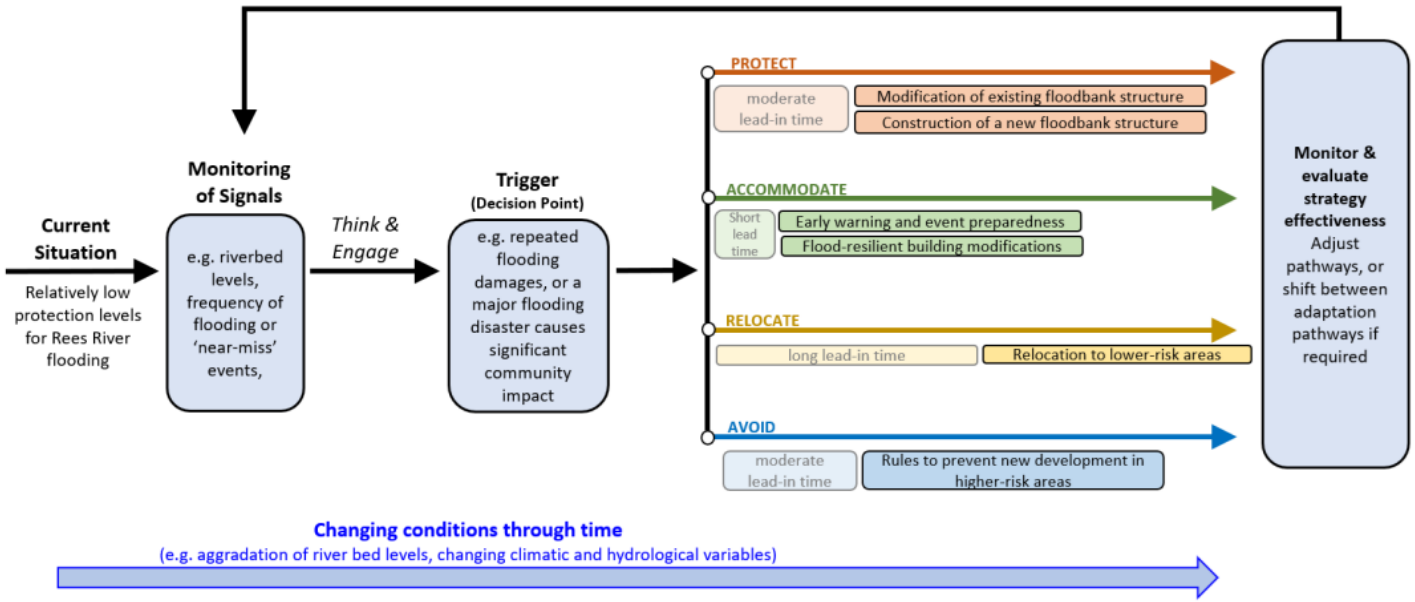


***Figure 2: Example of the adaptation pathways concept showing some possible management responses for flood hazard***

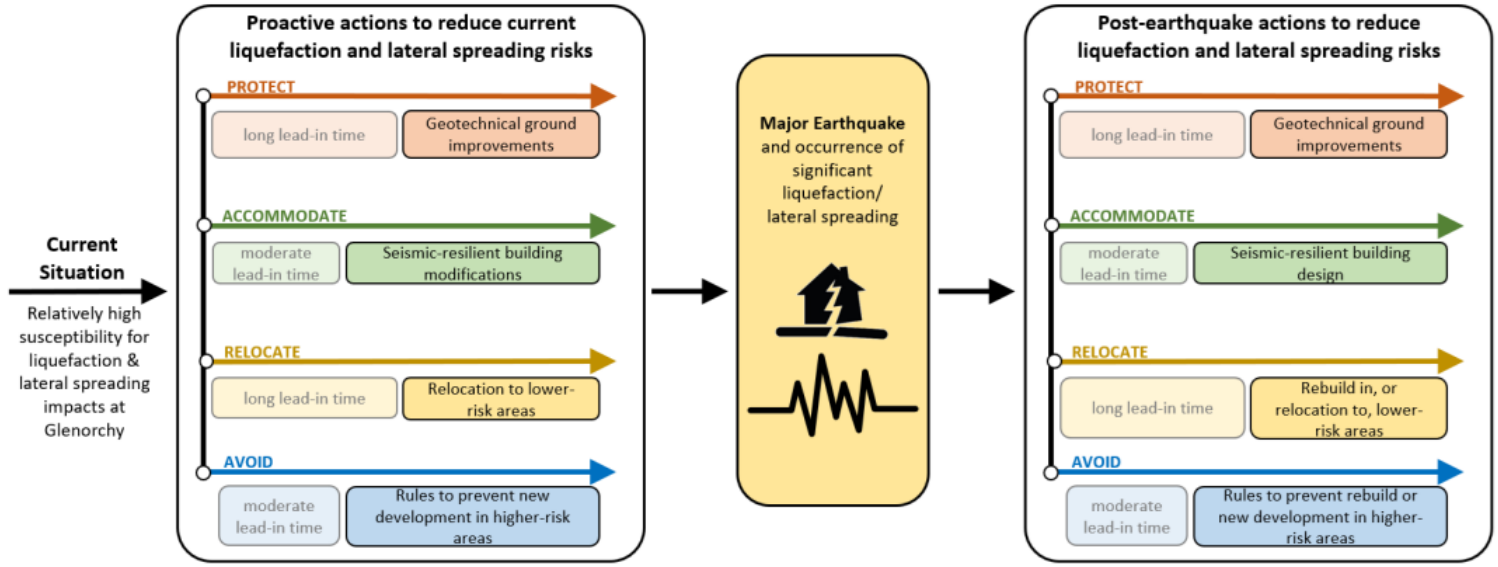


***Figure 3: Example of the possible hazard management responses for liquefaction and lateral spreading hazards.***

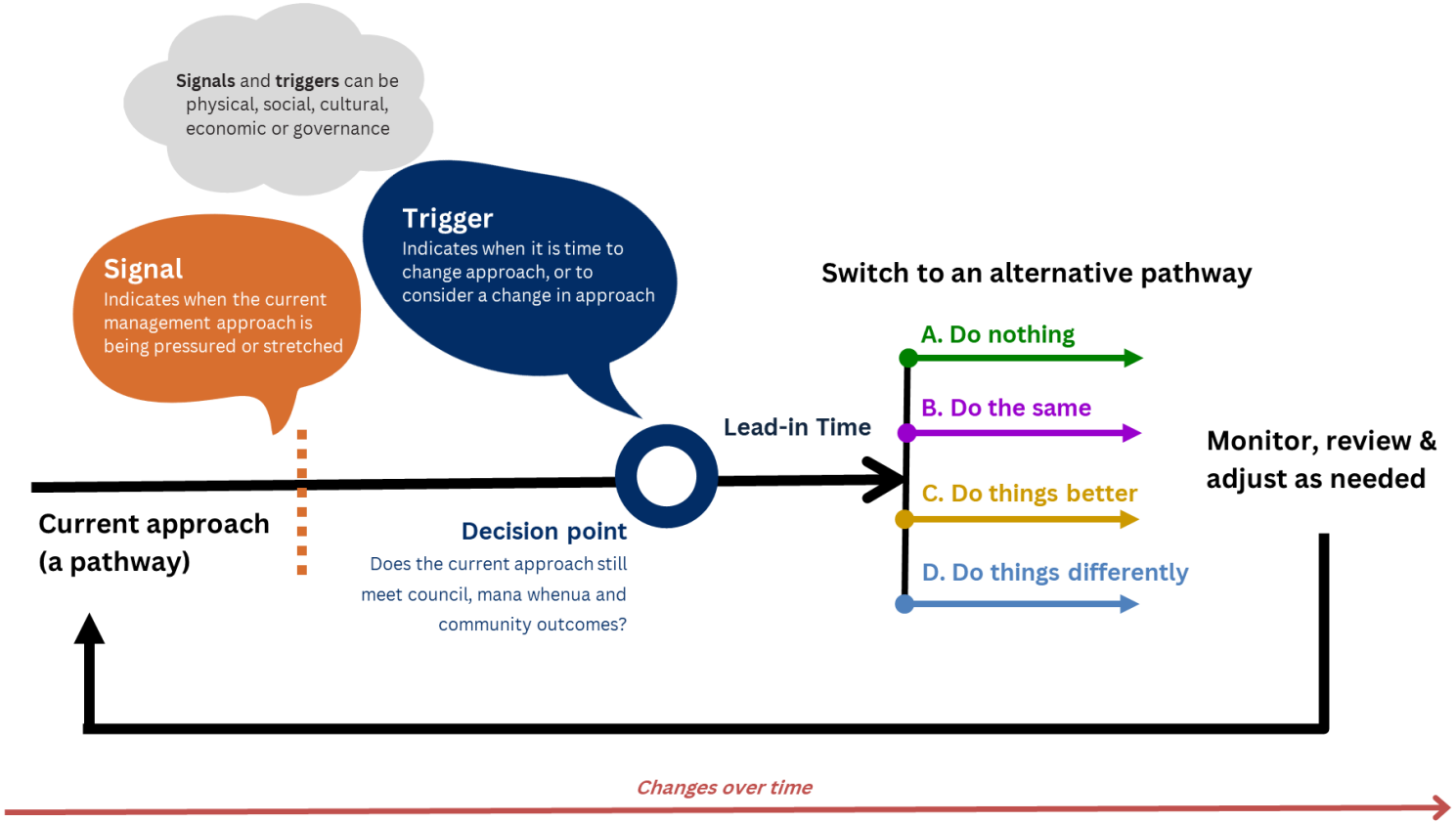


***Figure 4: High level overview of the adaptation pathways concept, including signals and triggers.***

**COMMUNITY ENGAGEMENT**

[24] ORC is considering community suggestions when planning the format, design, and timing of upcoming engagement. Suggestions from the recent online survey included evening or weekend sessions, online or hybrid sessions, and including submissions or presentations from community members as part of the session. The Glenorchy Community Association (GCA) is providing ongoing feedback.

[25] ORC has continued to provide an update newsletter monthly to the Head of Lake Whakatipu community. This newsletter was established in August 2020 and gives progress updates and an indication of upcoming work. There are 97 total newsletter subscribers at time of writing. A copy of the latest newsletter, which includes a summary of programme activities undertaken in 2023, is attached as Appendix A.

[26] ORC and Emergency Management Otago (EMO) staff hosted a stall at the Glenorchy Village Fair in November 2023 to talk about community resilience and preparedness for natural hazard event response and recovery (Figure 5). This was an opportunity to build community awareness and understanding of community response planning and what is currently in place to manage flood hazard risk through event monitoring and response activities (i.e., flood forecasting, and environmental data monitoring)


***Figure 5: Photo of ORC and Emergency Management Otago stall at the Glenorchy Village Fair, November 2023.***

[27] An engagement activity, planned for late 2023 to discuss potential adaptation pathways, did not go ahead at that time due to the following concerns and feedback:

- Overlap with socio-economic impact assessment fieldwork by Beca in November/December 2023
- Overlap with busy period for the community (high tourist season)
- Potential for engagement fatigue
- Community feedback, through the GCA, requesting to see the results of the risk assessment and socio-economic impact assessment first, before other engagement activities.

[28] The planned sequence and timing of community engagement activities has been adjusted in response to this feedback. The revised sequence will present the results of the technical assessments first; followed by a discussion of adaptation pathways; and then a review sequence for the draft strategy document (see paragraph 17-19 for details).

[29] Planning is underway for engagement activities in 2024. NIWA[2] is continuing to provide ORC with expertise in implementing the adaptative pathways approach and engagement planning. Engagement planning is a collaborative process, working with QLDC and the community.

**SOCIO-ECONOMIC IMPACT ASSESSMENT**

[30] A socio-economic impact assessment for the Head of Lake Whakatipu area is a key piece of work under the DAPP process to support decision making (Figure 1).

[31] ORC has procured consultant expertise from Beca Group Limited (Beca) to undertake Phase 1 of the socio-economic impact assessment. A draft report was delivered in mid-December 2023 and is currently under review. The community has been invited to provide feedback on the draft community profile.

[32] The Phase 1 methodology undertaken by Beca included both desktop analysis and fieldwork to develop the community profile. The goal was "*to ensure a wide range of stakeholders and community members experiences are captured and different types of local knowledge, experience and cultural values are reflected in the assessment*". Desktop analysis included collating the available programme, community, and economic data, and identifying and filling gaps. Feedback from the community (through the Glenorchy Community Association) on the economic component of the assessment, led to a revision of the scope to include an increased level of detail in the economic component of the study.

[33] A range of qualitative research methods were undertaken by Beca. The social research team spent 5 days gathering primary data at Head of Lake Whakatipu in November 2023, and utilized other engagement formats as well. The work built and expanded on the programme engagement that has already been undertaken by ORC. The social research team reached 70 people, through various primary data methods including:

- **Interviews** with key stakeholders (e.g. QLDC staff, Department of Conservation, emergency services providers, Glenorchy Community Nurse, Glenorchy Primary School Principal, Glenorchy Community Association); community organisation/club/group representatives; and business owners/operators.

[2] Dr Paula Blackett, Principal Scientist – Environmental Social Science

- **Semi-structured "drop in" interviews** with residents.
- **Focus groups** with Queenstown-based businesses operating at the Head of the Lake; community representatives (e.g. residents and representatives of community organisations/clubs/groups); Glenorchy Primary School students
- **Survey** of residents and businesses
- **Site observations**

[34] Phase 1 of the socio-economic impact assessment findings are intended to be used for the following purposes:

- To provide an understanding of the community profile and socio-economic impacts of various hazard events under "status quo" management actions. This information has been specifically requested by the community to help inform decision-making alongside technical and risk studies.
- To complement and provide information which will feed into other proposed studies, such as a risk assessment and Phase 2 of the socio-economic impact assessment.
- To provide information to inform next steps, for example, to help determine preferred adaptation pathways and to develop a robust evidence base for decision-making in the strategy.

[35] In first quarter 2024 (to be confirmed), Phase 2 will likely focus on screening a long-list of possible adaptation responses for their socio-economic risks and opportunities.

**NATURAL HAZARD RISK ASSESSMENT**

[36] A natural hazard risk assessment project for Glenorchy and Kinloch is being undertaken by Beca Group Limited (Beca). The project is systematically assessing the natural hazard risks in the Glenorchy and Kinloch areas, including those from flooding, seismic and alluvial fan hazards.

[37] Project work completed has included a site visit and a review of the available natural hazards datasets. A qualitative assessment of natural hazard risks is in progress, with qualitative risk assessments expected to be completed for the following hazards;

a. Rees and Dart River flooding
b. Lake Whakatipu flooding
c. Seismic shaking
d. Liquefaction and lateral spreading (at Glenorchy)
e. Buckler Burn flooding and erosion

[38] Where appropriate based on qualitative risk levels and the detail of the available natural hazards information, a more detailed quantitative risk assessment approach will also be applied.

[39] All risk assessment findings will be presented to both the community and to councillors once they have been externally reviewed and finalised, expected to be by early April 2024.

**FLOOD MITIGATION AND NATURE-BASED SOLUTIONS FEASIBILITY ASSESSMENTS**

[40] A technical feasibility study to investigate potential floodplain hazard management approaches for the Dart-Rees floodplain is being undertaken by Damwatch Engineering Ltd.

[41] This feasibility study builds on the initial high-level assessments of benefits, challenges and constraints for flood hazard management interventions outlined in the report completed in 2022.[3] That previous report was presented to the May 2023 meeting of the ORC Safety and Resilience committee.[4]

[42] For the lower Rees floodplain and Glenorchy township flood hazard, the proposed investigation scope includes consideration of (at least) the following potential engineered flood management interventions for the lower Rees River floodplain and Glenorchy township;

a. raising or modifying the existing Rees-Glenorchy floodbank structure;
b. construction of bunding or new floodplain structures to reduce overland flood flows from the Rees River into Glenorchy Lagoon; or
c. the use of innovative 'nature based' approaches such as vegetative buffers to modify overland flood flows from the Rees River into Glenorchy Lagoon; or
d. any combinations of these interventions a-c.

[43] For the Dart floodplain (including along Kinloch Road), and the upper Rees floodplain (upstream of the road bridge), the scope includes assessment of potential flood or erosion management interventions, with a focus on the use of 'nature-based' innovative approaches such as vegetative buffers for flood mitigation or erosion management.

[44] Project work to be completed as part of the study will include;

a. Development of conceptual designs for flood mitigations, and consideration of their resilience to future geomorphic changes, climate change effects and the occurrence of super-design flood events.
b. Investigation of the use of nature-based solutions for flooding and erosion management, such as the use of vegetation buffers along river banks.
c. The use of a computational hydraulic modelling approach to assess the effectiveness of the possible floodplain management interventions.
d. Assessment of the technical challenges and constraints for implementation of design concepts, potential environmental impacts, consenting requirements and indicative costings.

[45] The 'nature-based solutions' aspects of the investigations are being supported financially by the Ministry for the Environment (MfE) funding programme, *Nature Based Solutions for Resilience Planning*.

[46] All findings from this study will be presented to both the community and to councillors once they have been externally reviewed and finalised, expected to be by late April 2024.

**BUCKLER BURN FLOODING HAZARDS**

[3] Damwatch Engineering Ltd, 2022. *Dart-Rees floodplain adaptation – Report on 23-24 February workshop*. Report prepared for Otago Regional Council.
[4] van Woerden T & Payan J, 2023. *Head of Lake Whakatipu floodplain and liquefaction hazard intervention assessments*. ORC Report OPS2256, Report to the 10 May 2023 meeting of the Otago Regional Council Safety and Resilience Committee.

[47] A flood hazard assessment for the Bucker Burn was completed in August 2023. The technical report by Land River Sea Consulting Ltd[5] was included as an appendix to the November 2023 update paper to the Safety and Resilience Committee.

[48] The technical report has been made publicly available on the adaptation programme webpage.[6] A selection of the modelled scenario outputs have been uploaded to the ORC Natural Hazards Database.[7]

[49] The flood hazard investigation findings are being used in the assessment of flooding risks for Glenorchy, as part of the assessments being currently undertaken by Beca.

[50] The ORC Engineering team will consider the requirement for river management activities to address natural hazards issues (flooding or bank erosion), such as development of a target bed level profile and gravel management, depending on risk assessment findings and any additional technical advice.

[51] The study identified a number of information gaps which may need to be addressed by additional investigations or monitoring. Actions relating to geomorphic monitoring and collection of flooding event data will be addressed in an 'action plan' being developed as part of the natural hazards adaptation strategy.

## CONSIDERATIONS

### Strategic Framework and Policy Considerations

[52] The information presented and the adaptation approach discussed in this paper reflects Council's Strategic Directions where our vision states: communities that are resilient in the face of natural hazards, climate change, and other risks.

[53] The proposed Otago Regional Policy Statement June 2021[8], states that ORC and territorial authorities are both responsible for specifying objectives, policies, and methods in regional and district plans for managing land subject to natural hazard risk. ORC specifically is responsible for *"identifying areas in the region subject to natural hazards and describing their characteristics as required by Policy HAZ–NH–P1, mapping the extent of those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."*[9]

### Financial Considerations

[54] The budget in the 2023/24 Annual Plan provides for most of the forward work programme described in this paper. The budget for the 2023/24 financial year for professional services for the Head of Lake Whakatipu natural hazards adaptation programme is $470,000.

[55] The Ministry for the Environment (MfE) funding programme, *Nature Based Solutions for Resilience Planning* is financially supporting the 'nature-based solutions' aspects of the flood protection feasibility assessments.

[5] Land River Sea Consulting Ltd, 2023. *Buckler Burn flood hazard modelling*. Prepared for Otago Regional Council.
[6] https://www.orc.govt.nz/managing-our-environment/natural-hazards/head-of-lake-wakatipu
[7] http://hazards.orc.govt.nz
[8] Section HAZ-NH-M1
[9] ORC Natural Hazards Portal: http://hazards.orc.govt.nz

[56] The proposed budget in the draft 2024-34 LTP provides funding towards delivery, implementation and monitoring of the Head of Lake Whakatipu natural hazards adaptation strategy. The proposed budget for the 2024/25 financial year is approximately $175,000.

**Significance and Engagement Considerations**

[57] This noting paper in itself does not trigger ORC's He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy (He Mahi Rau Rika).

[58] Engagement planning to inform the work programme requires consideration of He Mahi Rau Rika, as the Head of Lake Whakatipu adaptation programme is highly complex and may have significant impacts on communities. It should be noted that each stage and aspect of the engagement process will be designed to be consistent with He Mahi Rau Rika.

**Legislative and Risk Considerations**

[59] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA.

[60] There is not currently a formalised programme governance agreement between ORC and QLDC for this adaptation programme, although there is a strong collaborative relationship at staff level. It will be critical to the successful delivery and implementation of the strategy that both councils endorse the strategy.

[61] The new central government has repealed the Natural and Built Environment Act and the Spatial Planning Act.[10] The implications of changes in legislative focus are not clear yet.

[62] There is no clear, specific, mandated requirement to reduce risk through planning and implementation of adaptation or relocation. Gaps identified in the current adaptation planning and planned relocation frameworks include the lack of national direction, insufficient powers, tools and mechanisms, and the lack of articulated roles and responsibilities.[11]

**Climate Change Considerations**

[63] The effects of climate change have been considered in flood hazard assessments for Dart and Rees Rivers, and Buckler Burn, and in the assessment of risks and potential hazard management responses for those hazards.

**Communications Considerations**

[64] ORC will continue to make all investigation findings available to the Head of Lake Whakatipu community and provide regular programme updates via the e-newsletter.[12]

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[10] https://www.beehive.govt.nz/release/nba-and-spa-successfully-repealed#:~:text=Parliament%20has%20passed%20legislation%20repealing,Reform%20Minister%20Chris%20Bishop%20says.

[11] Expert Working Group on Managed Retreat. 2023. *Report of the Expert Working Group on Managed Retreat: A Proposed System for Te Hekenga Rauora/Planned Relocation*. Wellington: Expert Working Group on Managed Retreat.

[12] https://www.orc.govt.nz/managing-our-environment/natural-hazards/head-of-lake-whakatipu/community-get-in-touch-be-involved

[65] The programme team are working with the Communications team to ensure alignment for engagement and communications planning.

[66] A series of community engagement activities are part of the adaptation strategy development process. Engagement input from the community will continue to inform the next stages of the DAPP process as we move through *"What can we do about it?" and "Make it happen"*.

**NEXT STEPS**

[67] The key next step activities for the work programme which are in progress or scheduled are identified in Figure 1.

[68] A high-level timeline for key programme and engagement activities, and development of an adaptation strategy, is given in Table 2.

***Table 2: High-level timeline for key programme and engagement activities, and development of an adaptation strategy, for the Head of Lake Whakatipu programme.***

| | Programme Activity | Community Engagement |
|---|---|---|
| **2024 Q1** | Progress technical assessments<br>Strategy development and design | Planning |
| **2024 Q2** | Deliver technical studies:<br>• Socio- economic assessment<br>• Cultural assessment<br>• Natural hazard risk assessment for Glenorchy and Kinloch<br>• Flood management interventions and nature-based solutions for floodplain hazard management | Focus of community engagement:<br>• Technical studies update<br>• Discussion of adaptation pathways |
| **2024 Q3** | Deliver draft strategy and action plans (for comment) | Focus of community engagement:<br>• Draft strategy |
| **2024 Q4** | November – deliver final Strategy | Focus of community engagement:<br>• Final strategy |

[69] Quarterly programme updates for the Safety and Resilience Committee are scheduled for 2024. These may include workshops and/or committee papers, as appropriate.

**ATTACHMENTS**

1. Appendix A - Head of Lake Whakatipu Newsletter_December 2023 [**8.3.1** - 11 pages]

View this email in your browser

# HEAD OF LAKE WHAKATIPU

## COMMUNITY UPDATE 32 | DECEMBER 2023

Kia ora koutou,

Here is our final programme update for 2023. It includes a summary of the milestones we've achieved together this year, progress updates on some ongoing projects, information about ORC's Environmental Data Portal, and an introduction to some more members of our team.

This year, we have achieved some major milestones in the programme of work toward a natural hazard adaptation strategy for the Head of Lake Whakatipu.

We're very grateful to the community members who continue to share their experiences, perspectives and ideas to help us develop this collaborative work.

We will be back with another update in February. Have a lovely summer break and we look forward to seeing you again in 2024!

## Reflecting on 2023

It's been a busy year for the Head of Lake Whakatipu natural hazards adaptation programme, and we wanted to give a quick overview of everything that has been achieved over the past 12 months. Thank you to everyone who has been involved.

**Reports 2023:**

- An assessment report by Tonkin + Taylor Ltd looks at possible engineered hazard mitigation or management approaches for liquefaction and lateral spreading. You can watch a presentation from Mike Jacka, who wrote this report, here.

- A flood hazard report and summary document were completed on the Buckler Burn.

Archive for reports from previous years can be found on the ORC website.

**Glenorchy Flood Forecasting Model**

- A flood forecasting model was developed for Glenorchy Lagoon, allowing early warning of potential high water levels or possible flooding into Glenorchy.

- The model was tested in the late September weather event as a tool for forecasting the floodwater level from the lagoon. The performance and accuracy of the model are being evaluated, and the model will be refined following monitoring observations from this event.

**Council updates**

- There were three update reports to the ORC Safety and Resilience Committee in May, August and November.

**Telling the Head of the Lake Whakatipu story**

Natural Hazards Adaptation Specialist Jamie MacKenzie completed her master's research on storytelling and the ORC's community engagement process in developing the Head of Lake Whakatipu Adaptation Strategy. Jamie presented the findings of her research to the Glenorchy Community Association in August.

**Staff and team updates**

We welcomed four new team members to the ORC Natural Hazards team – Jamie MacKenzie, Ann Conroy, Simon Robinson and, most recently, Toan Nguyen! Check out his profile below. Ann and Simon lead the Adaptation and Analysis teams respectively.

**Talking to the community**

- We held two in-person workshops at the end of August. The workshops focused on draft community outcomes and discussed a ‘long list’ of possible adaptation options.
- We conducted an online survey in September/October about community values, draft outcome statements and how we should engage with the community in the future. There were 47 responses.
- We had a stall at the Glenorchy Village Fair in November alongside Emergency Management Otago to talk about community resilience, readiness and response.

### In progress

- The natural hazard risk assessment led by Beca is on track to be completed early next year.
- The socio-economic impact assessment, also led by Beca, is progressing, and the first phase is due to be completed by the end of the year.
- An assessment of potential engineered flood management and ‘nature-based solutions’ approach for the Rees and Dart floodplain areas and the Glenorchy township is now underway with the team from Damwatch Ltd. This project is partially funded by the Ministry for the Environment through the ‘Nature Based Solutions for Resilience Planning’ programme.

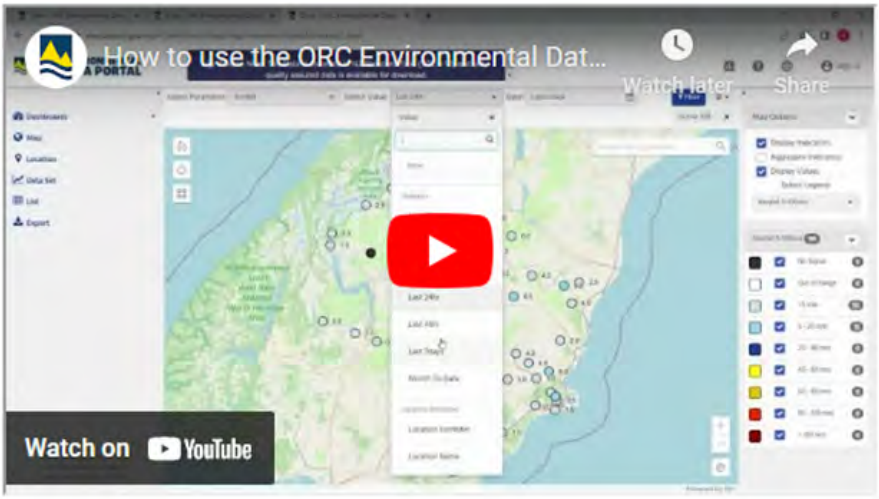

Image: Glenorchy's Red Shed

## Check out ORC's new portal for water data

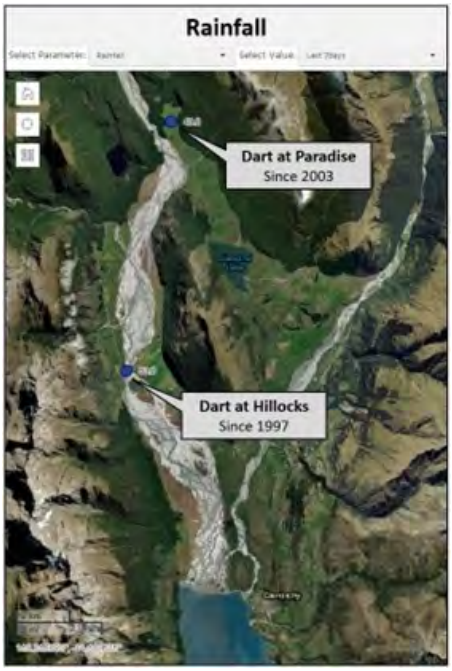
You may have used ORC's website to check monitoring data for rainfall, water levels and river flows. The old system has been replaced with a new water monitoring data portal that will give you access to even more data in an easy-to-navigate map-based format.

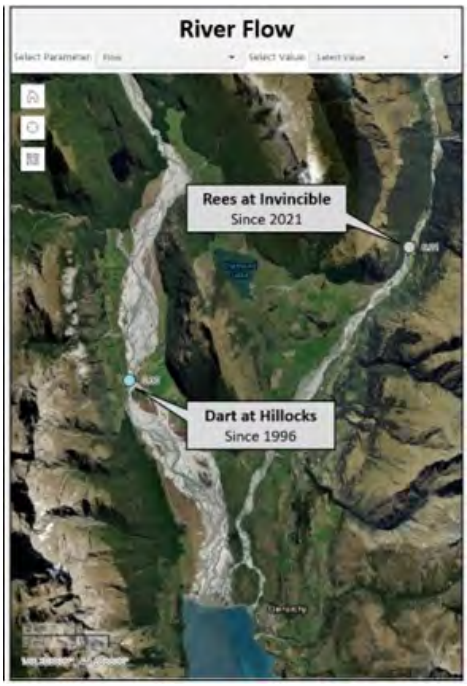
You can access the Environmental Data Portal here. Please note that the old WaterInfo monitoring sites no longer work.

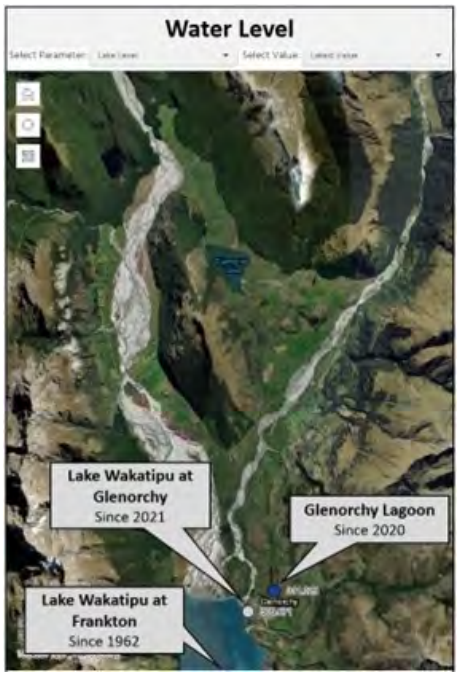
The Environmental Data Portal includes user guides and a training video if you need help. Each monitoring site has a dashboard with data for the last 30 and 180 days, but you can also view the full historical dataset for each site.




Examples of the monitored parameters (rainfall, river flow and water level) for the ORC-monitored sites in the Head of Lake Whakatipu area are shown below.






## Out and about in Glenorchy

If you stopped by the Glenorchy Village Fair on Sunday, 19 November, you may have seen Jamie from the Natural Hazards team with Craig Gibson from Emergency Management Otago. It was a beautiful sunny day and a great chance to see some of the awesome things happening in the community.

Jamie and Craig had some good conversations about the natural hazards adaptation programme, community resilience, and what you can do to be better prepared for a potential hazard event!

It was great to hear what some of you are already doing at home, work and across the community to be more resilient.


Images: Jamie MacKenzie (top) and Graig Gibson at the Glenorchy Village Fair in November

## Progress on the socio-economic impact assessment

Jo and Kaitlyn from Beca, who are leading the socio-economic impact assessment, visited Glenorchy in early November.

They spoke to key stakeholders, held a community focus group, ran a session at Glenorchy Primary School, spoke to some parents from the local playgroup, and held drop-in sessions.

Thank you to those who spoke with them.

To capture additional information, there is also a residents and business survey: https://forms.office.com/r/tVLTvWPGzb.

The survey will close today, Friday, 8 December, so get in quick if you want to participate. A range of businesses are also being spoken to.

## Meet the Team

### Jean-Luc Payan – Manager Natural Hazards

Image: Jean-Luc Payan

Jean-Luc has been with ORC for 15 years. His role is to ensure the various natural hazard investigations and adaptation programmes, including the Head of Lake Whakatipu, are progressing well.

He has a background in hydrology and river management and a solid understanding of natural hazards in Otago.

Originally from France, Jean-Luc came to New Zealand in 2008, and Otago's outstanding landscape (and fishing spots!) convinced him to stay.

### Toan Nguyen – Senior Natural Hazards Adaptation Specialist

Image: Toan Nguyen

Toan joined the ORC in the role of Senior Natural Hazards Adaptation Specialist in November. He recently completed a PhD in natural hazards and climate change adaptation and has many years of experience working in this space in Asia, the Pacific and New Zealand.

Toan will be providing expert advice and analysis to help develop a Natural Hazards Adaptation Strategy for the Head of Lake Whakatipu area and deliver work supporting natural hazards and climate change adaptation across the Otago region.

## As always, we value your feedback

This adaptation programme was initiated because complex, increasing natural hazards in the Head of Lake Whakatipu require a comprehensive management response that takes a long-term view and encompasses all types of natural hazards.

This is your community, and we want to work with you to develop understanding and resilience. Check here to learn more about the whole programme.

If you have questions or need information, visit our website to see the reports and get answers.

You can also speak to a member of the ORC Natural Hazards team on 0800 474 082 or email us for more information at headofthelake@orc.govt.nz.

We will provide responses to any emailed questions and facilitate answers from our consultants if needed.

**Head of Lake Whakatipu newsletter sign-up**

If you are currently not receiving our monthly newsletters, you can sign up here and view archives of past editions.

**Contacts**

If you have any questions or would like to get in touch with us, please email us at headofthelake@orc.govt.nz.

Otago Regional Council

**8.4. Lower Taieri Risk Assessment**

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Committee |
| **Report No.** | ENG2302 |
| **Activity:** | Governance Report |
| **Author:** | Ellyse Gore, Project Manager – Special Projects<br>Brett Paterson, Team Leader Programme Management<br>Michelle Mifflin, Manager Engineering<br>Pam Wilson, Principal Technical Advisor |
| **Endorsed by:** | Gavin Palmer, General Manager |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To inform Council of the findings of the Lower Taieri Flood Protection Scheme Floodbank Risk Assessment and to provide an overview of the wider ORC programme of flood infrastructure risk management for the Taieri Plain.

## EXECUTIVE SUMMARY

[2] This paper provides an update on an activity set out in the current Long-Term Plan 2021-2031, which is to carry out a Scheme Review for the Lower Taieri Flood Protection Scheme (the Scheme).

[3] The original project scope set out to examine the *performance of the scheme*, in terms of how it performs against known design standards, and to investigate improvements where relevant to increase the performance through infrastructural changes, e.g., raising floodbanks or altering spillways which have been the subject of community discussions previously.

[4] The project was extended to examine and consolidate historical flooding, hydraulic and condition reports and information for the Scheme and to carry out an initial exercise to better understand the risk associated with its current condition and performance. As part of this, a Scheme floodbank risk assessment has been undertaken. The assessment informs ORC of the relative risks of failure within the Scheme which in turn informs management of floodbank and associated assets. This was deemed a critical initial phase of a broader scheme review process which is discussed further in this paper.

[5] The outcomes achieved to date include the completion of a Floodbank Risk Assessment which is detailed in this paper.

[6] The results of the assessment for the selected flood scenario show that 0.4 km (0.4%) of the assessed floodbank sections (total length ~109km) have an Extreme risk rating, and 16 km (15%) have a Very High-risk rating. 51 km (47%) have a High-risk rating. The remaining sections have a Medium or lower risk rating. Steps are being taken to reduce the Extreme risks, and reduction plans will be developed for all the other identified risks.

[7] The Draft Infrastructure Strategy [1]2024-2054 provides for an ongoing programme of activities that will inform risk assessment outcomes, including routine condition assessments and monitoring, performance assessments and geotechnical investigations. Throughout the lifetime of the Infrastructure Strategy $56.8M of capital expenditure is assigned to projects that are intended to increase the resilience of flood protection infrastructure on the Lower Taieri. For example, the Contour Channel Resilience Upgrade, Lower Taieri adaptation works and Outram resilience improvements.

[8] The nature of the consequences of the risks at some locations are such that it is not feasible to reduce the risk attributable to floodbank performance to less than Medium. For example, any breach scenario that impacts Dunedin Airport will always be Medium risk or higher. These situations rely on readiness measures or site-specific measures to further reduce the risk.

## RECOMMENDATION

*That the Committee:*

1) ***Notes*** *this report.*
2) ***Notes*** *the report by Tonkin + Taylor Ltd;* Taieri Flood Protection Scheme, Floodbank Risk Assessment*, dated November 2023.*
3) ***Notes*** *the programme of work underway that will reduce the flood risk for the Lower Taieri floodplain.*
4) ***Recommends that Council endorses*** *proceeding with communication of the Floodbank Risk Assessment to the broader community though the development of a Phase 1 Communications and Engagement Plan for the risk assessment and wider programme of work.*

## BACKGROUND

[9] The Taieri Plains is a low-lying alluvium-filled basin with an elevation of about 40m in the east, to below mean sea level in the west (as shown in Figure 1). It has three significant watercourses crossing it: the Taieri River, Silver Stream and the Waipori River along with smaller watercourses including the Owhiro Stream, Mill Creek, Meggat Burn and Quarry Creek. The floodplain has a catchment area of ~565,000 ha (Figure 2). Lakes Waipori and Waihola mark the plain's western boundary and have a regulating effect on drainage for the western part of the plains.

[1] *Infrastructure Strategy 2024-2054*, Report to 6 December 2023 meeting of Council, Report No. ENG2101.

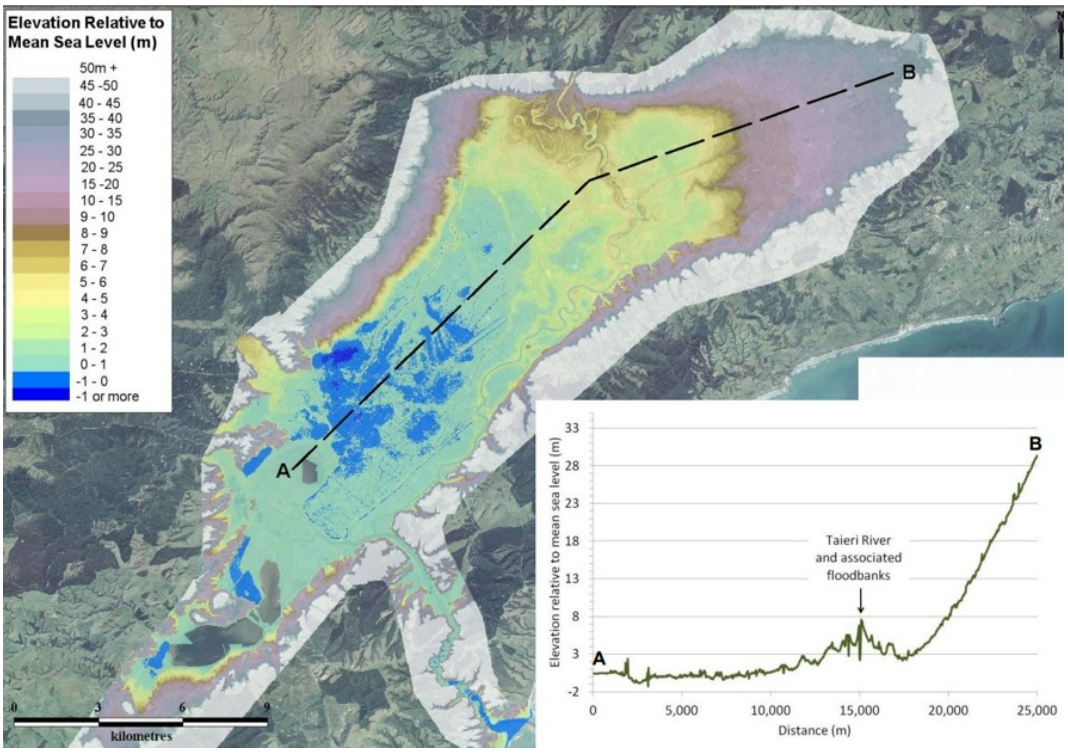



***Figure 1: LiDAR map of Lower Taieri floodplain along with LiDAR cross-sections through Taieri River and Lake Waipori floodbanks.***


***Figure 2: Map of Taieri catchment.***

[10] Approximately 6,082ha of the floodplain is at or below current mean sea level (Figure 1). At its lowest point (excluding drains and ditches), it lies about 1.5m below current mean sea level. Much of West Taieri is lower than the level of Lake Waipori (which is tidally influenced) and therefore relies on the Scheme floodbanks to hold the water back even when the Taieri and Waipori Rivers are not in flood.

[11] Previous ORC reports[2] have identified the Taieri Plains as exposed to the potential impacts of natural hazard events, particularly flooding (Figure 3 and 4 show examples of the floodplain in flood).

***Figure 3: Aerial photo of part of the floodplain as viewed from near Allanton, towards the Maungatua Range, 2017 (looking upstream).***

***Figure 4: Aerial photo of Taieri River floodway Northwest of Henley in 2017 (looking upstream).***

[12] The Scheme provides flood mitigation to an area of ~18,000 ha of the Taieri plain, with floodbanks extending ~109 km in length. This includes extensive farming areas, the townships of Mosgiel, Outram, Momona, and Dunedin Airport.

[2] eg. Flood hazard on the Taieri Plain Review of Dunedin City District Plan: Natural hazards First revision: August 2015. Flood Hazard on the Taieri Plain and Strath Taieri Review of Dunedin City District Plan: Natural hazards, June 2014. Natural Hazards on the Taieri Plains, Otago, March 2013.

[13] Development of the Scheme has significantly modified the flood hazard of parts of the Taieri Plain[3]. The Taieri River, Silver Stream, Waipori River, Owhiro Stream, Mill Creek, Meggat Burn and Quarry Creek have all been modified in some way by engineering works. The Scheme relies on the temporary detention of floodwaters within defined ponding areas, and spillways and floodways to manage flows in an orderly way. Figures 5 and 6 show two of the spillways (Gordon Road Spillway and Riverside Spillway) in operation.

***Figure 5: Gordon Road Spillway operating (April 2006).***

[3] Houston, A.J. (1966) Flooding and Flood Control on the Taieri Plains, Unpublished Masters Dissertation, Department of Geography, University of Otago.

***Figure 6: Riverside Spillway operating November 2018. The Taieri River is at left (looking upstream).***

[14] Flows within the Taieri River frequently exceed the capacity of the channel (Figure 7). In these floods there is a reliance on effective performance of Scheme floodbanks.

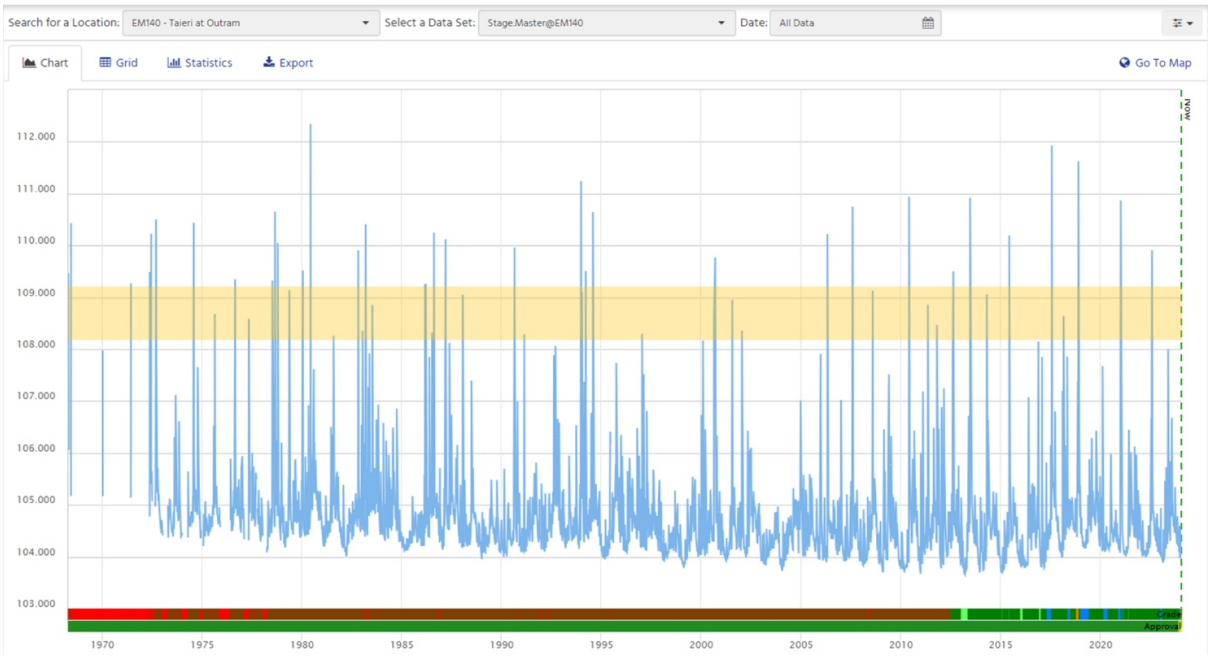


***Figure 7: Taieri Stage at Outram whole of record (1968-2024) with berm level superimposed (orange shaded area indicates when channel capacity is usually exceeded).***

[15] Despite the Scheme, residual risk remains for the parts of the Taieri Plains that rely on the Scheme for some degree of protection. For example, the possibility of floodbanks being overtopped or breached can never be eliminated, including during floods that are smaller than the 'design' flood. Issues such as defects, historical construction methods, dispersive soils, weaknesses at embedded structures (including pump stations, bridges and culverts) can lead to heightened likelihood of floodbank failure. Examples of past damage to parts of the Scheme are shown in Appendix A. It is noted that the Scheme is not intended to prevent pluvial[4] flooding or internal ponding (as shown in Figure 8 at Dunedin Airport).

***Figure 8: Dunedin Airport, flooding event 2017.***

[16] ORC's flood protection, land drainage and river management infrastructure has been constructed over a period of 150 years. As such, there may not be a comprehensive understanding of the construction method or quality of materials and construction for some of this older infrastructure. This increases the risk that unknown factors may contribute to the integrity of this infrastructure.

[17] Also, as infrastructure ages the condition can degrade, or the technology becomes redundant. Factors such as installation, operational environment and manufacturing defects can also reduce the useful life of infrastructure. Continuing to operate and maintain infrastructure beyond its intended useful life also increases the frequency and cost of maintenance, increases the risk of failure, and often does not enable forward planning to design and construct solutions to modern standards.

[4] Pluvial flooding means a flood event caused by rainfall where the rainfall exceeds the capacity of the ground, drainage systems, or swales to absorb or drain the rainfall. This can be independent of an overflowing water body from rivers. It can result in isolated surface flooding.

[18] Floodbanks typically have several potential failure modes including overtopping during floods, slope and foundation stability (under flood, non-flood and seismic conditions), and seepage through the floodbank or its foundation. The condition of a floodbank can degrade over time due to the development of seepage paths or as a result of damage during high flows, increasing the likelihood of a floodbank breaching during a flood. Overtopping can also occur due to reduced scheme capacities, potentially through gravel migration/river behaviour, crest settlement, crest damage (e.g. vehicles), overtopping or failure.

[19] Infrastructure resilience has been identified as a strategic risk for ORC[5]. The significant issues and associated risks are set out in the Draft Infrastructure Strategy[6] 2024 – 2054, which are presented diagrammatically in Figure 9.

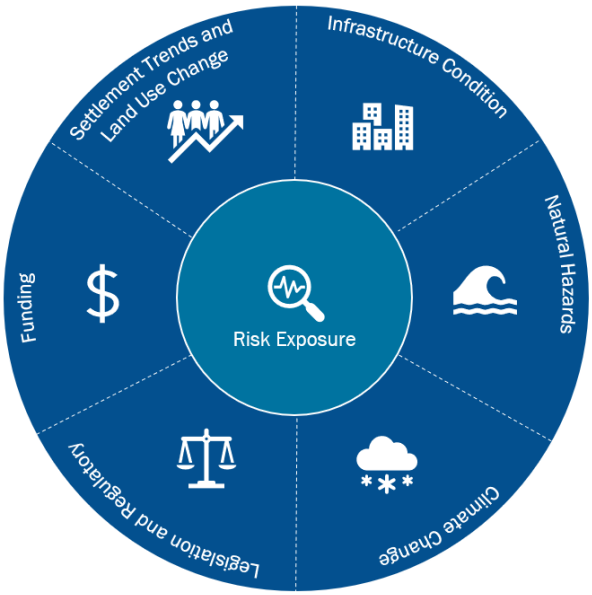



***Figure 9: Significant issues and associated risks as set out in the Draft Infrastructure Strategy 2024 – 2054***

[20] Extreme weather events that have occurred in New Zealand in recent times (for example, Cyclone Gabrielle's impact on parts of the North Island in February 2023) have illustrated the criticality of flood infrastructure for providing lifelines and community resilience as part of the PARA framework (Figure 10). Over the last five years Otago has experienced several flood events, most notably in November 2019, February 2020, January 2021, July/August 2022, and September 2023. With the occurrence of recent and ongoing extreme weather events comes expanding community interest in the

[5] *Infrastructure Resilience Risk Deep Dive*, Report to 6 December 2023 meeting of the Audit and Risk Subcommittee, Report No. A&R2303.
[6] *Infrastructure Strategy 2024-2054*, Report to 6 December 2023 meeting of Council, Report No. ENG2101.

performance of flood protection infrastructure and the associated vulnerabilities and resilience of communities.

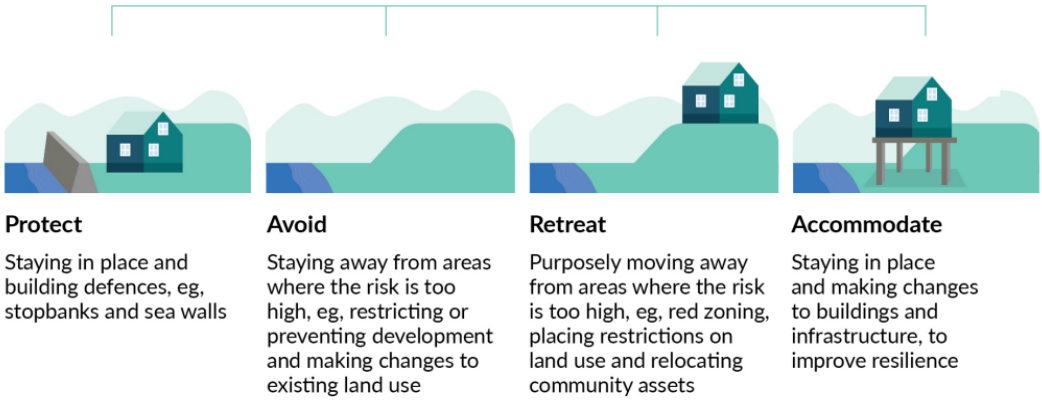



***Figure 10. The Protect, Avoid, Retreat, Accommodate (PARA) Framework (Ministry for the Environment, 2023).***

[21] Given the risk exposure, a wider programme of work is underway to increase the resilience of the Scheme flood infrastructure (Appendix B). This has been developed to understand these risks through a full assessment of the Scheme, evaluating all its potential weak points and planning for future pathways for maintaining the Scheme and living alongside it. The current Long-Term Plan 2021 – 2031 provisioned for the commencement of Scheme analysis and the draft Long-Term Plan 2024 – 2034 continues Scheme analysis and resilience work.

[22] As part of this programme a floodbank risk assessment has been undertaken for the Lower Taieri Flood Protection Scheme by Tonkin + Taylor (Report in Appendix C)[7]. The report presents a high-level risk assessment with the objective to understand the relative risks of floodbank failure within the Lower Taieri River Flood Protection Scheme. It builds on previous work on floodbank stability and condition[8,9].

[23] The findings of this report will assist ORC in the next stages of work such as prioritising potential floodbank improvements, guiding further assessments, understanding the tolerable risk and building adaptation plans.

[24] This paper, and attached report, describe the risk assessment and outline the broader risk reduction programme of work.

[7] Tonkin + Taylor Ltd; "*Taieri Flood Protection Scheme, Floodbank Risk Assessment*" report, November 2023.
[8] Floodbank Stability Assessment, Lower Clutha and Taieri Flood Protection Schemes, Report to Engineering and Hazards Committee, Report No. 2005/486, 19 July 2005.
[9] Tonkin + Taylor Ltd; *"Floodbank condition and structural integrity assessment"* report, prepared for Otago Regional Council, May 2018. T+T ref 1001453.v4.

## DISCUSSION

### Floodbank Risk Assessment

[25] All floodbanks of the Scheme[10] (~109 km) were assessed in this risk assessment. The floodbanks were delineated into separate sections based on a field condition assessment undertaken within the Scheme in 2017/2018[11] (Figure 11).


***Figure 11: A zoomed-in section of part of the Taieri River as an example of the delineation of floodbanks (the colours distinguish each segment and do not represent asset condition or failure risk and the numbers demonstrate section length in metres).***

[26] The risk assessment takes the form of scenario testing. As a limited number of breach scenarios were tested, and the focus of the work is infrastructure performance, the modelled outputs do not give a complete picture of the risk for every part of the floodplain.

[27] The risk assessment has been undertaken for a reference flow of 3,000 cumecs (approximately 1% AEP[12]) in the Taieri River at Outram, 300 cumecs (1% AEP) in the Silver Stream at Gordon Road, 90 – 93 cumecs (10% AEP) for the Contour Channel and 113 cumecs (2% AEP) for the Waipori River. There is a 26% chance of this flow in the Taieri River being equalled or exceeded within a 30-year period (i.e. the period of the Infrastructure Strategy), and a 40% chance in a 50-year period, assuming a stationary climate. Under these reference flows the Gordon Road spillway operates and the floodway is conveying water from the Silver Stream to the East Taieri Upper Pond near Dukes Road North.

[10] Including the length alongside the Ohwiro and excluding a privately owned section of floodbank on the Meggat Burn.
[11] Tonkin + Taylor Ltd; *"Floodbank condition and structural integrity assessment"* report, prepared for Otago Regional Council, May 2018. T+T ref 1001453.v4.
[12] Annual Exceedance Probability.

[28] These particular flows were selected as they are slightly above the design flows and therefore stress-test the performance of the floodbanks whilst enabling differentiation of risks across the floodbank system. Smaller flows would not reveal some risks and would understate the risks. Higher flows would probably show all risks as being Very High or Extreme and would not inform a meaningful prioritisation of risk reduction measures.

[29] The assessment has been undertaken for flood-related risks only. It is assumed that floodbanks are not damaged from a pre-flood seismic event or a tsunami. Seismic-related risks will be investigated as part of the wider programme (Appendix B), building on earlier work[13,14].

[30] The framework adopted for the risk assessment generally follows that described in the NZ River Managers Forum (RMF) Code of Practice document *'Flood Protection Assets Performance Assessment Code of Practice',* March 2015. This has been developed by Te Uru Kahika's River Managers' Special Interest Group as a standard methodology for the risk assessment of floodbanks in New Zealand. Councils are at various stages of implementing the methodology.

[31] For the purpose of this assessment risk has been assessed as a combination of *Likelihood* and *Consequence* where; *Likelihood* is the severity of known condition and performance defects that can lead to failure during a design flood event and *Consequence* is the preliminary assessment of the effect of failure of the floodbanks at select locations.

[13] Floodbank Stability Assessment, Lower Clutha and Taieri Flood Protection Schemes, Report to Engineering and Hazards Committee, Report No. 2005/486, 19 July 2005.
[14] Geosolve Limited; *"Seismic Assessment of the Waipori Floodbank",* report February 2016, Geosolve Ref 150244.

[32] To estimate the likelihood of failure at each floodbank section, three failure modes have been assessed as recommended by the RMF Tool, including field condition (berm, structures, surface condition and other), intrinsic strength (slope instability and seepage/piping), and capacity (eg. overtopping). Examples of each mode are shown in Figure 12 (three diagrams).

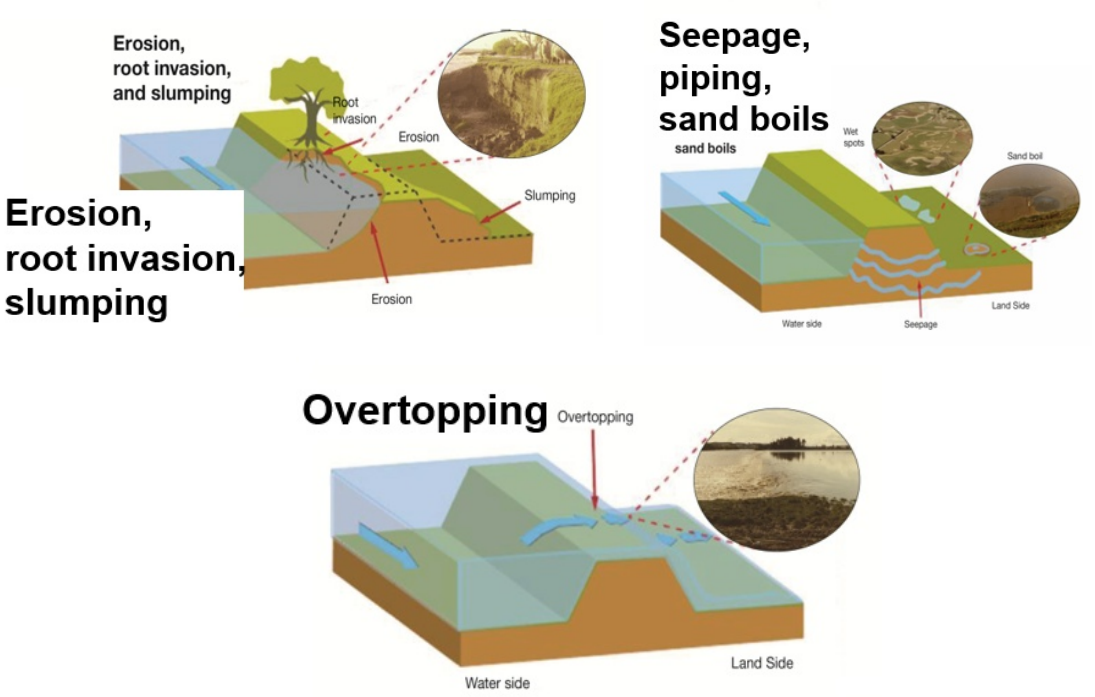



***Figure 12: Examples of floodbank failure modes.***

[33] To estimate the effect of failure at each floodbank section, consequence categories were adopted from the International Infrastructure Management Manual (IIMM), as recommended by the RMF Tool[15]. These include consequences felt by social (safety & health, loss of service extent/duration), environmental and economic factors (property inundation damages; building, productive farmland, airport).

[34] To inform the consequence of failure ratings a high-level floodbank breach Two-dimensional hydraulic model was used to simulate inundation (Figure 13) under the reference flood for 15 representative points along the existing floodbanks. The RMF spreadsheet tool then provided an overall risk rating for each floodbank section using the risk rating table in Figure 14.

[15] The standard IIMM consequence categories have been adjusted based on site specific information, data availability and adopting part of ORC's Natural Hazard Risk Assessment descriptors.

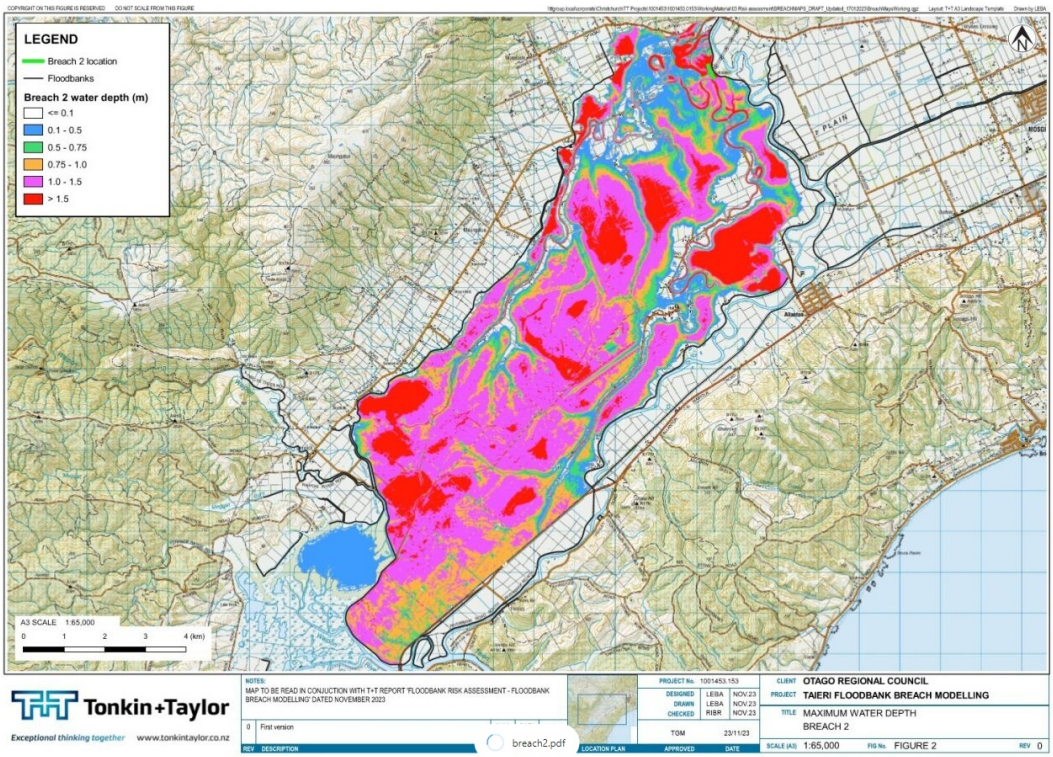



***Figure 13: Sample breach inundation map, for a scenario with a breach near Outram (modelled breach location shown as green line next to floodbank).***

| | | | Consequence | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| | | | Insignificant | Minor | Moderate | Major | Catastrophic |
| Likelihood | 1 | Very low | (1) very low | (2) very low | (3) low | (4) medium | (5) medium |
| | 2 | Low | (2) very low | (4) low | (6) low | (8) medium | (10) high |
| | 3 | Medium | (3) very low | (6) low | (9) medium | (12) high | (15) high |
| | 4 | High | (4) low | (8) medium | (12) medium | (16) high | (20) very high |
| | 5 | Very High | (5) medium | (10) medium | (15) high | (20) very high | (25) Extreme |

***Figure 14: Performance score and risk rating matrix applied to the Lower Taieri Flood Protection Scheme.*** **(Numbers) within the cells demonstrate the Consequence x Likelihood rating relationship.*

[35] Figure 15 provides a summary of the results, showing that 0.4 km (0.4%) of the assessed floodbank sections have an Extreme risk rating, and 16 km (15%) have a Very High-risk rating. 51 km (47%) have a High-risk rating. The remaining sections have a Medium or lower risk rating.

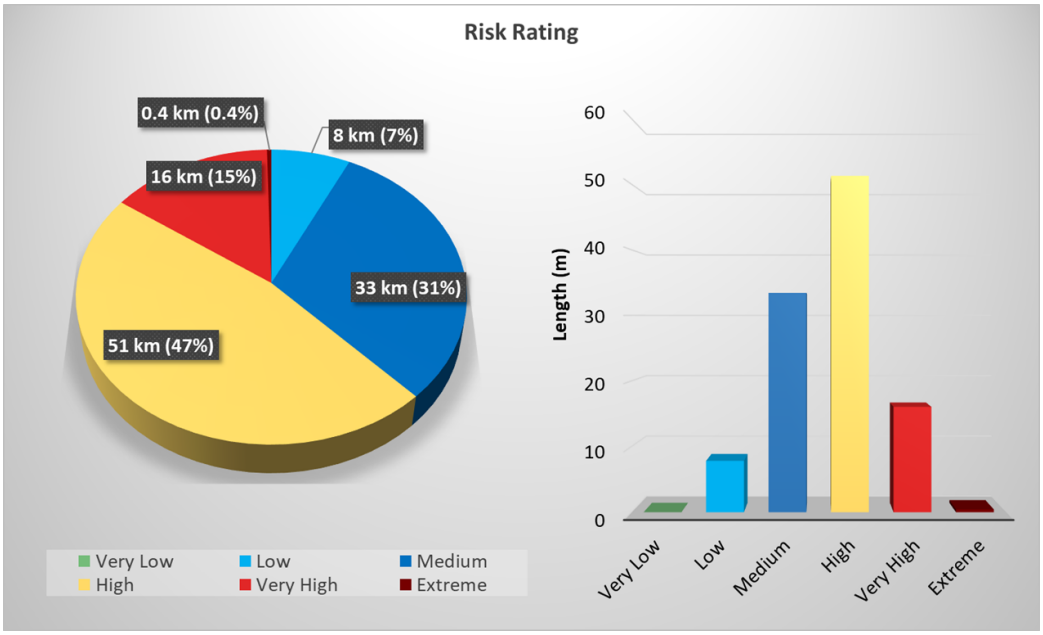



***Figure 15: Risk rating summary for the Lower Taieri Flood Protection Scheme floodbanks***

[36] Table 1 provides general reasoning for the floodbank sections with an 'Extreme' rating. The locations of these sections are shown in Figure 16.

| Risk rating | Floodbank Section | Reasoning |
|---|---|---|
| Extreme | Two sections of Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100.<br>Very high likelihood rating due to potential seepage/piping susceptibility. |

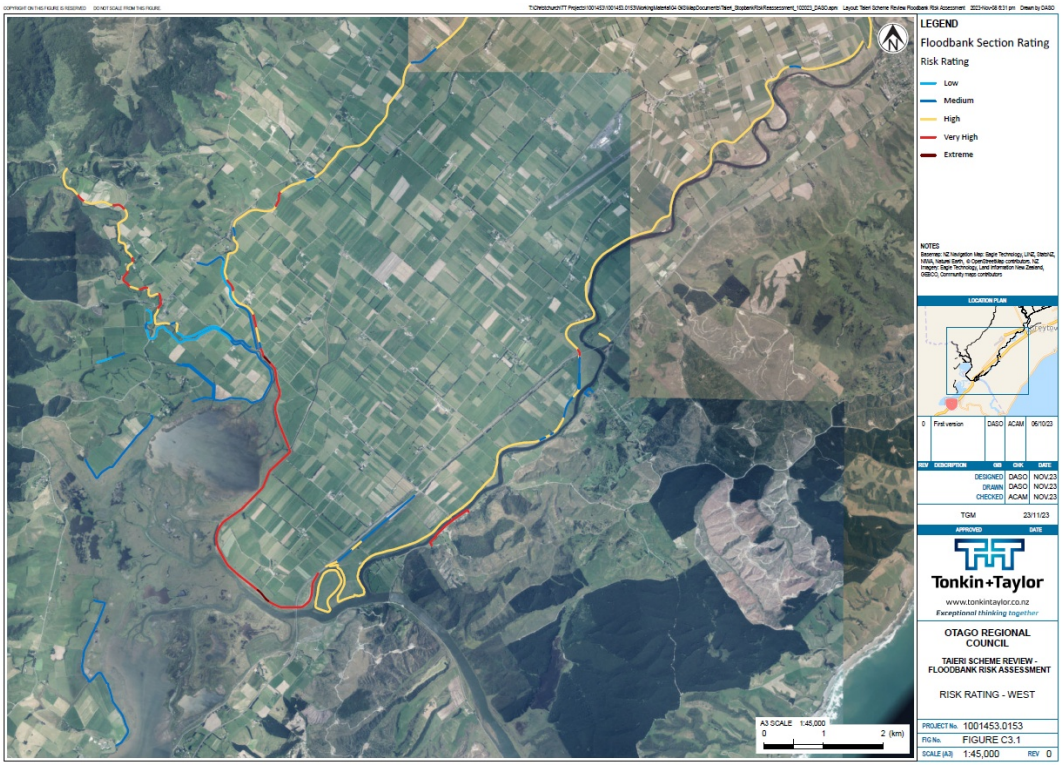
***Table 1. Reasoning for risk rating 'Extreme'.*** **Note that PAR stands for Population at Risk.*

[37] Table 2 provides general reasoning for the floodbank sections with a 'Very High' rating. The locations of these sections are shown in Figure 16.

| Risk rating | Floodbank Section | Reasoning |
|---|---|---|
| Very high | Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100. High likelihood rating due to intrinsic strength value. |
| | Cut-off bank between Riccarton Road West and Gladfield Road | Major consequence rating due to PAR between 11 and 100. Very high likelihood rating due to capacity/overtopping. |
| | Several sections along Waipori River upstream of Berwick, lower Contour Channel, Taieri River right floodbank upstream of Silver Stream, Silver Stream upstream of SH87, Taieri River left floodbank at Henley. | Reasons vary but generally major consequences due to PAR and very high likelihood rating due to capacity/overtopping or intrinsic strength. |

***Table 2: Reasoning for risk rating 'Very High'.***


***Map 1 of 2***




***Map 2 of 2***

***Figure 16: Maps showing risk rating for floodbank sections referred to in Tables 1 and 2.***

[38] The full report in Appendix C includes further detail on the general reasoning behind the ratings for all of the rating categories (including High, Medium, Low and Very low).

[39] The report and its findings have provided an overall perspective of the level of risk for the floodbanks, highlighting some sections in particular which will inform risk reduction measures and the wider programme of work.

**Risk Reduction Measures**

[40] The two sections of the Waipori floodbank downstream of the Contour Channel identified as Extreme risk have been further investigated post completion of the risk assessment report to fully understand the drivers behind the likelihood of failure.

[41] In one instance, the river sits higher than the adjacent land the floodbank protects and there is a significant risk of piping susceptibility. This location also has a tree growing within the bank. A work plan has been put in place for the tree and associated root ball to be removed and the floodbank to be remediated post works. It is expected that the planning for these risk reduction measures will be incorporated with priority into the remainder of this current Annual Plan (FY2023/2024).

[42] At the other location identified as Extreme risk the floodbank tapers down dropping ~1m close to the road and nearby bridge structure over ~100 m. A work plan has been scoped to raise this section of floodbank. Trees have also been identified in the area close to the floodbank and will be removed as part of this work programme. It is

expected that the planning for these risk reduction measures will be incorporated with priority into the remainder of this current Annual Plan (FY2023/2024).

[43] Given the Extreme rating of risk for these sections of floodbanks they were investigated immediately, and risk reduction plans put in place. Remaining areas that require more detailed planning will be factored into current Annual Plan (FY2023/2024) and prioritised with current planned works. Current planned works include remedying structural deficiencies in the Riverside Spillway.

[44] A Risk Reduction investigation is planned for all remaining sections of floodbanks, triaged based on severity of their risk rating. This will involve reviewing the drivers of the likelihood of failure ratings and what appropriate risk reduction measures can be effectively implemented.

[45] It is important that the drivers of the risk profile are understood spatially as that enables appropriate risk reduction measures to be identified. Infrastructure renewal is not necessarily the appropriate measure at all locations. For example, the removal of a spillway may not necessarily remove the risk profile further downstream.

[46] The Draft Infrastructure Strategy [16]2024-2054 provides for an ongoing programme of activities that will inform risk assessment outcomes, including routine condition assessments and monitoring, performance assessments and geotechnical investigations. Operational expenditure of $10.4M is assigned to these work programmes over the 30-year period of the Strategy.

[47] Throughout the lifetime of the Infrastructure Strategy $56.8M of capital expenditure is assigned to projects that are intended to increase the resilience of flood protection infrastructure on the Lower Taieri. For example, the Contour Channel Resilience Upgrade, Lower Taieri adaptation works and Outram resilience improvements.

[48] $1M of operational expenditure is also allocated throughout the lifetime of the Infrastructure Strategy to maintaining a Flood Preparedness and Response Plan that is aimed to further increase resilience by working alongside CDEM and Natural Hazards to prepare communities to respond to flood events and their potential consequences.

**Tolerable Risk**

[49] The nature of the consequences of the risks at some locations are such that it is not feasible to reduce the risk attributable to floodbank performance to less than Medium. For example, any breach scenario that impacts Dunedin Airport will always be Medium risk or higher (see Figure 14 and last columns of Tables 1 and 2). These situations rely on readiness measures or site-specific measures to further reduce the risk.

[50] The modern approach to flood risk management is to take greater account of residual risk and consider how schemes and infrastructure perform beyond design up to Probable Maximum Flood (PMF) or Maximum Credible Event (MCE). Infrastructure should be designed to fail safely under super design (overdesign) events. ORC is incorporating this approach into the way it manages its schemes and infrastructure.

[16] *Infrastructure Strategy 2024-2054*, Report to 6 December 2023 meeting of Council, Report No. ENG2101.

[51] The wider programme of work includes a safety audit to determine whether occupation is safe and whether evacuation is a sufficiently reliable method of mitigating the risk of floodbank failure. In the event of a catastrophic failure, the overland flow (including the rate of travel of the flood wave) will be key considerations along with the sequence of inundation as to whether appropriate safe escape and access routes exist.

[52] The programme is presently managing risks to as low as reasonably practicable. Further work will be undertaken, with the community and stakeholders, to develop tolerable risk and to prioritise risk reduction measures. This will use ORC's Natural Hazards Risk Assessment Framework and Toka Tū Ake EQC's Risk Tolerance Methodology[17]. It is noted that in New Zealand there are no legislated performance standards for floodbanks and that the Building Act 2004 expressly excludes floodbanks from the dam safety provisions of Subpart 7 of the Act. There is one mandatory performance measure for flood protection in New Zealand for "*major flood protection and control works*" (as defined in the Non-Financial Performance Measures Rules 2013)[18].

**On-going Infrastructure Resilience Programme**

[53] The broader programme of infrastructure resilience work underway for the Taieri is outlined at a high level in Appendix B which summarises the key phases to the Scheme Analysis. Delivery of the programme is currently in the "Identifying what the scheme does now/how safe?" phase where the recently completed T+T floodbank risk assessment report informs the 'Scheme Performance' and 'Risk Assessment' components. Further work is currently underway or planned within all components of this phase which will collectively feed into the Risk Management approach.

[54] More detail on the phases of this work programme and what they entail is included within Appendix B. It should be noted these are presented as high-level planning diagrams which have been developed by staff internally to facilitate next steps and future considerations. Future considerations have been factored into the Draft Infrastructure Strategy 2024 – 2054, where relevant as discussed above.

[55] Co-investment and/or other funding is one element of progressing priority repairs and renewals in infrastructure, which may otherwise have a longer timeframe to progress due to funding constraints. The co-investment can assist with the risk profile by being able to accelerate key infrastructural repair and renewal programmes.

[56] ORC has been successful in delivering its four Climate Resilience projects with central government co-funding, with the current Climate Resilience programme amounting to $8.5M, comprised of 64% ($5.44M) provided by Central Government and 36% ($3.06M) funded by ORC.

[57] Endeavours to obtain further co-investment funding is continuing with Te Uru Kahika submitting a request for a second tranche of co-investment to Central Government for consideration in its climate resilience budgets. Three of the projects put forward by ORC

[17] https://www.eqc.govt.nz/assets/Research/Risk-Tolerance-Methodology-v2.pdf

[18] The performance measure is: The major flood protection and control works that are maintained, repaired and renewed to the key standards defined in the local authority's relevant planning documents (such as its activity management plan, asset management plan, annual works program or long term plan).

would increase the resilience of Lower Taieri Flood Protection Scheme infrastructure. The three projects have a total estimated cost of $16.2M, of which $9.72M is sought from central government.

**Communication and Public Access to Information**

[58] Communication to the public will be developed through a communications and engagement plan by Engineering with support required from Communications and Natural Hazards and Emergency Management Otago. This will be new consolidated information to the community, and it is crucial that the communities that live on the Taieri Plain understand the (risk) environment of the Taieri Plains.

[59] The Floodbank Risk Assessment will be new information to the community. It is important that the community understands the relevance of the floodbank risk assessment and the risk mitigations that ORC undertake to manage the risk.

[60] Key stakeholders such as Dunedin City Council (DCC), Dunedin International Airport (DIA) and the Mosgiel Taieri Community Group have been given an initial briefing prior to this committee meeting.

[61] It is planned to hold a series of information sessions for the community during February 2024 to explain the purpose of the risk assessment and the broader issues and considerations that will be developed in to work programmes as relevant. The Draft Infrastructure Strategy (2024 – 2054) will also be communicated on as it has links to the broader issues and considerations through its relevant Lower Taieri Flood Protection Investment Programme.

[62] The report and the breach maps will be uploaded and linked to the Otago Natural Hazards Database.

[63] The report and the breach maps through the Otago Natural Hazards database can also be provided on Land Information Memorandum (LIM), noting that the responsibility for deciding whether this information is provided on a LIM is for the respective Territorial Authority, which is Dunedin City Council in this case.

[64] ORC will continue its practise of providing the Otago Territorial Authorities with the most up to date Natural Hazards information as soon as it becomes available.

## CONSIDERATIONS

**Strategic Framework and Policy Considerations**

[65] The information presented in this paper reflects ORC's Strategic Direction to achieve its vision, for Otago *"communities that are resilient in the face of natural hazards, climate change and other risks".*

[66] The proposed Otago Regional Policy Statement June 2021[19], states that ORC and territorial authorities are both responsible for specifying objectives, policies and methods in regional and district plans for managing land subject to natural hazard risk. ORC specifically is responsible for" identifying *areas in the region subject to hazards and describing their characteristics as required by Policy HAZ–NH–P1, mapping the extent of*

[19] Section HAZ-NH-M1

*those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."*[20]

**Financial Considerations**

[67] Funding of the work described in this paper is provided for in ORC's current FY2023/2024 Annual Plan. The budget for the FY2023/24 financial year for this work is approximately $416K, which has had $224K expended to date. The balance of this budget will continue to be used on resilience work relating to the Lower Taieri Flood Protection Scheme as discussed in this paper.

**Significance and Engagement**

[68] This noting paper does not trigger ORC's He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy (He Mahi Rau Rika).

[69] The planning of the communication and engagement of the information contained in this paper will consider the ORC's He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy (He Mahi Rau Rika).

**Legislative and Risk Considerations**

[70] Council has statutory functions and powers under the Soil Conservation and Rivers Control Act 1941 for river management, flood protection and soil conservation within Otago.

[71] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA and the Soil Conservation and Rivers Control Act 1941.

[72] Infrastructure Resilience has been identified as a Strategic Risk for ORC as previously reported to Council on 6 December 2023 through report ENG2301, Infrastructure Resilience Risk Deep Dive.

**Climate Change Considerations**

[73] The work described in this paper is enabling adaptation to the effects of future climate change.

[74] The development of future Lower Taieri 'infrastructure' adaptation programme will ensure alignment with upcoming and/or future climate change strategies for ORC and DCC, including the current Future Dunedin Strategy (FDS) development.

**Communications Considerations**

[75] The development of a communications and engagement plan is underway. The Engineering team is working with the Communications team to ensure alignment so that communications and engagement planning are integrated and complementary of any communications and engagement planned.

**NEXT STEPS**

[76] Communicate the Floodbank Risk Assessment to the broader community and make available through the Otago Natural Hazards database.

[20] ORC Natural Hazards Portal: http://hazards.orc.govt.nz

[77] Continue progressing work on the Scheme Analysis as indicated in Appendix B.

**ATTACHMENTS**

1. Appendix A 20231123. T+ T. Lower Taieri Floodbank Risk Assessment [**8.4.1** - 62 pages]
2. Appendix B Lower Taieri Flood Protection Scheme historic floodweather damage [**8.4.2** - 5 pages]
3. Appendix C - Scheme Analysis [**8.4.3** - 3 pages]

REPORT

Tonkin+Taylor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## Document control

| Title: Taieri Flood Protection Scheme | | | | | |
|---|---|---|---|---|---|
| Date | Version | Description | Prepared by: | Reviewed by: | Authorised by: |
| 7/2/2023 | 1 | DRAFT work in progress | RIBR | TGM | |
| 22/3/2023 | 1 | 2nd DRAFT | RIBR | TGM | |
| 10/10/2023 | 1 | 3rd DRAFT | RIBR | TGM | |
| 23/11/2023 | 1 | Final Issue - incorporating ORC comments on previous drafts | RIBR | TGM | TGM |
| | | | | | |
| | | | | | |

Distribution:

| | |
|---|---|
| Otago Regional Council | 1 electronic copy |
| Tonkin & Taylor Ltd (FILE) | 1 electronic copy |

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## Executive summary

Otago Regional Council (ORC) have engaged Tonkin & Taylor Ltd (T+T) to undertake a high-level risk assessment for the Lower Taieri River Flood Protection Scheme ("the scheme").

The objective of this risk assessment is to understand the relative risks to the community of floodbank failure within the Lower Taieri River Flood Protection Scheme. This will assist the Asset Manager (ORC) in understanding the appropriate level of service and prioritising potential floodbank improvements.

This high-level risk assessment has been commissioned as part of a wider body of work currently being undertaken by ORC assessing the Taieri scheme. This assessment includes all 109 km of floodbanks within the Scheme as shown on Figure 1. The Taieri River reach is bounded by the State Highway 87 bridge at Outram, Henley-Berwick Road Bridge at Waipori and State Highway 1 bridge at Waipori. The Silver Stream reach is bounded by Solway Place and the Taieri River confluence. The Contour Channel and Waipori River/Lake Waipori reaches within the Scheme are included with exception of a private section of floodbank on the Meggat Burn.


*Figure 1: Lower Taieri River Flood Protection Scheme assessed floodbanks, highlighted in green.*

The framework adopted for the risk assessment generally follows the methodology described in the NZ River Managers Forum (RMF) Code of Practice document *'Flood Protection Assets Performance Assessment Code of Practice',* March 2015. The RMF Code of Practice provides an Excel spreadsheet tool which estimates the performance score and relative risk rating of each floodbank section.

For this assessment, risk has been defined as the product of likelihood and consequence of failure where:

*Likelihood:* *The severity of known condition and performance defects that can lead to failure during a design flood event.*

*Consequence:* *The preliminary assessment of the effect of failure of the floodbanks at select locations.*

The floodbank was delineated into sections based on the findings of a field condition assessment undertaken within the Scheme in 2017/2018, soon after the July 2017 flood event. The 2017/2018 condition assessment recorded 629 field observation points along the Scheme floodbanks at an average distance of 173 m apart. The start and end of each section was set at the mid-point between each field observation point.

To estimate the likelihood of failure at each floodbank section, three failure modes were assessed, comprising field condition (berm, structures, surface condition and other), intrinsic strength (slope instability and seepage/piping), and capacity (e.g. crest height and river channel capacity). A rating of 1 to 5 (very low, low, medium, high, very high) was estimated for each floodbank section to reflect the vulnerability to each of the failure modes. Each of the three failure modes comprise of several components.

Rating for the field condition failure mode at each floodbank section were estimated based on findings from the 2017/2018 condition assessment. Ratings for the intrinsic strength failure modes were estimated using a combination of both semi-quantitative geotechnical analysis and qualitative evaluation incorporating the results of the 2017/2018 condition assessment. The rating for the overtopping failure mode at each floodbank section was estimated by comparing flood levels modelled by ORC (3,000 $m^3/s$ in the Taieri River) to the floodbank crest levels.

To estimate the consequence of failure at each floodbank section, consequence categories were adopted from the International Infrastructure Management Manual including the effect as those consequences felt by social (safety & health, loss of service extent/duration), environment and property inundation damages (buildings, productive farmland and airport). A consequence rating of 1 to 5 (insignificant, minor, moderate, major, catastrophic) at each floodbank section was estimated for each consequence category. An overall consequence rating from 1 to 5 was then calculated for each floodbank section based on the highest rating from each category.

Consequence ratings for the social, environment and property inundation consequence categories were estimated based on high-level floodbank breach 2-dimensional hydraulic modelling and indicative damage assessment.

The likelihood and consequence rating estimates were used to populate the fields within the RMF spreadsheet tool. The tool provides an overall risk rating for each floodbank section as shown in the chart below.

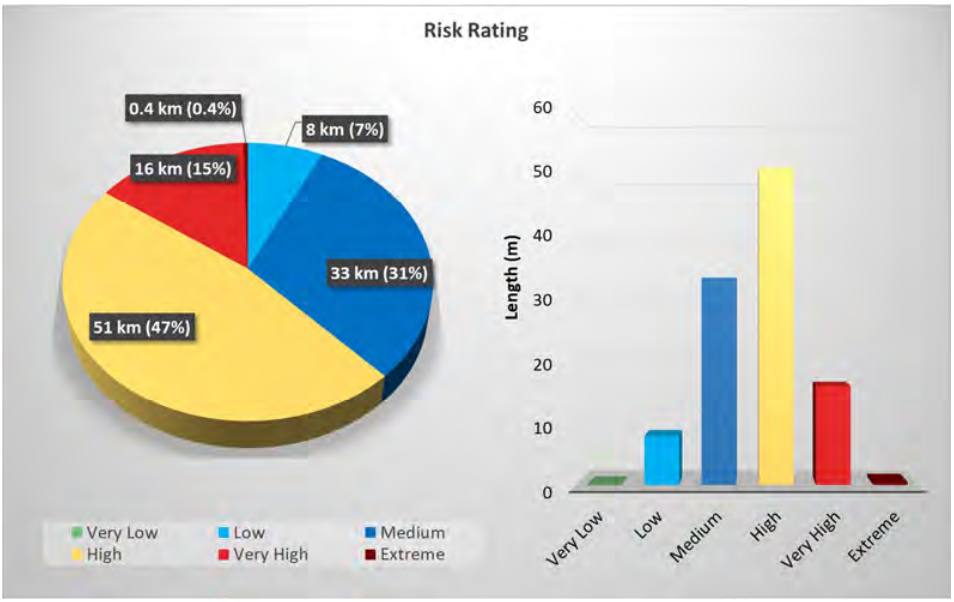



*Figure 2: Risk rating summary*

Generalisations of the risk rating along the floodbank are summarised in the table following.

Table 1: General reasoning for risk ratings

| Risk rating | Floodbank Section | Reasoning |
|---|---|---|
| Extreme | Two sections of Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100. Very high likelihood rating due to potential seepage/piping susceptibility. Piping susceptibility in this area is relatively higher than other areas due to the landside elevation being close to, or at a lower elevation than, the normal water level in the adjacent waterway. These two sections have a higher likelihood rating than adjacent sections due to the presence of trees, and associated root systems, located within approximately 5 m of the floodbank. |
| Very high | Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100. High likelihood rating due to intrinsic strength value. Intrinsic strength values are generally high due to the piping susceptibility rating. Piping susceptibility in this area is relatively higher than other areas due to the landside elevation being close to, or at a lower elevation than, the normal water level in the adjacent waterway. |

| Risk rating | Floodbank Section | Reasoning |
|---|---|---|
| | Cut-off bank between Riccarton Road West and Gladfield Road | Major consequence rating due to PAR between 11 and 100. Very high likelihood rating due to capacity/overtopping. |
| | Several sections along Waipori River upstream of Berwick, lower Contour Channel, Taieri River right floodbank upstream of Silver Stream, Silver Stream upstream of SH87, Taieri River left floodbank at Henley. | Reasons vary but generally major consequences due to PAR and very high likelihood rating due to capacity/overtopping or intrinsic strength. |
| High | Waipori River upstream Berwick | Major consequence rating due to PAR between 11 and 100. High or very high likelihood rating due to intrinsic strength rating. Intrinsic strength values are generally high due to the piping susceptibility rating in these sections. |
| | Silver Stream upstream of Carlye Road | Catastrophic or major consequence rating due to high PAR (Mosgiel township). Variable likelihood ratings from medium to very high. |
| | Taieri River right floodbank between Outram and Otokia | Catastrophic consequence rating due to PAR >100. Medium or high likelihood rating caused by field condition and capacity/overtopping. |
| | Taieri River right floodbank downstream of Otokia to Waipori confluence | Moderate consequence rating due to PAR between 2 and 10. Very high likelihood rating caused by field condition and capacity/overtopping. |
| | Contour Channel downstream Dow Road | Major consequence rating due to PAR between 11 and 100. Low, medium, high or very high likelihood rating. |
| | Several sections of Taieri River left floodbank upstream of Silver Stream confluence, Silver Stream downstream of Gladfield Road | Moderate consequence rating due to inundation of McKays Triangle Wetland. High or very high likelihood rating due to overtopping. |
| Medium<br>Low<br>Very low | Contour Channel upstream of Dow Road | Reasons vary along sections. Consequence rating either insignificant, minor or moderate. Likelihood rating vary from very low to very high. |
| | Owhiro right floodbank | |
| | Various sections at Lake Waipori | |
| | Waipori River downstream Berwick | |
| | Taieri River left floodbank upstream of SH1 | |
| | Silver Stream left and right floodbank downstream of Carlye Road | |

# 1 Introduction

Otago Regional Council (ORC) have engaged Tonkin & Taylor Ltd (T+T) to undertake a high-level risk assessment for the Lower Taieri River Flood Protection Scheme.

The objective of this risk assessment is to understand the relative risks of floodbank failure within the Lower Taieri River Flood Protection Scheme. This will assist the asset owner in understanding the appropriate level of service and prioritising potential floodbank improvements.

This high-level risk assessment has been commissioned as part of a wider body of work currently being undertaken by ORC assessing the Taieri scheme. This broader work involves scheme assessments and future planning for the full Taieri Scheme, including the Taieri River primary floodbanks, primary ponding zones, and tributaries including Silver Stream, Contour Canal, Waipori River/Lake Waipori and Owhiro Stream. This project is part of identifying the current state and risks of the scheme to inform scheme requirements for the community both now and into the future. The risk assessment only focuses on floodbanks and not other assets.

ORC has requested that the risk assessment generally follows the methodology described in the NZ River Managers Forum (RMF) Code of Practice document "*Flood Protection Assets Performance Assessment Code of Practice*", March 2015 and the corresponding Flood Protection Assets Performance Assessment Tool V2 (the "RMF Tool").

This report has been prepared for ORC in accordance with the conditions of engagement in dated 11 November 2021, Variation 01.

# 2 Background

The Lower Taieri Flood Protection Scheme ("the Scheme") comprises approximately 110 km of floodbanks located on the Taieri Plains southwest of Dunedin as shown on Figure 3. The primary floodbanks along the scheme protect surrounding land from river induced flooding from the Taieri River, Silver Stream, Waipori River/Lake Waipori, Contour Channel, as well as several smaller streams. Within the scheme, several ponding areas, cut-off banks, ring banks and surface water pump stations complement the primary flood protection system.

The lower Taieri area is very flat and gravity drainage is very limited. The west Taieri area relies on three pump stations (Waipori, Lake Ascog, Henley) and a network of drains for drainage. The primary role of the pumps is to discharge runoff back into the river during dry conditions and small rainfall events. The pumps are not designed to alleviate flooding during severe flood events. After a severe flood, water that has flowed or fell into the west Taieri area can only be removed by pumping over time after the event. The East Taieri area including the upper and lower ponding areas can drain away under gravity once river levels recede.

Land use within the Scheme area is predominantly rural. Agricultural uses within the area vary but predominantly include cropping, beef, sheep and dairy. Township communities include Mosgiel to the east, Outram to the north, Allanton to the south east and Henley to the South. Of particular significance, the Dunedin International Airport is located within the lower Taieri area between Allanton and Henley. Three State Highways are located within the Scheme including SH1, SH86 and SH87.

The Scheme has been constructed and upgraded in various stages since the late 19$^{th}$ century. A significant flood event occurred in 1980, during which the peak flow recorded at Outram was approximately 2,500 m$^3$/s. The peak flow recorded during the 1980 flood is the largest to have occurred since records began in the late 19$^{th}$ century. The return period of a 2,500 m$^3$/s flow was at the time of the flood, estimated to be a 1% Annual Exceedance Probability (AEP) event. The AEP of the 1980 event may now be different due to an additional 43 years of flow data being available.

Another large flood event occurred in July 2017 which recorded a peak flow at Outram of 1,700 $m^3/s$.

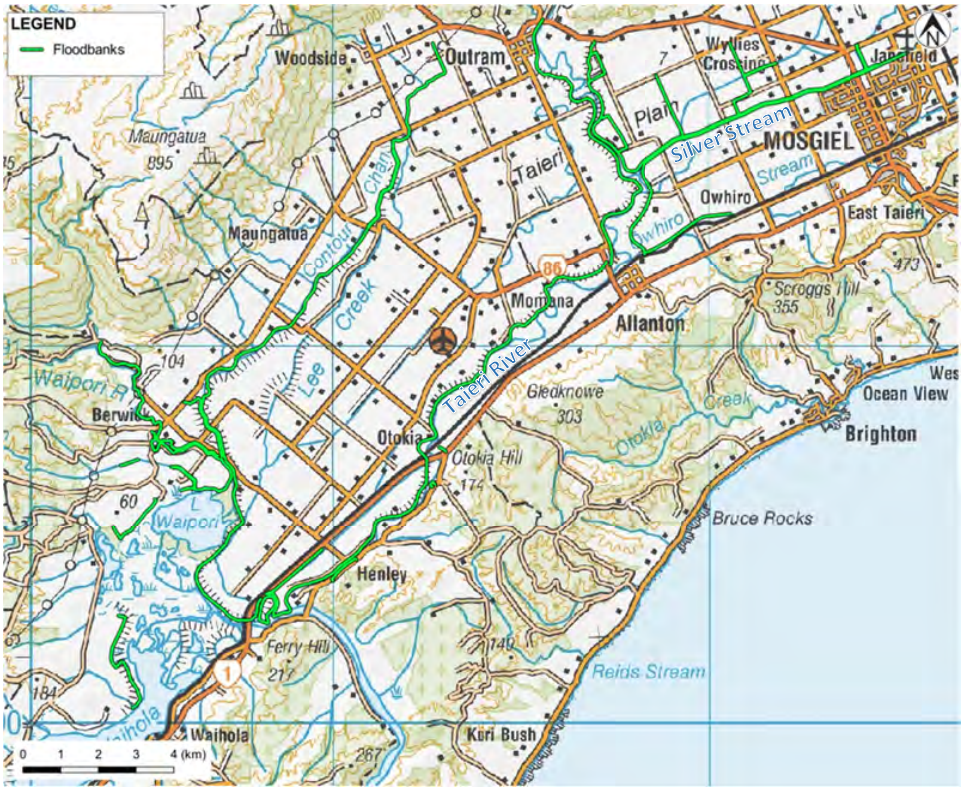



*Figure 3: Lower Taieri River Flood Protection Scheme assessed floodbanks*

# 3 Methodology

The following sections summarise the methodology adopted for the risk assessment.

## 3.1 Framework

The framework adopted for the risk assessment generally follows the methodology described in the NZ River Managers Forum (RMF) Code of Practice document *'Flood Protection Assets Performance Assessment Code of Practice'*, March 2015. The method is predicated on observed condition and performance during a design (or near-design) flood event.

The RMF Code of Practice provides a framework for assessing the performance of flood protection assets where the assessment methodology and frequency is aligned to the amount of risk posed to the community. The framework takes the asset owner through the following general methodology to calculate a performance score and relative risk rating for the flood protection asset:

- Defining level of service and design/construction standards (in this instance the level of service is inferred from as-built infrastructure as opposed to a design standard per se);
- Sectioning assets appropriately into suitable scale;
- Identifying failure modes;

- Estimating consequence of failure including social, environmental and property inundation damage;
- Scoring confidence in the information;
- Estimation of the performance score; and
- Assigning a relative risk rating.

Figure 4 shows a graphical representation of the RMF framework methodology adopted for this assessment.

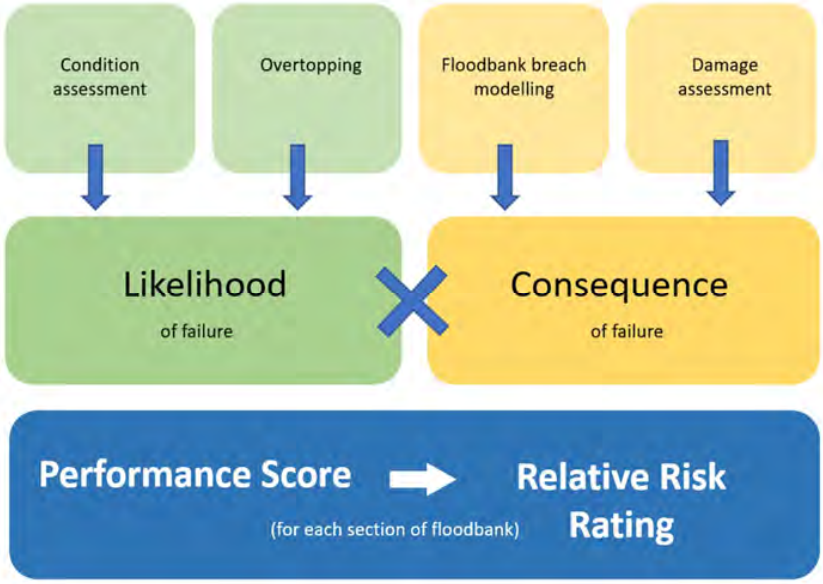



*Figure 4: RMF framework methodology*

For this assessment, risk has been defined as the product of likelihood and consequence where:

*Likelihood:* *The severity of known condition and performance defects that can lead to failure during a design flood event.*

*Consequence:* *The preliminary assessment of the effect of failure of the floodbanks at select locations.*

Further information and background regarding the RMF framework methodology is provided in the RMF Code of Practice.

The RMF Code of Practice provides an Excel spreadsheet tool ("The RMF Tool") which leads the user through the RMF framework methodology, from setting the context of the assessment to estimating the performance score and relative risk rating. The RMF Tool allows for flexibility to customise the parameters specific to each user and flood protection asset.

## 3.2 Floodbank sectioning

The RMF Tool requires the floodbank to be delineated into representative sections. It is recommended by the RMF Code of Practice that sections are delineated such that local floodbank conditions are suitably reflected depending on the resolution of data held for a particular floodbank reach.

This assessment includes all 109 km of floodbanks within the Scheme as shown on Figure 1. The Taieri River reach is bounded by the State Highway 87 bridge at Outram, Henley-Berwick Road Bridge at Waipori and State Highway 1 bridge at Waipori. The Silver Stream reach is bounded by Solway Place and the Taieri River confluence. The Contour Channel and Waipori River/Lake Waipori reaches within the Scheme are included with exception of a private section of floodbank on the Meggat Burn.

The floodbank was delineated into sections as shown in Appendix A, Figures A1 and A2 based on the findings of a field condition assessment undertaken within the Scheme in 2017/2018. The 2017/2018 condition assessment[1] recorded field observation points along the Scheme floodbanks at intervals ranging from 21 m to 1289 m at an average of 173 m. The start and end of each section was set at the mid-point between each field observation point.

Further information regarding the 2017/2018 condition assessment is provided in Section 3.3.1

## 3.3 Likelihood of failure

*Likelihood:* *The severity of known condition and performance defects that can lead to failure during a design flood event.*


To estimate the likelihood of failure at each floodbank section, three failure modes have been assessed as recommended by the RMF Tool, including field condition, intrinsic strength, and capacity.

The standard RMF failure modes have been adjusted based on site specific information, data availability and discussions with ORC[2]. The adopted failure modes are shown in Table 2.

[1] T+T report *"Floodbank condition and structural integrity assessment"* report (May 2018), T+T ref 1001453.v4
[2] Proposed failure mode provided to ORC in document 20220309.saff.proposed rating criteria.v1.docx

Table 2: Likelihood of failure modes

| Failure mode | Description |
|---|---|
| Field condition | |
| Berm | Undermining of the floodbank from the river during flood conditions. |
| Structures | Floodbank integrity at structures which penetrate or are within a zone which may potentially affect integrity of the floodbank. |
| Surface condition | Presence and condition of trees, grass, crossings, stock damage, rabbit burrows and erosion which may potentially affect integrity of the floodbank. |
| Other | Presence and condition of other factors such as geomorphic features, excavations, evidence of seepage, potentially steep hydraulic gradient, encroachments, factors inhibiting view of floodbank which may potentially affect integrity of the floodbank. |
| Intrinsic strength | |
| Slope instability (including foundation) | Presence of slips and/or slumping on the floodbank, based on the 2017/2018 condition assessment. |
| Seepage/piping | Piping susceptibility based on the hazard assessment summarised in the 2017/2018 condition assessment. |
| Capacity | |
| Overtopping | Susceptibility to overtopping during design flood conditions which may potentially lead to erosion/scour of the floodbank |

A rating of 1 to 5 (very low, low, medium, high, very high) was estimated for each floodbank section to reflect the vulnerability to each of the failure modes. This is described further in the following sections.

### 3.3.1 Field condition

Likelihood ratings for the field condition failure modes (berm, structures, surface condition and other) at each floodbank section were estimated based on findings from a field condition assessment undertaken along the Scheme floodbanks in 2017, soon after the July 2017 flood event.

The 2017/2018 condition assessment comprised of walking the crest of the Scheme floodbanks and recoding field observations points for a range of condition criteria. In total, 401 observation points were recorded along the Taieri and Silver Stream reaches as shown in Figure 5. Each field observation point corresponds to a floodbank section as described in Section 3.2.


*Figure 5: 2017/2018 condition observation points*

Additional field observations collected by ORC staff since the 2017/2018 condition assessment have been provided by ORC[3]. Where overlap existed between the 2017 and additional observations, the more recent observations were adopted. In total, 34 of the 629 observations points were updated with the more recent observations. Output datasets have been given a unique identifier to indicate which observation (2017 or additional ORC) were used in the risk assessment.

Table 3 explains how the likelihood ratings were estimated for the field condition failure modes.

[3] Data package 'Engineering Operations General Backup' sent via email from Ellyse Gore (ORC) to Scott Forster (T+T), 'FW: Field Observations', 16 November 2022

Table 3: Field condition rating

| Field condition failure mode | Rating | Description[1] |
|---|---|---|
| Berm | 1 | Wide bench with normal flow distant from floodbank, or well armoured bank |
| | 2 | Transition |
| | 3 | Moderate width bench between floodbank and river |
| | 4 | Minor bench |
| | 5 | Floodbank slope extends directly down to river with no bench or armour |
| Structures | 1 | No structures in/on stopbank, or structure unlikely to contribute to floodbank vulnerability. |
| | 2 | NA |
| | 3 | Structure may contribute to floodbank vulnerability. |
| | 4 | NA |
| | 5 | Potentially significant issue, further assessment and/or monitoring recommended. |
| Surface condition | 1 | Hazard rating 1 for criteria trees, grass, crossings, stock damage, rabbit burrows and erosion |
| | 2 | Hazard rating 2 for criteria trees, grass, crossings, stock damage, rabbit burrows and erosion |
| | 3 | Hazard rating 3 for criteria trees, grass, crossings, stock damage, rabbit burrows and erosion |
| | 4 | Hazard rating 4 for criteria trees, grass, crossings, stock damage, rabbit burrows and erosion |
| | 5 | Hazard rating 5 for criteria trees, grass, crossings, stock damage, rabbit burrows and erosion |
| Other | 1 | Additional observation unlikely to contribute to floodbank vulnerability. |
| | 2 | NA |
| | 3 | Additional observation may contribute to floodbank vulnerability. |
| | 4 | NA |
| | 5 | Additional observation noted as a potentially significant issue, further assessment and/or monitoring recommended. |

1. Further information regarding descriptions are provided in the T+T report '*Floodbank Condition and Structural Integrity Assessment*', May 2018.

The Riverside Spillway Structure rating was manually adjusted to 5 to reflect observations made during the 2017 flood which resulted in significant scour and erosion of the spillways rock protection.

### 3.3.2 Intrinsic strength

Likelihood ratings for the intrinsic strength failure modes (slope instability and seepage/piping) at each floodbank section were estimated using a combination of both quantitative geotechnical analysis and qualitative evaluation incorporating the results of the 2017/2018 field condition assessment.

Table 4 explains how the likelihood ratings were estimated for the intrinsic strength failure modes.

Table 4: Intrinsic strength rating

| Intrinsic strength failure mode | Rating | Description[1] |
|---|---|---|
| Slope instability (including foundation) | 1 | No slippage |
| | 2 | Slippage affecting land surrounding/near floodbank |
| | 3 | Minor slipping/slumping not affecting crest, but on lower slopes of floodbank |
| | 4 | Extensive developed slippage affecting crest |
| | 5 | Severe slips/slumps |
| Seepage/piping | 1 | Seepage may occur at or near the floodbank toe. Not expected to result in severe soil strength loss or piping during flood. |
| | 2 | Seepage may occur at or near the floodbank toe. Higher seepage rate and potentially erosion may occur at/around ground penetrations such as tree roots or structures and/or other preferential flow paths, mainly on natural ground on landside rather than through floodbank. |
| | 3 | Seepage expected to occur at or near floodbank toe. Soil strength loss may result in erosion of soil material. |
| | 4 | Significant seepage is expected to occur and may result in erosion of soil material, particularly around penetrations such as tree roots or structures. |
| | 5 | Observed locations of seepage and/or piping in previous flood events. |

1. Further information regarding descriptions are provided in the T+T report '*Floodbank Condition and Structural Integrity Assessment*', May 2018.

### 3.3.3 Overtopping

The likelihood rating for the overtopping failure mode at each floodbank section was estimated by a combination of quantitative water level review, field observation data and engineering judgement.

The quantitative water level review was undertaken by comparing modelled flood levels[4] to the floodbank crest levels[5] Modelled flood levels were based on peak flows of 3,000 $m^3/s$ (estimated as a 1% AEP event[4]) for the Taieri River, 300 $m^3/s$ (1% AEP) flow upstream of the Gordon Road spillway for Silver Stream, 90 - 93 $m^3/s$ (10% AEP) flow for the Contour Channel and 113 $m^3/s$ (approximately 2% AEP) for the Waipori River.

[4] 2-dimensional hydraulic model outputs provided by ORC as described in ORC report 'Lower Taieri River Model Development Report', Preliminary Draft, August 2020. Flood levels from Design Scenario 3 adopted for this assessment.
[5] Floodbank crest levels taken from 2021 LiDAR level survey.

Due to spatial limitations in the design flood level data, 2.5 km of the total 109 km length of floodbank does not have a flood level. For these lengths of floodbank, overtopping rating was assigned based on the nearest available flood level.

Table 5 explains how the likelihood rating was estimated for the overtopping failure mode.

Table 5: Overtopping rating

| Rating | Description[1] | |
|---|---|---|
| 1 | More than 0.5 m freeboard predicted. | No overtopping expected. Very low probability of compromise to the integrity of the floodbank by overtopping (i.e. breach). |
| 2 | 0.5 m freeboard to 0.0 m freeboard predicted, with grass/vegetation, crossing, stock, or erosion rating(s) of 1 or 2 (from field condition assessment). | Minor overtopping may occur (due to variability of crest height, minor flow stalling etc.), and is expected to be sustainable for an extended period with minimal or no scour damage. Low probability of compromise to the integrity of the floodbank (i.e. breach). |
| 3 | 0.5 m freeboard to 0.0 m freeboard predicted, with grass/vegetation, crossing, stock, or erosion rating(s) greater than 2 (from field condition assessment) | Minor overtopping may occur (due to variability of crest height, minor flow stalling etc.), minor damage may occur over a period of about an hour, or significant damage may occur over greater periods. Low to moderate probability of compromise of the integrity of the floodbank (i.e. breach). |
| 4 | 0.0 m freeboard to 0.3 m overtopping predicted. | Overtopping expected to occur, resulting in scour damage over a period of several hours. Moderate probability of compromise of the integrity of the floodbank (i.e. breach). |
| 5 | More than 0.3 m overtopping predicted. | Severe overtopping expected to occur, resulting in scour damage which affects integrity of the floodbank. High probability of a breach if overtopping lasts for more than a few hours. |

1. Further information regarding overtopping descriptions are provided in the T+T report '*Floodbank Condition and Structural Integrity Assessment*', May 2018.

Spillways at Riverside Road, Gordon Road, Henley and two along the Contour Channel are designed to overtop in a design flood event. Therefore, an overtopping rating of 1 was assigned to these sections. This assumes that the spillways are appropriately designed for overtopping.

## 3.4 Consequence of failure


*Consequence:* *The preliminary assessment of the effect of failure of the floodbanks at select locations.*

To estimate the effect of failure at each floodbank section, consequence categories were adopted from the International Infrastructure Management Manual (IIMM). The RMF Tool recommends the use of the IIMM categories. The IIMM describes the effect as those consequences felt by social, environmental and economic factors.

The standard IIMM consequence categories have been adjusted based on site specific information, data availability and adopting part of ORC's Natural Hazard Risk Assessment descriptors as agreed with ORC. The adopted categories are shown in Table 6 on the following page.

A rating of 1 to 5 (insignificant, minor, moderate, major, catastrophic) was estimated for each floodbank section based on high-level floodbank breach modelling and damage assessment described in the following sections.

An overall consequence rating from 1 to 5 was calculated for each floodbank section based on the highest rating from each category, this is also known as a "first past the post" approach as agreed with ORC.

Table 6: Consequence of failure categories

| Rating | | Consequence of failure category | | | | | |
|---|---|---|---|---|---|---|---|
| | | Social | | Environment | Property inundation damages | | |
| | | Safety & health | Loss of service extent/duration | | Building damages | Productive farmland damages | Airport damages |
| 1 | Insignificant | PAR[1] = 0 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | < 1% of Productive land area affected | - |
| 2 | Minor | PAR = 1 | Significant service disruption affecting small number of customers | Material damage, localised impacts and importance, return to natural state within 1 – 3 months | 2-10% of buildings have functionality compromised | 2-10% of Productive land area affected | - |
| 3 | Moderate | PAR = 2 to 10 | Significant localised disruption over extended period (two weeks) | Serious damage, localised impacts and importance, return to natural state within 12 months | 11-20% of buildings have functionality compromised | 11-20% of Productive land area affected | - |
| 4 | Major | PAR = 11 to 100 | Major localised disruption over extended period (over a month) | Serious damage, national impacts and importance, return to natural state within 5 months | 21-49% of buildings have functionality compromised | 21-49% of Productive land area affected | - |
| 5 | Catastrophic | PAR > 100 | Major long-term service disruption affecting rest of region | Serious damage of national importance. Long term remediation/study required. May not return to natural state | > 50% of buildings have functionality compromised | > 50% of Productive land area affected | Catastrophic damages if terminal building flooded |

1. PAR: Population at risk - definition: The number of people who would be directly exposed to inundation greater than 0.5m in depth if they took no action to evacuate. Definition from NZSOLD Guidelines 2015.

### 3.4.1 Floodbank breach modelling

T+T undertook high-level floodbank breach modelling along the Taieri River and Silver Stream floodbank to estimate the flooded extent and water depth resulting from a hypothetical floodbank breach. This information was used to inform the damage assessment for each of the consequence of failure categories; social, environmental and property inundation.

Further information and limitations regarding the breach modelling are provided in the T+T report '*Flood Risk Assessment – Taieri Scheme Review – Floodbank breach modelling*', 1 February 2023, and provided in Appendix B.

A 2-dimensional hydraulic model of the Taieri River and Silver Stream flood scheme area was developed in TUFLOW software (Version 2020-10-AA) to predict the flooded extent during various floodbank breach scenarios.

Fifteen representative locations on the landward side of the floodbanks were selected to apply a hypothetical breach hydrograph as a point source. The locations were selected based on floodbanks with a history of observed locations of seepage in previous flood events, and to broadly cover the scheme area from upstream to downstream. Appendix A, Figure A3 shows the locations of the modelled stopbank breaches. There is potential for floodbanks to breach at any location within the scheme area. Floodbank breaches at other locations would result in different flooded extents. Breaches may form in a different manner to that assumed and breach arrangements different to those assumed will also result in different outcomes. Breaches have been modelled independently. If multiple breaches occur at the same time the flooding extent and depth could be larger.

Each modelled breach result was applied to multiple floodbank sections based on the location of the section in relation to the breach. The length, depth and formation time of each section was based on judgment. In general, breach results apply to floodbank sections downstream of the breach location until it intercepts with another breach location (e.g. Breach 1 and 2). In ponding areas, breach results are also applied to upstream floodbank sections (e.g. Breach 6).

Floodbank breach hydrographs applied to each breach location were estimated using the method described in Zomorodi, 2020. This method provides theoretical equations to estimate the peak discharge from a floodbank breach scenario based on the height and material composition of the floodbank. The failure mode for all the breach scenarios is assumed to be overtopping. Floodbanks may have other failure modes (e.g. piping) however the overtopping failure mode results in the larger and more conservative discharge when using the Zomorodi equations. The equations assume that the water level within the river at the time of the breach is at the crest of the floodbank which would be required for an overtopping failure.

A breach hydrograph shape was estimated based on peak discharge and the river hydrograph shape of the 1980 flood event for the Taieri River and April 2006 event for the Silver Stream. These events were selected due to their significant magnitude. A sensitivity analysis was undertaken with an extended breach duration hydrograph shape. This analysis indicates that although the volume, depth and area of flooding increases with the extended breach duration, the overall consequence rating did not significantly change.

It has been assumed that during a  breach of the Taieri River right floodbank downstream of Otokia, SH1 does not breach and therefore, all flooding is contained between SH1 and floodbank.

Figure 6 and Figure 7 shows the derived breach hydrographs.

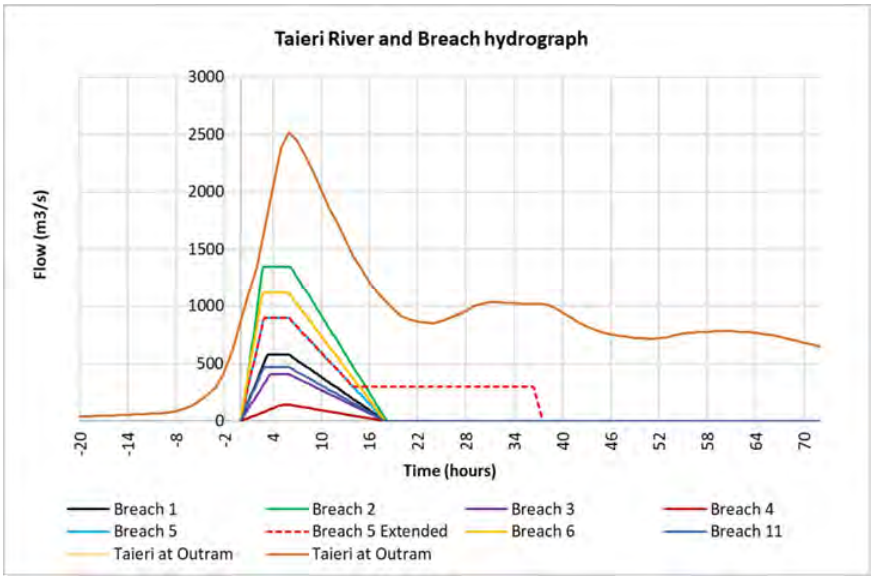



*Figure 6: Breach hydrographs Taieri*

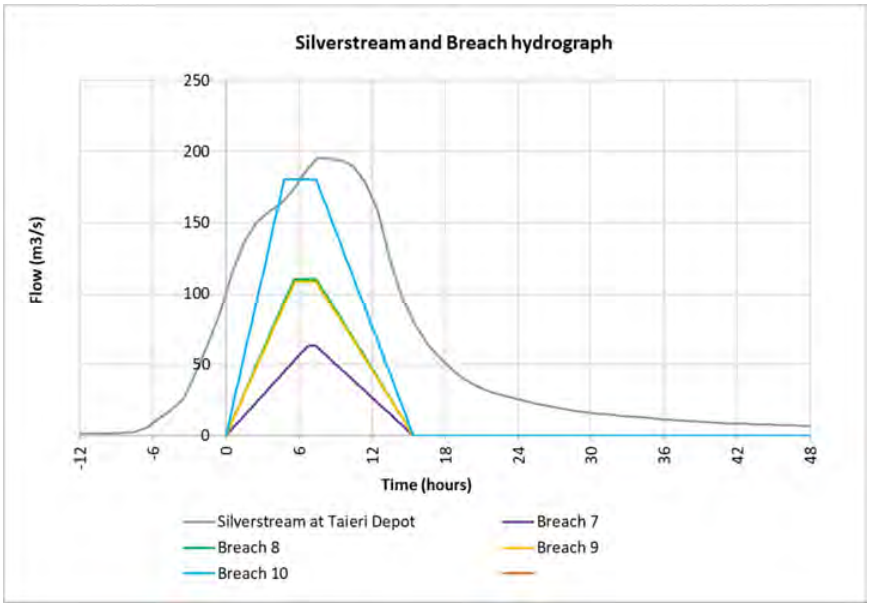



*Figure 7: Assumed breach hydrographs Silver Stream*

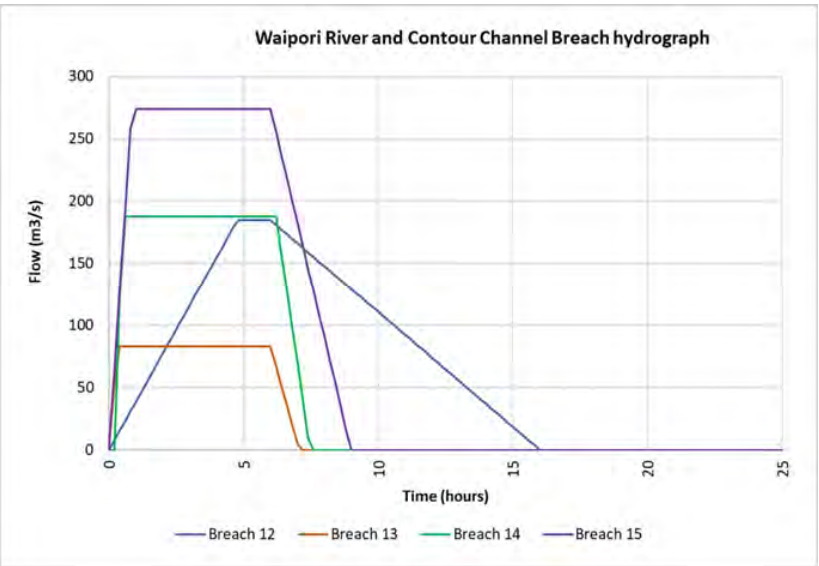



*Figure 8: Assumed breach hydrographs Waipori River and Contour Channel*

### 3.4.2 Damage assessment

The flood depth results from the breach modelling were overlaid with asset information to estimate the damage associated with the modelled hypothetical floodbank breach scenarios. The damage estimate is assessed for each of the consequence categories: social, environmental and property flood inundation.

T+T in collaboration with ORC developed the damage criteria for each consequence category as shown in Table 7. This table shows how the breach model flood depth results were used to estimate the damage for each consequence category.

Table 7: Consequence damage

| Category | Damage criteria |
|---|---|
| Social | |
| Safety & health | Population At Risk[1] (PAR) assumed to 2.7 persons per building[2] if estimated flood depth is 0.5 m or more.<br>PAR > 100 for Dunedin Airport[3] terminal building if estimated flood depth is 0.5 m or more.<br>Other non-permanent itinerants (e.g. schools and other facilities) are excluded from the assessment to avoid double counting PAR within residential dwellings. This does not apply to the Airport as it is assumed that most PAR at the Airport would not be local residents. |

| | | |
|---|---|---|
| Loss of service extent/duration | | |
| Road[4] | SH1 | Significant localised disruption over extended period if estimated flood depth is 0.5 m or more. |
| | SH86 and 87 | Significant service disruption affecting a small number of customers if estimated flood depth is 0.5 m or more. |
| | All other roads | Minor service disruption if estimated flood depth is 0.5 m or more. |
| Rail[5] | | Significant localised disruption over extended period if estimated flood depth is 0.5 m or more. |
| Dunedin Airport | | Major localised service disruption over extended period if runway and/or terminal is flooded by an estimated flood depth of 0.5 m or more. |
| Power infrastructure | | Minor service disruption if one power substations is flooded.<br>Significant localised disruption over extended period if two or more adjacent power substations are flooded. |
| Environment | | Serious damage, localised impacts and importance, return to natural state within 12 months if Henley Swamp, Otokia Swamp, Mckays Triangle Wetland or Mosgiel Waste Water Treatment Plant are flooded by an estimated flood depth of 0.5 m or more. |
| Property Inundation | | |
| Building damages | | Proportion of affected buildings[2] if estimated flood depth is 0.5 m or more |
| Productive farmland damages | | Proportion of affected productive farmland[6] area if estimated flood depth is 0.5 m or more. |
| Airport damages | | Dunedin Airport treated independently, if terminal building is flooded by an estimated flood depth of 0.5 m or more then consequence rating is catastrophic. |

1. Population at risk definition: The number of people who would be directly exposed to inundation greater than 0.5m in depth if they took no action to evacuate. Definition from NZSOLD Guidelines 2015. Only permanent population at risk within residential dwellings included. An average of 2.7 people per building.
2. Buildings were identified using the LINZ building spatial data (Building outlines derived from LINZ Building Outline layer, sourced 16/1/2023). LINZ building information does not different between use (e.g. residential commercial, utility etc). Building areas less than 50m$^2$ were removed from the data. For PAR estimates, only one flooded building per land parcel was counted. (e.g. if 5 buildings within one land parcel are flooded, only one building counted towards PAR).
3. Highest PAR rating category from NZSOLD Guidelines 2015 Section 3.1.
4. Roads alignments identified using the LINZ Roads spatial data, sourced 16/1/2023.
5. Rail alignment identified using the LINZ Rail spatial data, sourced 16/1/2023.
6. Landuse sourced from Land Cover Database (LCDB) GIS layer. Productive farmland defined as High Producing Exotic Grassland, Perennial Crops and Short-rotation Cropland.

A location map of the consequence categories is shown in Appendix A, Figure A4.

## 3.5 Performance score and risk rating

The performance score and risk rating are determined by multiplying the likelihood rating by the consequence rating.


Table 8 shows the performance score and risk rating matrix adopted from the RMF Tool.

Table 8: Performance score and risk rating matrix

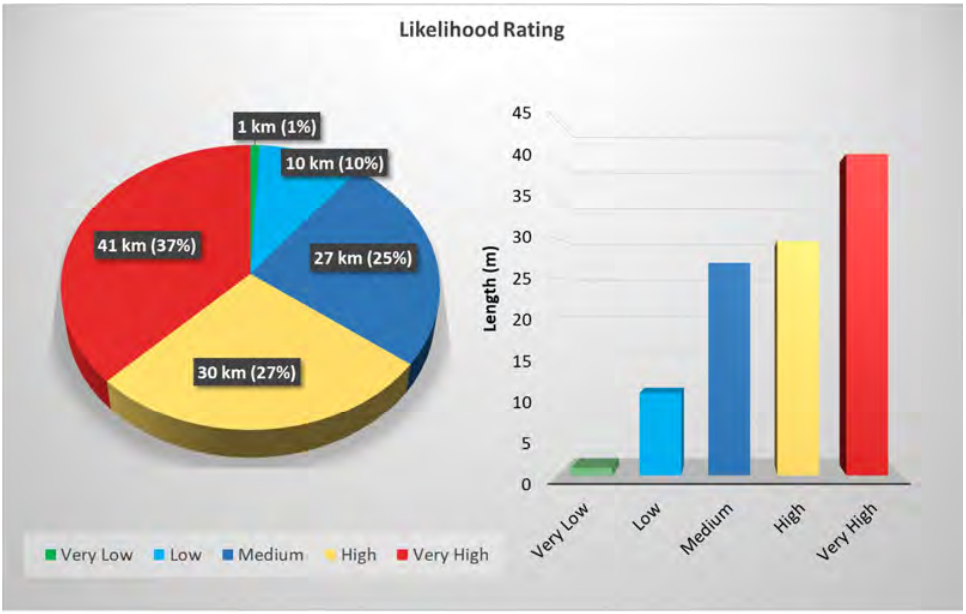
| | | | Consequence | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| | | | Insignificant | Minor | Moderate | Major | Catastrophic |
| Likelihood | 1 | Very low | (1) very low | (2) very low | (3) low | (4) medium | (5) medium |
| | 2 | Low | (2) very low | (4) low | (6) low | (8) medium | (10) high |
| | 3 | Medium | (3) very low | (6) low | (9) medium | (12) high | (15) high |
| | 4 | High | (4) low | (8) medium | (12) medium | (16) high | (20) very high |
| | 5 | Very High | (5) medium | (10) medium | (15) high | (20) very high | (25) Extreme |

# 4 Risk assessment results

The following sections present the results from the risk assessment.

## 4.1 Likelihood of failure rating

Figure 9 shows a summary of the overall likelihood rating.



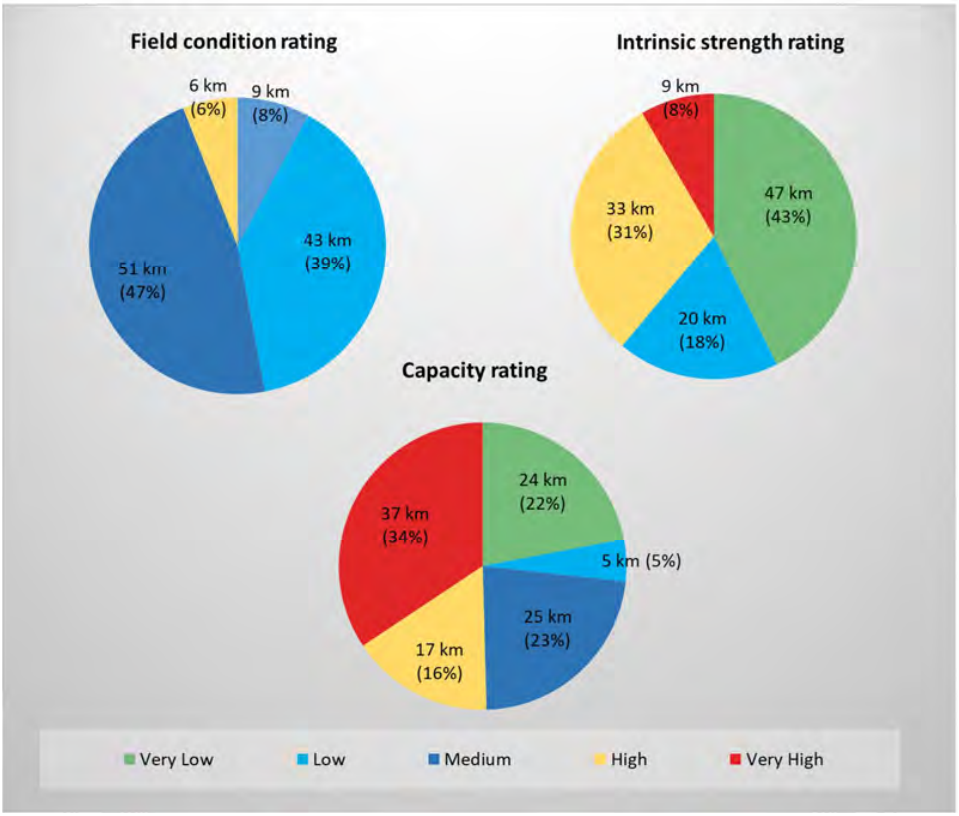

| Likelihood of failure modes | | |
|---|---|---|
| Field condition | Intrinsic strength | Capacity |

*Figure 9: Likelihood rating summary*

Appendix C provides maps showing the likelihood rating for each floodbank section.

Figure 9 shows that 71 km (64%) has a high or very high likelihood rating. This means that based on the three failure modes (field condition, intrinsic strength, and capacity), the likelihood of failure is high or very high during the specified design flood event. The remaining floodbank sections have a medium or lower likelihood rating.

The reasons for the different likelihood ratings along the floodbank vary. Figure 10 shows the likelihood rating for the three failure modes.




| Likelihood of failure modes | | | | | | | |
|---|---|---|---|---|---|---|---|
| Failure mode | Field condition | | | | Intrinsic Strength | | Capacity |
| Components | Berm | Structures | Surface condition | Other | Slope instability | Seepage/piping | Overtopping |

*Figure 10: Likelihood rating summary breakdown*

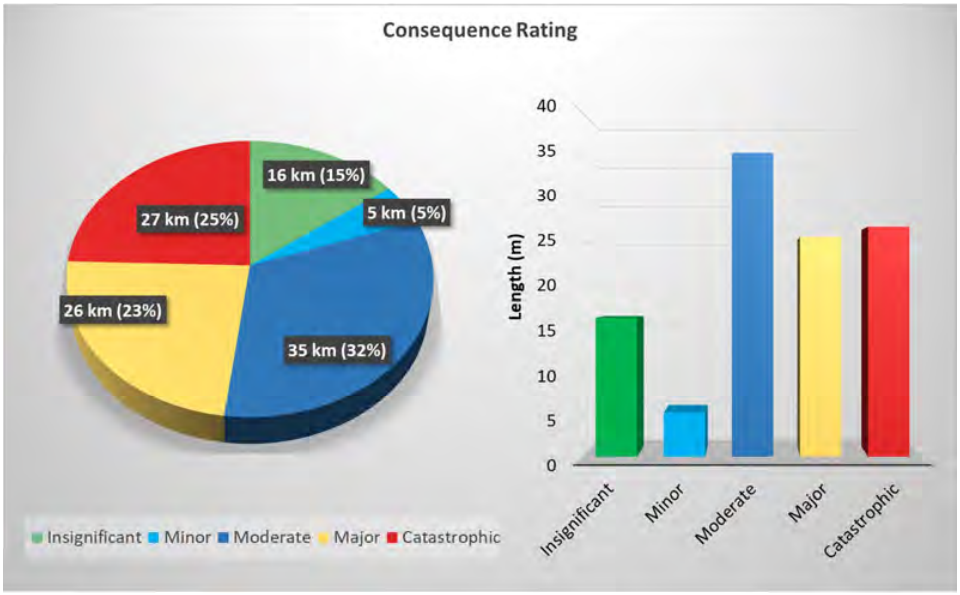
The general reasons for different likelihood ratings along the floodbank are summarised in Table 9.

Table 9: General reasoning for likelihood of failure ratings

| Likelihood rating | Floodbank Sections | Reasoning |
|---|---|---|
| Very high | Several sections of Taieri River left floodbank upstream Silver Stream confluence | Generally due to capacity/overtopping rating with more than 0.3m overtopping |
| | Silver Stream downstream Gladfield Road | |
| | Cut-off bank | |
| | Owhiro right floodbank | |
| | Taieri River left floodbank at Henley | |
| | Several sections at Lake Waipori | |
| | Several sections of Waipori River | Due to intrinsic strength values, which are generally high due to the piping susceptibility rating. |
| | Lower Contour Channel | Due to intrinsic strength values and/or capacity/overtopping. Intrinsic strength values are generally high due to the piping susceptibility rating. |
| | Taieri River downstream Otokia | Due to intrinsic strength values and/or capacity/overtopping. Intrinsic strength values are generally high due to the piping susceptibility rating. |
| High | Several sections of Taieri River right floodbank downstream of Outram. | Due to overtopping rating with 0.0 m to 0.3 m overtopping. |
| | Several sections of Taieri River left floodbank downstream of Silver Stream confluence. | |
| | Several sections of Silver Stream upstream of SH87 | |
| | Several sections of Waipori River | Due to intrinsic strength values, which are generally high due to the piping susceptibility rating. |
| | Lower Contour Channel | |
| | Waipori downstream of Contour Channel | |
| Medium & Low | Taieri River right floodbank from Outram to Otokia | Generally due to field condition rating higher than intrinsic strength and capacity/overtopping ratings. Field condition rating incorporates numerous inputs and difficult to draw broad conclusions, noting that field condition primarily relates to floodbank surface condition and berm/bench width. |
| | Contour Channel | |
| | Silver Stream upstream Gladfield Road | Due to field condition and capacity/overtopping ratings being slightly higher than intrinsic strength. |
| Very low | Isolated sections along Taieri River and Silver Stream | Due to field condition, intrinsic strength and capacity/overtopping ratings being favourable. |

## 4.2 Consequence of failure rating

Figure 11 shows a summary of the overall consequence rating.




| Consequence of failure category | | | | | | |
|---|---|---|---|---|---|---|
| Category | Social | | Environmental | Property inundation | | |
| Component | Safety & health | Loss of service extent/duration | Environment | Building damages | Productive farmland damages | Airport damages |

*Figure 11: Consequence rating summary*

Appendix C provides maps showing the consequence rating for each floodbank section.

Figure 11 shows that 38 km (35%) of the assessed floodbank sections have a catastrophic consequence rating, and 26 km (23%) of the sections have a major consequence rating. The remaining sections have a moderate or lower consequence rating.

Table 10 shows the damage estimates for each modelled breach scenario.

Table 10: Damage estimate and overall consequence rating

| Breach scenario | Consequence of failure category | | | | | | Rating |
|---|---|---|---|---|---|---|---|
| | Social | | Environment | Property inundation damages | | | |
| | Safety & health (PAR) | Loss of service extent/duration | | Building damages | Productive farmland damages | Airport damages | |
| 1 | 794 | Major localised disruption over extended period (over a month) | Negligible impact, no impact to natural state | 2-10% of buildings have functionality compromised | 21-49% of Productive land area affected | - | 5 |
| 2 | 1180 | Major localised disruption over extended period (over a month) | Negligible impact, no impact to natural state | 11-20% of buildings have functionality compromised | 21-49% of Productive land area affected | Airport terminal flooded > 0.5m | 5 |
| 3 | 0 | Small number of customers experiencing minor service disruption | Serious damage, localised impacts and importance, return to natural state within 12 months | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 3 |
| 4 | 0 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 2 |
| 5 | 329 | Major localised disruption over extended period (over a month) | Negligible impact, no impact to natural state | 2-10% of buildings have functionality compromised | 21-49% of Productive land area affected | - | 5 |
| 6 | 413 | Major localised disruption over extended period (over a month) | Negligible impact, no impact to natural state | 2-10% of buildings have functionality compromised | 21-49% of Productive land area affected | Airport terminal flooded > 0.5m | 5 |
| 7 | 419 | Significant service disruption affecting small number of customers | Serious damage, localised impacts and importance, return to natural state within 12 months | 2-10% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 5 |
| 8 | 19 | Small number of customers experiencing minor service disruption | Serious damage, localised impacts and importance, return to natural state within 12 months | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 4 |
| 9 | 5 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10 | 0 | Small number of customers experiencing minor service disruption | Serious damage, localised impacts and importance, return to natural state within 12 months | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 3 |
| 11 | 30 | Small number of customers experiencing minor service disruption | Serious damage, localised impacts and importance, return to natural state within 12 months | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 4 |
| 12 | 32 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 4 |
| 13 | 3 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 3 |
| 14 | 11 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 4 |
| 15 | 38 | Small number of customers experiencing minor service disruption | Negligible impact, no impact to natural state | < 1% of buildings have functionality compromised | 2-10% of Productive land area affected | - | 4 |

The general reasons for different consequence ratings along the floodbank are summarised in Table 11.

Table 11: General reasoning for consequence of failure ratings

| Consequence rating | Floodbank Sections | Estimated consequences |
|---|---|---|
| Catastrophic | Taieri River right floodbank upstream of Otokia and Waipori left floodbank downstream Contour Channel | PAR > 100<br>Damage and PAR associated with flood depths > 0.5 m within Outram township, Airport, rural residential properties and productive farmland<br>Significant productive farmland and building inundation<br>Major loss of service at Airport, local roads, and SH86/87<br>Inundation of Henley Swamp and Otokia Swamp<br>Inundation of Outram substation |
| | Silver Stream left floodbank upstream of Carlyle Road | PAR > 100<br>Potential inundation of WWTP<br>Significant building inundation |
| Major | Cut-off bank between Riccarton Road and Gladfield Road | PAR = 30<br>Inundation of McKays Triangle Wetland |
| | Silver Stream right floodbank upstream of Riccarton Road West | PAR = 19<br>Inundation of McKays Triangle Wetland |
| | Contour Channel downstream Dow Road | PAR = 11 to 38 |
| | Waipori River upstream of Berwick | PAR = 32 |
| | Taieri River left floodbank at Henley | PAR > 11 |
| Moderate | Contour Channel upstream of Dow Road | PAR = 3 |
| | Silver Stream right floodbank downstream of Riccarton Road West | Inundation of McKays Triangle Wetland |
| | Silver Stream left floodbank downstream of Carlyle Road | PAR = 5 |
| | Taieri River left floodbank upstream of the Silver Stream confluence | Inundation of McKays Triangle Wetland |
| | Taieri River right floodbank downstream of Otokia to Waipori confluence | PAR = 6 |

| | | |
|---|---|---|
| Minor | Taieri River left floodbank downstream of the Silver Stream confluence | Some productive farmland inundation in ponding area |
| | Owhiro right floodbank | Some productive farmland inundation in ponding area |
| Insignificant | Various sections at Lake Waipori, left bank lower Contour Channel, lower floodbanks Waipori River | N/A |

## 4.3 Risk rating

Figure 12 shows a summary of the risk rating.

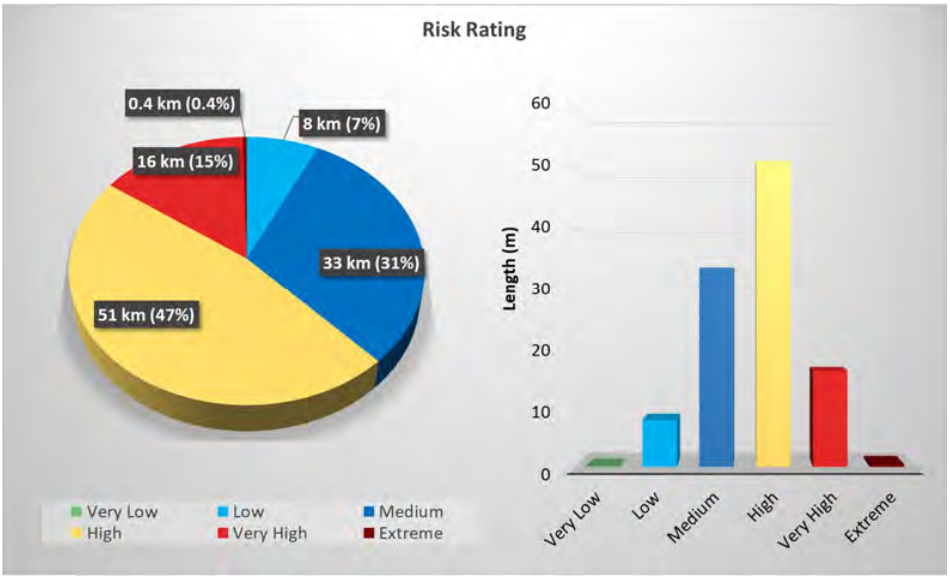



*Figure 12: Risk rating summary*

Appendix C provides maps showing the risk rating for each floodbank section.

Figure 12 shows that 0.4 km (0.4%) of the assessed floodbank sections have an extreme risk rating, and 16 km (15%) have a very high risk rating. 51 km (47%) have a high risk rating. The remaining sections have a medium or lower risk rating.

It is difficult to make generalisations of the risk rating along the floodbank as the reasons are section specific. However, some generalisations have been made as summarised in Table 12.

Table 12: General reasoning for risk ratings

| Risk rating | Floodbank Section | Reasoning |
|---|---|---|
| Extreme | Two sections of Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100. Very high likelihood rating due to potential seepage/piping susceptibility. Piping susceptibility in this area is relatively higher than other areas due to the landside elevation being close to, or at a lower elevation than, the normal water level in the adjacent waterway. These two sections have a higher likelihood rating than adjacent sections due to the presence of trees, and associated root systems, located within approximately 5 m of the floodbank. |

| | | |
|---|---|---|
| Very high | Waipori downstream Contour Channel | Catastrophic consequence rating due to inundation of airport and PAR >100. High likelihood rating due to intrinsic strength value. Intrinsic strength values are generally high due to the piping susceptibility rating. Piping susceptibility in this area is relatively higher than other areas due to the landside elevation being close to, or at a lower elevation than, the normal water level in the adjacent waterway. |
| | Cut-off bank between Riccarton Road West and Gladfield Road | Major consequence rating due to PAR between 11 and 100. Very high likelihood rating due to capacity/overtopping. |
| | Several sections along Waipori River upstream of Berwick, lower Contour Channel, Taieri River right floodbank upstream of Silver Stream, Silver Stream upstream of SH87, Taieri River left floodbank at Henley. | Reasons vary but generally major consequences due to PAR and very high likelihood rating due to capacity/overtopping or intrinsic strength. |
| High | Waipori River upstream Berwick | Major consequence rating due to PAR between 11 and 100. High or very high likelihood rating due to intrinsic strength rating. Intrinsic strength values are generally high due to the piping susceptibility rating in these sections. |
| | Silver Stream upstream of Carlye Road | Catastrophic or major consequence rating due to high PAR (Mosgiel township). Variable likelihood ratings from medium to very high. |
| | Taieri River right floodbank between Outram and Otokia | Catastrophic consequence rating due to PAR >100. Medium or high likelihood rating caused by field condition and capacity/overtopping. |
| | Taieri River right floodbank downstream of Otokia to Waipori confluence | Moderate consequence rating due to PAR between 2 and 10. Very high likelihood rating caused by field condition and capacity/overtopping. |
| | Contour Channel downstream Dow Road | Major consequence rating due to PAR between 11 and 100. Low, medium, high or very high likelihood rating. |
| | Several sections of Taieri River left floodbank upstream of Silver Stream confluence, Silver Stream downstream of Gladfield Road | Moderate consequence rating due to inundation of McKays Triangle Wetland. High or very high likelihood rating due to overtopping. |
| Medium<br>Low<br>Very low | Contour Channel upstream of Dow Road | Reasons vary along sections. Consequence rating either insignificant, minor or moderate. Likelihood rating vary from very low to very high. |
| | Owhiro right floodbank | |
| | Various sections at Lake Waipori | |
| | Waipori River downstream Berwick | |
| | Taieri River left floodbank upstream of SH1 | |
| | Silver Stream left and right floodbank downstream of Carlye Road | |

# 5 Conclusions and recommendations

The objective of this risk assessment was to understand the relative risks to the community of floodbank failure within the Lower Taieri River Flood Protection Scheme.

The framework adopted for the risk assessment generally follows the methodology described in the NZ River Managers Forum (RMF) Code of Practice document *'Flood Protection Assets Performance Assessment Code of Practice',* March 2015. For this assessment, risk was defined as the product of the likelihood and consequence of failure estimates. For the purpose of this assessment, likelihood was based on the severity of known condition and performance defects that could lead to failure during a flood event. Consequence was based on the preliminary assessment of the effect of failure of the floodbanks.

This assessment includes 109 km of floodbanks within the scheme area. The floodbanks were delineated into 629 separable sections based on a field condition assessment undertaken by T+T within the Scheme in 2017/2018.

Each floodbank section was assigned a risk rating based on the RMF framework method. A summary of the resulting risk rating estimates within the scheme area is provided below. Refer to Table 12 for further breakdown of the general reasoning for each floodbank.

Extreme risk: Two separate sections of the Waipori floodbank downstream of Contour Channel. These sections have an extreme risk due to a catastrophic consequence rating caused by a PAR >100, combined with a very high likelihood rating influenced by high seepage/piping susceptibility. These two sections have a higher likelihood rating than adjacent sections due to the presence of trees, and associated root systems, located within approximately 5 m of the floodbank.

Very High risk: Waipori floodbank downstream of the Contour Channel, and cut-off bank between Riccarton Road West/Gladfield Road. Several sections along the Waipori River upstream of Berwick, the lower Contour Channel, Taieri River right floodbank upstream of Silver Stream and Silver Stream upstream of SH87. These floodbanks have a very high risk rating generally due to a catastrophic or major consequence caused by a high PAR, combined with a very high likelihood rating influenced by capacity/overtopping and/or intrinsic strength (which includes seepage/piping susceptibility and/or slope instability) issues.

The following floodbank risk ratings are high, medium or low due to several different combinations of consequence and likelihood ratings. Refer to Table 12 for a further breakdown of the general reasoning for each floodbank.

High risk: Waipori River upstream of Berwick, Silver Stream upstream of Carlye Road, Taieri River right floodbank downstream of Outram and Contour Channel downstream of Dow Road. Several sections in the Taieri River left floodbank upstream of Silver Stream and Silver Stream downstream of Gladfield Road.

Medium risk: Contour Channel upstream of Dow Road, Taieri River left floodbank between Silver Stream/Owhiro Stream, Silver Stream between SH87/Gladfield Road. Several sections in the Waipori area and Taieri River left floodbank upstream of Silver Stream.

Low risk: Several sections of the Contour Channel near Dow Road, Taieri River left floodbank between Silver Stream/Owhiro Stream, Silver Stream downstream of Riccarton Road West and various sections in the Waipori area.

The consequence rating for the floodbanks is based on assessing potential damage that could result from a floodbank breach. However, the rating does not consider other aspects such as ingress and egress during a breach event. Safe escape may be extremely difficult from some areas of the scheme due to the limited amount of warning time (e.g. ring banks). It is recommended that a review is undertaken to assess ingress and egress which impact the consequence and therefore overall risk rating for some areas.

Given the significant length of high and very high-risk rating (driven by largely catastrophic consequences) along the floodbank, it is recommended that a review is undertaken to assess whether the current requirement for the scheme level of service (currently assessed against a performance measure of 2,500 $m^3/s$) coincident with embankment crest level (i.e. nil freeboard) provides "adequate" performance for the scheme and the community relying on the scheme.

This assessment has been carried out on the basis of the inputs, assumptions and limitations stated in this report. Limitations are provided in the following Section 6.

# 6 Limitations

The following limitations apply to this assessment:

1 All inputs into the risk assessment rely on judgement based on our previous work, as well as information provided by ORC, and there is uncertainty associated with the estimated values. The inherent uncertainty in the inputs will result in uncertainty in the calculated risk estimate. It is likely that the results of this assessment will identify areas of uncertainty associated with various inputs into the risk calculation, which in itself may identify areas where further work is required to better understand the contributions to the risk level.

2 This assessment relies on the 2017/2018 condition assessment and supplemental information from ORC. The condition of floodbanks may have changed since this information was collected.

3 Buildings were identified using the LINZ building spatial data. Building areas less than 50 $m^2$ were removed from the data. Furthermore, for the PAR estimate only one flooded building per land parcel was counted. (e.g. if 5 buildings within one land parcel are flooded, only one was counted). This approach has several limitations including:

   – There may be properties which contain more than one residential dwelling within each land parcel (e.g. farm worker accommodation).

   – There are likely to be several non-residential buildings (such as sheds, commercial facilities). Incorporating a building use type would improve the accuracy of this analysis. We understand ORC do not hold any such information currently. LINZ is currently working on developing this dataset for the country.

   – Floor levels of buildings have not been assessed. It is possible that many of the buildings identified as being flooded > 0.5m have raised foundations (e.g. piles). This would reduce the actual depth of flooding.

4 An estimate of the population at risk (PAR) was completed based on the NZSOLD 2015 Guidelines which includes buildings flooded by 0.5 m or more of flood depth. For this assessment, only permanent population at risk within residential dwellings was included. There may be other populations at risk (e.g. recreational users, commercial workers etc) not included in this assessment.

5 Likelihood failure modes and consequence categories have been assessed based on agreed categories with ORC. There may be other modes of failure and consequences which have not been assessed in this assessment.

6 More comprehensive techniques are available to help identify and quantify the likelihood of the failure mechanism(s) and consequences e.g. event tree, fault tree, etc. However, such techniques require information and data inputs that are currently unavailable and out of scope for this assessment.

7 There are several inputs and assumptions into this assessment which are limited by data availability and accuracy. Some of these inputs and assumptions weigh more heavily on the risk rating than others. For example, the consequences or likelihood of airport operation, including what other factors may impact the airport's ability to function, and the potential for incremental damages under different circumstances which are relevant.

# 7 Applicability

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

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

| Report prepared by: | Authorised for Tonkin & Taylor Ltd by: |
|---|---|
| ..... | ..... |
| Richard Brunton | Tim Morris |
| Water Resource Engineer | Project Director |

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# Appendix A Figures

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PROJECT FLOODBANK RISK ASSESSMENT
TITLE FLOODBANK SECTIONS - EAST
SCALE (A3) 1:40,000 FIG No. FIGURE A1 REV 0

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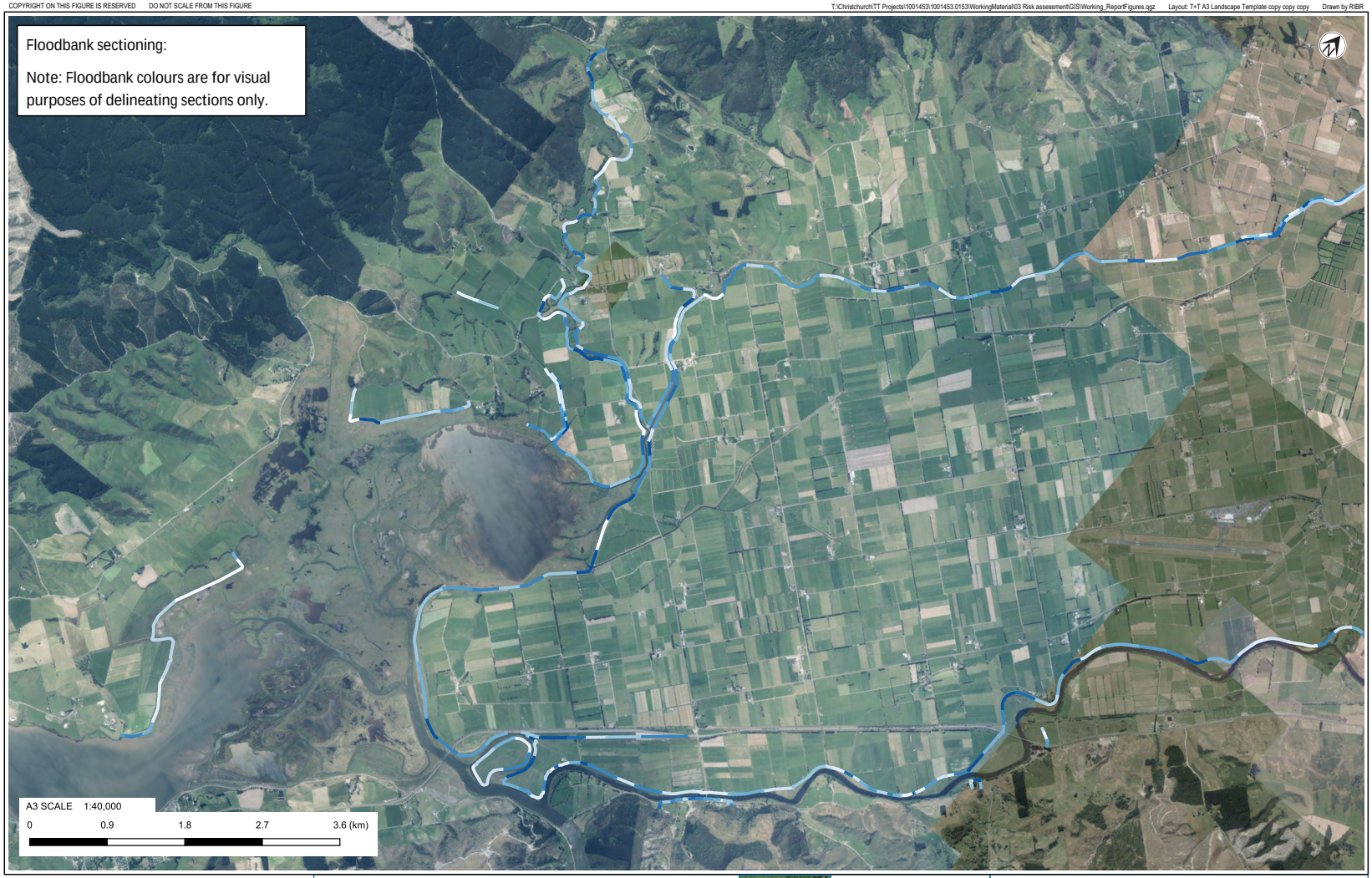


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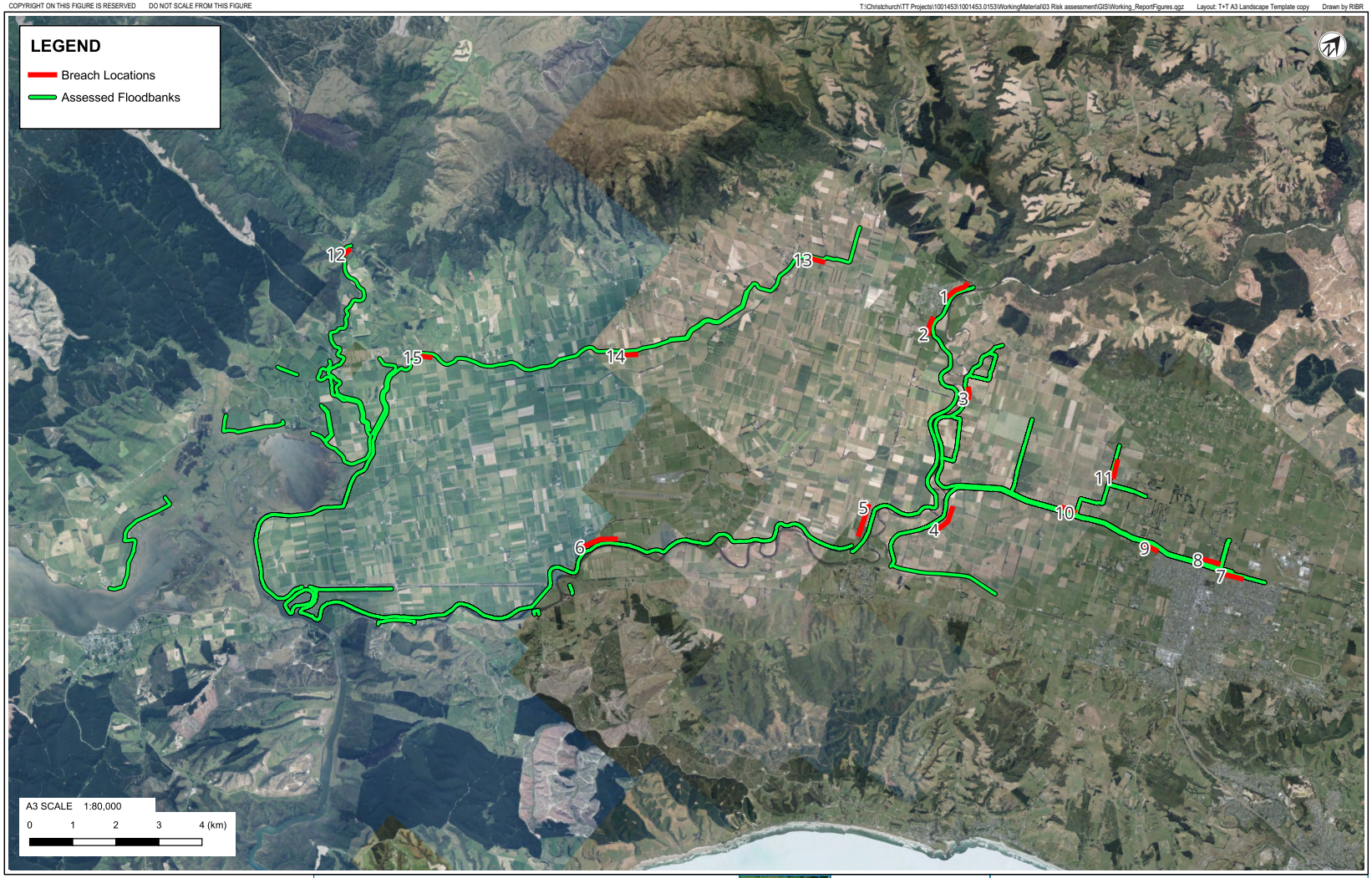


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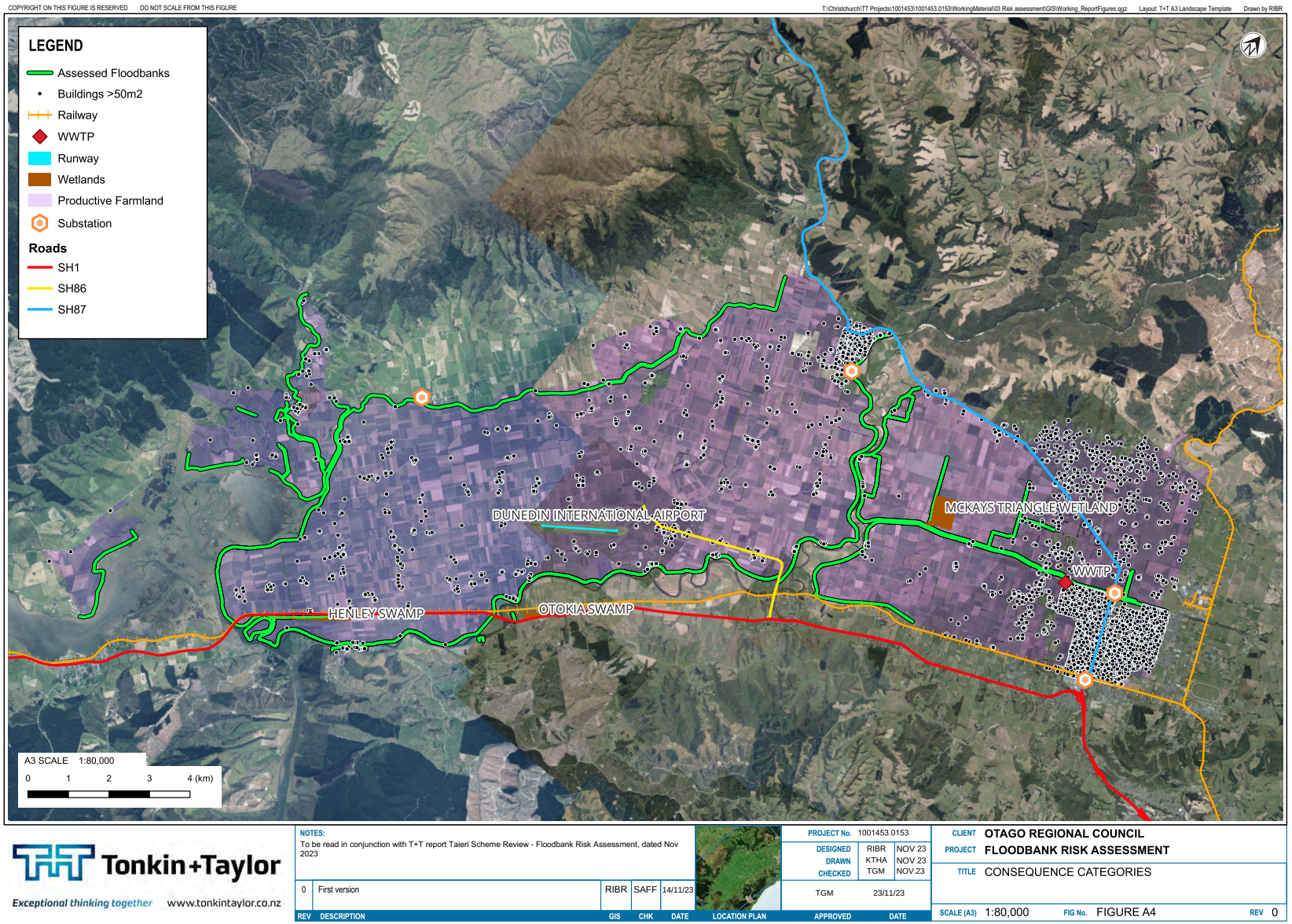
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Buildings >50m2
Railway
WWTP
Runway
Wetlands
Productive Farmland
Substation
Roads
SH1
SH86
SH87
DUNEDIN INTERNATIONAL AIRPORT
MCKAYS TRIANGLE WETLAND
WWTP
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# Appendix B Floodbank breach model report

Tonkin+Taylor

Job No: 1001453.0153
23 November 2023

Otago Regional Council
70 Stafford Street
Private Bag 1954
Dunedin 9054

Attention: Brett Paterson & Ellyse Gore

Dear Brett & Ellyse

**Floodbank Risk Assessment**

**Floodbank breach modelling**

Otago Regional Council (ORC) have engaged Tonkin & Taylor Ltd (T+T) to undertake high-level floodbank breach modelling at select locations to inform the consequence portion of the risk assessment being carried out as part of a wider body of work currently being undertaken by ORC assessing the Taieri scheme.

This work has been prepared for ORC in accordance with the conditions of engagement in dated 13 April 2022, Variation 03 and 27 June 2023, Variation 04.

## 1 Introduction

Our scope of work included developing a high-level breach model to estimate the flooded extent resulting from a hypothetical potential floodbank breach at various locations along the Taieri River, Silver Stream, Waipori River and Contour Channel. The results of this work will be used to inform the consequence portion of the risk assessment being carried out for the flood protection scheme review. Our scope of work included:

- Develop a high-level hydraulic model of the Taieri Plains to predict the flooded extent during various floodbank breach scenarios.
- Develop a high-level breach hydrograph at 15 representative points along the existing floodbank.
- Inundation mapping using the hydraulic model results to estimate the population at risk and area of productive farmland located within the flooded extent.

## 2 Hydraulic model

A 2-dimensional hydraulic model of the Taieri River and Silverstream flood scheme area was developed in TUFLOW software (Version 2020-10-AA) to predict the flooded extent during various floodbank breach scenarios.

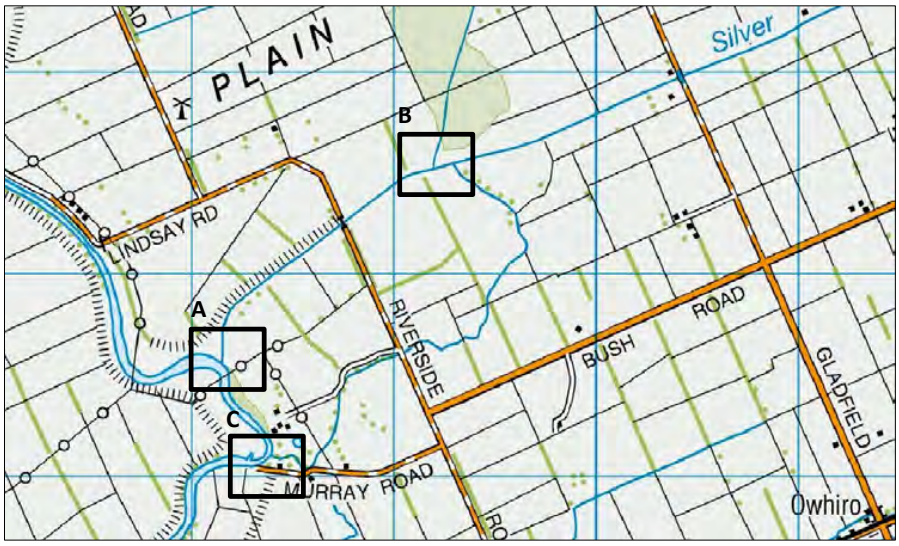
Representative locations on the landward side of the floodbanks within the model domain were selected to apply a hypothetical breach hydrograph as a point source. The locations were selected based on floodbanks with a history of susceptibility and to broadly cover the scheme area from upstream to downstream. Appendix A, Figure A1 shows the locations of the modelled stopbank breaches.

It is important to note that there is potential for floodbanks to breach at any location within the scheme area. Floodbank breaches at other locations would result in different flooded extents.

A static downstream boundary condition has been assumed for the model. A water level of -5 mRL was assumed which effectively removes any effect of a tidal boundary. Tide and breach hydraulic interactions are complex, with breach duration and flow likely to be affected at different rates as the tide fluctuates over the duration of the breach. A detailed assessment of tide conditions is out of scope for this work.

Model topography was represented in the model using 2021 LiDAR survey data[1]. 2016 LiDAR survey data was used to cover a small area in the eastern side of the model domain not covered by the 2021 LiDAR. The computational grid size for the floodplain area is 20 x 20m. So that the crest levels of existing stopbanks are better represented in the model, the grid size was reduced to 1.25 m x 1.25 m along and 10 m either side of floodbank alignments[2].

Corrections were made to the model topography at three locations shown on Figure 2 including the A1 gate outfall, Silverstream pumpstation and Mill Creek pumpstation. At these locations, the LiDAR incorrectly represents actual ground levels, allowing water to artificially enter the ponding areas from the river. Correction involved increasing the ground level to match the floodbank level either side. For the A1 Gate Outfall, it is assumed that the water level within the Taieri River during the breach is high enough that water is prevented from flowing out of the upper ponding area via the flap gates.




[1] DEM for LiDAR data from the Otago Region captured in 2021, sourced from LINZ Data Service November 2022
[2] ORC_Assett_Floodbank shapefile provided by ORC


*Figure 2: Model topography corrections*

## 3 Breach hydrograph

Floodbank breach hydrographs applied at each breach location have been estimated using the method described in Zomorodi[3], 2020. This method provides theoretical equations to estimate the peak discharge ($Q_{peak}$) from a floodbank breach scenario based on the height and material composition of the floodbank. The failure mode for all the breach scenarios is assumed to be overtopping. Floodbanks may have other failure modes (e.g. piping) however the overtopping failure mode results in the larger and more adverse discharge when using the Zomorodi equations.

The equation for $Q_{peak}$ from Zomorodi, 2020:

$$Q = \frac{2}{3} C_D W_b \sqrt{2g}\, H^{\frac{3}{2}} \quad (19)$$

Where

Q = Peak discharge ($m^3/s$),

$C_D$ = Discharge coefficient,

$W_b$ = Final breach dimension in the direction of flow (m),

G = Gravity acceleration= 9.81 ($m/S^2$),

H = Elevation head, which is equivalent to the height of water measured from levee base (could be approximated by levee height), ignoring any depth of erosion hole at the levee base (m).

[3] K. Zomorodi (September 2020), *Empirical equations for levee breach parameters based on reliable international data.*

The equations assume that the water level within the river at the time of the breach is at the crest of the floodbank which would be required for an overtopping failure. If the floodbank breaches at the lower river water level (i.e. via piping failure) the peak discharge $Q_{peak}$ would be lower. There are a range of uncertainties for the method such as:

- Scour hole formation.
- How fast water spreads out relative to the breach size and thus the available head to drive the breach discharge.
- The extent to which water levels build up prior to the breach forming (e.g. depending upon duration of overtopping, the nature of grass cover and embankment slope).

Factors such as these will affect how a particular breach will form.

For levees of height 0.5 m to 10 m and comprised of cohesive material, the equation for $W_b$ from Zomorodi, 2020:

$W_b = 22 \times H_b$

The height ($H_b$) has been estimated from existing 2021 LiDAR data and is the height from the riverbank crest to ground level on the landward side of the riverbank.

A breach hydrograph shape was estimated based on $Q_{peak}$ and the river hydrograph shape of the 1980 flood event for the Taieri River and April 2006 for the Silverstream. These events were selected due to their significant magnitude. The following assumptions were made in the derivation of the breach hydrograph:

- Breach start time: Initialised approximately halfway up the rising limb of the flood hydrograph.
- Breach development time: Estimated from Equation 13 of Zomorodi, 2020.For each breach location $Q_{peak}$ has been set at a constant flow rate from the time of full breach development to the end of the river flood peak flow. $Q_{peak}$ varies for each breach location due to the variation in floodbank crest heights which is an input into the Zomorodi equation.
- Breach end time: Set approximately at the bottom of the falling limb of the river flood hydrograph. At this point the water level in the river is likely to fall below the invert of the breach cut and breach flow will cease. A sensitivity analysis on the beach end time is provided further in this letter.

Figure 3 and Figure 4 shows the breach hydrographs.

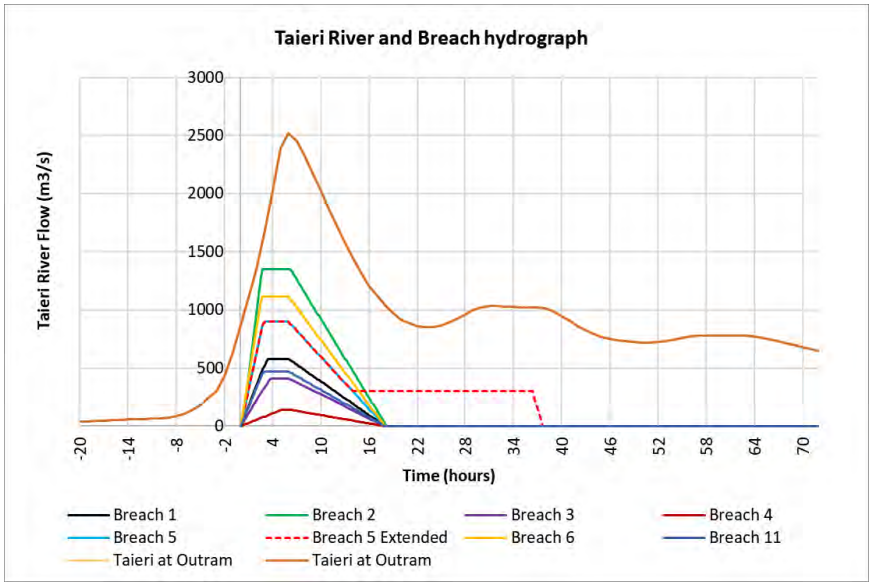



*Figure 3: Breach hydrographs Taieri River*

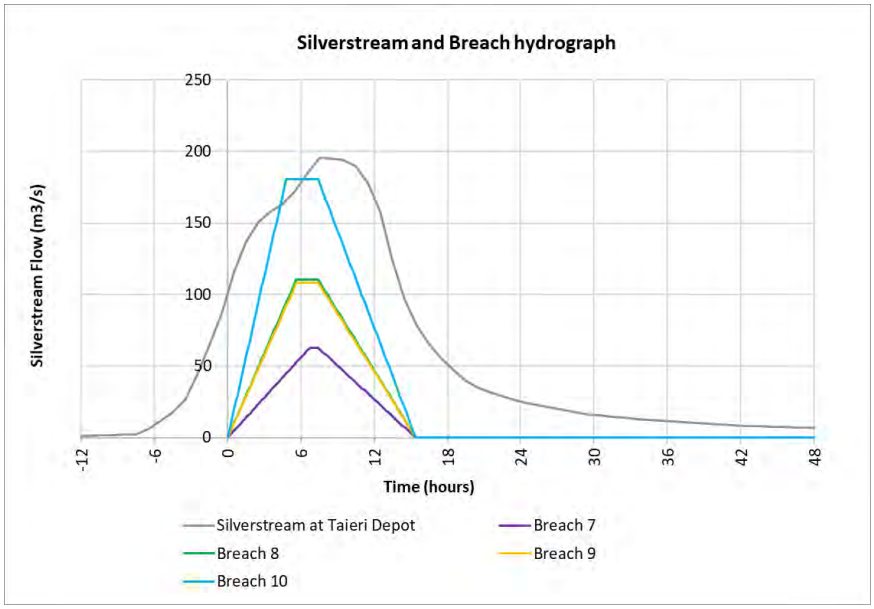



*Figure 4: Breach hydrographs Silverstream*

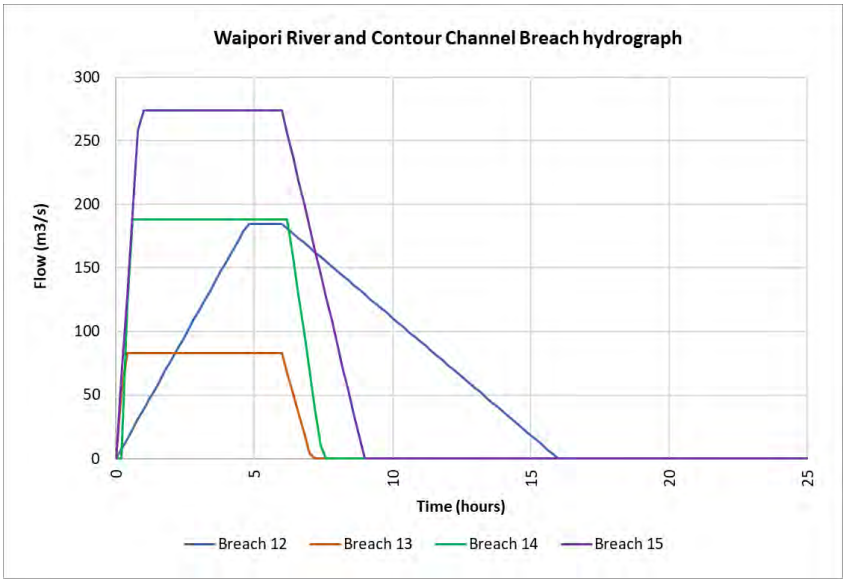



*Figure 5: Breach hydrographs Waipori River and Contour Channel*

Breach 11 (cut-off floodbank) assumes that the lower ponding area is filled to the top of the floodbank when a breach occurs. This scenario is conservative as it assumes that the entire ponding area is filled with water before a breach occurs.

Due to the height of the Contour Channel stopbanks, the estimated peak flows for breaches 12, 13 and 14 were found to be unrealistically high relative to the maximum flow capacity of the Contour Channel. Therefore, breach flows were capped to the combined 50-year flow rates from each Contour Channel sub-catchment as estimated by ORC. Peak flows were assumed to be coincident.

There are many factors which could influence the start and end time of a breach, such as the failure type (overtopping vs piping), river conditions (flood hydrograph shape and duration), variable tailwater levels and interventions. A detailed sensitivity analyses has not been undertaken in this assessment as it is out of scope.

The 1980 Taieri River flood featured a double peak which could extend the duration of a breach if the water level in the river remains above the invert of the breach cut. This water level is likely to vary along the floodbank depending on the relative river water level and geometry of the river channel and floodbanks. A sensitivity analysis was undertaken for Breach 5 assuming the double peak continues to force water through the breach cut. Although the volume, depth and area of flooding increases with the extended breach duration, the overall consequence rating does not change. As the overall consequence rating does not change with the extended breach duration, the original breach hydrographs were adopted for the final consequence assessment.

## 4 Mapping

The hydraulic model depth results were overlaid with the Building Outline GIS layer from LINZ[4] to estimate the number of buildings inundated by floodwater. Buildings with areas less than 50 $m^2$ were removed. Furthermore, only one flooded building per land parcel was counted for the PAR estimate. (e.g. if 5 buildings within one land parcel are flooded, only one was counted as contributing towards PAR ). This approach adopted for PAR is simplistic because:

- There may be properties which contain more than one residential dwelling within each land parcel (e.g. farm worker accommodation).
- There are likely to be several non-residential dwellings (such as farm sheds, commercial facilities) remaining in the dataset. Incorporating a building use type would improve the accuracy of this analysis. We understand ORC do not hold any such information at this time. LINZ is currently working on developing this dataset for the country however the release date is currently unknown.

An estimate of the population at risk (PAR) was then completed based on the NZSOLD 2015 Guidelines which includes buildings flooded ≥ 0.5 m depth. For this assessment, only permanent population at risk within residential dwellings was included. An average of 2.7 people per building was assumed to estimate PAR. There may be other populations at risk (e.g. recreational users, commercial workers etc) not included in this assessment.

Table 1 shows the number of buildings flooded ≥ 0.5 m deep and the resulting PAR for the breach scenarios modelled.

The hydraulic model depth results were overlaid with the Land Cover Database[5] (LCDB) GIS layer to estimate the area of productive farmland flooded during the breach scenarios. Productive farmland was assumed to include High Producing Exotic Grassland, Perennial Crops and Short-rotation Cropland defined by the LCDB and as shown in Figure 6.

[4] Building outlines, sourced from LINZ Data Service April 2022
[5] LCDB Version 5 – https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/ - downloaded November 2022.

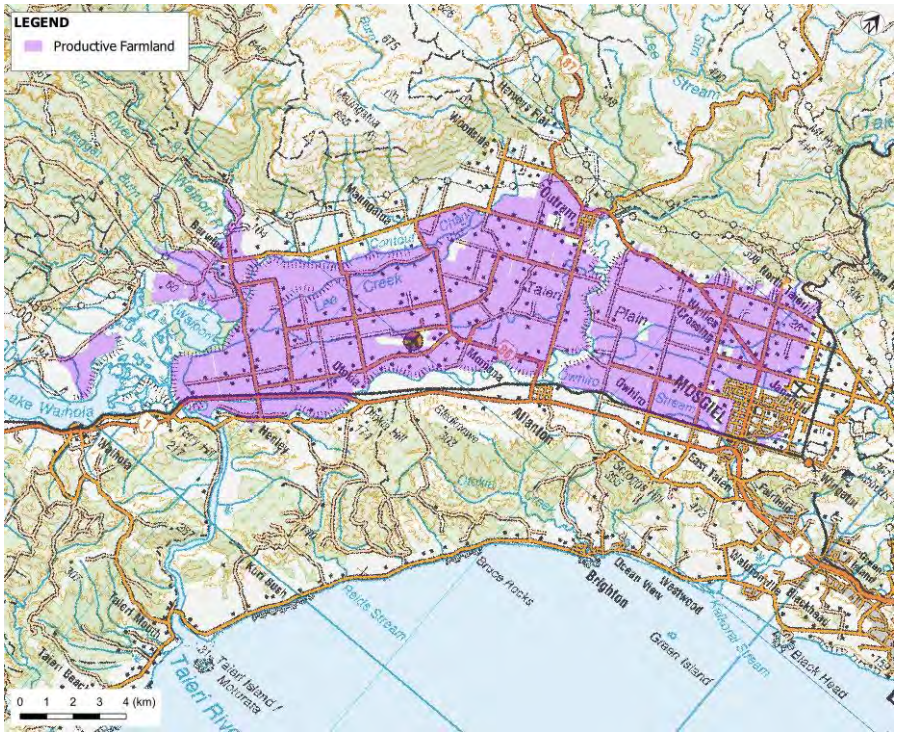



*Figure 6: Farmland derived from LCDB*

Farmland may be susceptible to varying degrees of damage from a combination of factors, typically including flood depth, velocity and duration. It has been assumed for this assessment that farmland will be damaged at depths ≥ 0.5 m. Table 1 shows the area of farmland flooded ≥ 0.5 m deep for the breach scenarios modelled.

Dunedin Airport is a significant asset located within the scheme area and will have a large weighting on the consequence portion of the risk assessment. The operation of the airport during a breach scenario will depend on a combination of factors. It has been assumed for this assessment that the airport would be inoperative if the runway is flooded at any depth. The rows highlighted in red within Table 1 indicate which breach scenarios result in flooding of the runway.

**Table 1: Estimates of PAR, flooded farmland and airport operation during breach scenarios (red highlight = impact to airport)**

| Breach location | Number of buildings flooded ≥ 0.5m | Number of PAR buildings flooded ≥ 0.5m | PAR based on 2.7 people per dwelling (average) | Area of farmland flooded ≥ 0.5m (ha) |
|---|---|---|---|---|
| 1 | 460 | 294 | 794 | 3194 |
| 2 | 781 | 400 | 1180 | 5823 |
| 3 | 0 | 0 | 0 | 665 |
| 4 | 0 | 0 | 0 | 356 |
| 5 | 280 | 122 | 329 | 4373 |
| 6 | 322 | 116 | 413 | 3892 |
| 7 | 167 | 155 | 419 | 220 |
| 8 | 12 | 7 | 19 | 338 |
| 9 | 5 | 2 | 5 | 371 |
| 10 | 0 | 0 | 0 | 395 |
| 11 | 17 | 11 | 30 | 809 |
| 12 | 15 | 12 | 32 | 298 |
| 13 | 1 | 1 | 3 | 226 |
| 14 | 4 | 4 | 11 | 521 |
| 15 | 25 | 14 | 38 | 763 |

The results show that during several of the breach scenarios the PAR is larger than 100. Based on the proposed consequence criteria[6] the Consequence of Failure for these scenarios is Catastrophic.

The modelling results indicate the airport is potentially flooded during Breach scenarios 1, 2, 5 and 6. Due to flooding on the runway (at any depth) it is likely that the runway would be unusable during all four of these Breach scenarios. The airport terminal is flooded ≥ 0.5 m deep only in Breach scenario 2. It is likely that the airport would be at risk of flooding due to a breach in the stopbank along any location along the right bank between Henley and Outram.

## 5 Conclusion

The results of this assessment (estimated population at risk, flooded farmland, and airport operation) will be used to estimate the consequence portion of the risk assessment for the flood protection scheme.

The results indicate that several of the breach scenarios will likely result in a Catastrophic Consequence of Failure due to the high estimated PAR. It is recommended that consideration is given to this when deciding upon future performance standards of the scheme. We consider this conclusion valid irrespective on uncertainties with the model inputs as described in preceding sections.

[6] Memo 'Proposed consequence criteria for ORC comment' dated 17 June 2022

## 6 Model Limitations

The purpose of the breach model is to estimate and provide a general perspective on the number of buildings and area of farmland that may be flooded during a theoretical breach from the floodbank at defined locations. For example:

- In order to inform this estimate, the modelling undertaken has been based on theoretical equations for breach discharge which make several assumptions.
- The model does not assess the probability of a floodbank breach.
- Breaches may occur at locations other than the locations modelled.
- The model does not include any structures, drainage features or pumpstations which may affect the flow path of the breach other than those represented within the LiDAR surface.
- The model is not suitable for assessing flooding on individual properties.
- The method used to identify buildings is simplistic.
- The flooded depth threshold of 0.5 m for buildings and farmland has been adopted for this assessment. In reality, buildings and farmland may be susceptible to varying degrees of damage from a combination of factors, typically including flood depth, velocity and duration. These combined factors have not been assessed.

## 7 Applicability

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

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

| Report prepared by: | Authorised for Tonkin & Taylor Ltd by: |
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|  |  |
| ..... | ..... |
| Richard Brunton<br>Water Resources Engineer | Tim Morris<br>Project Director |

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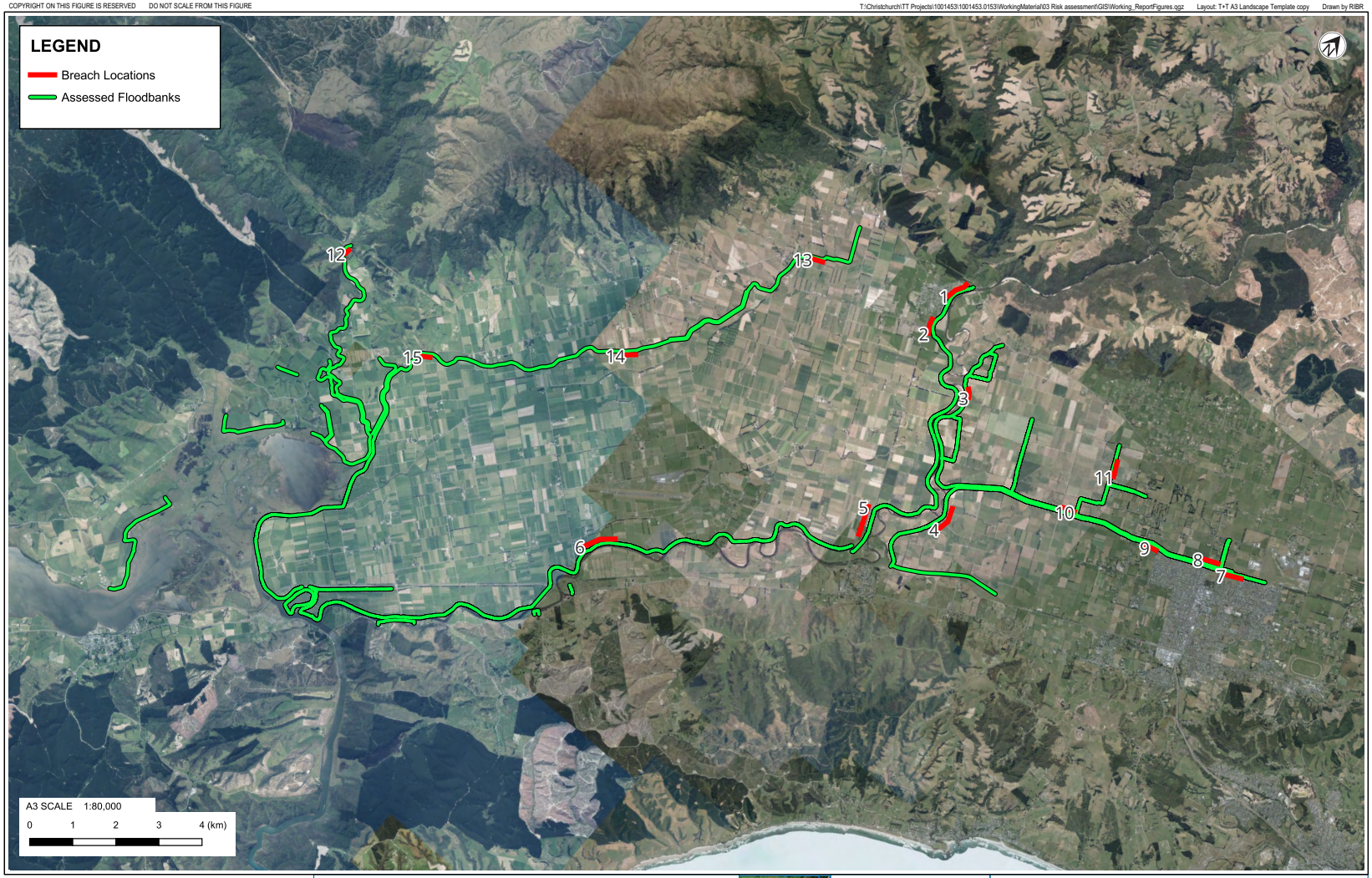


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SCALE (A3) 1:80,000 FIG No. FIGURE A1 REV 0

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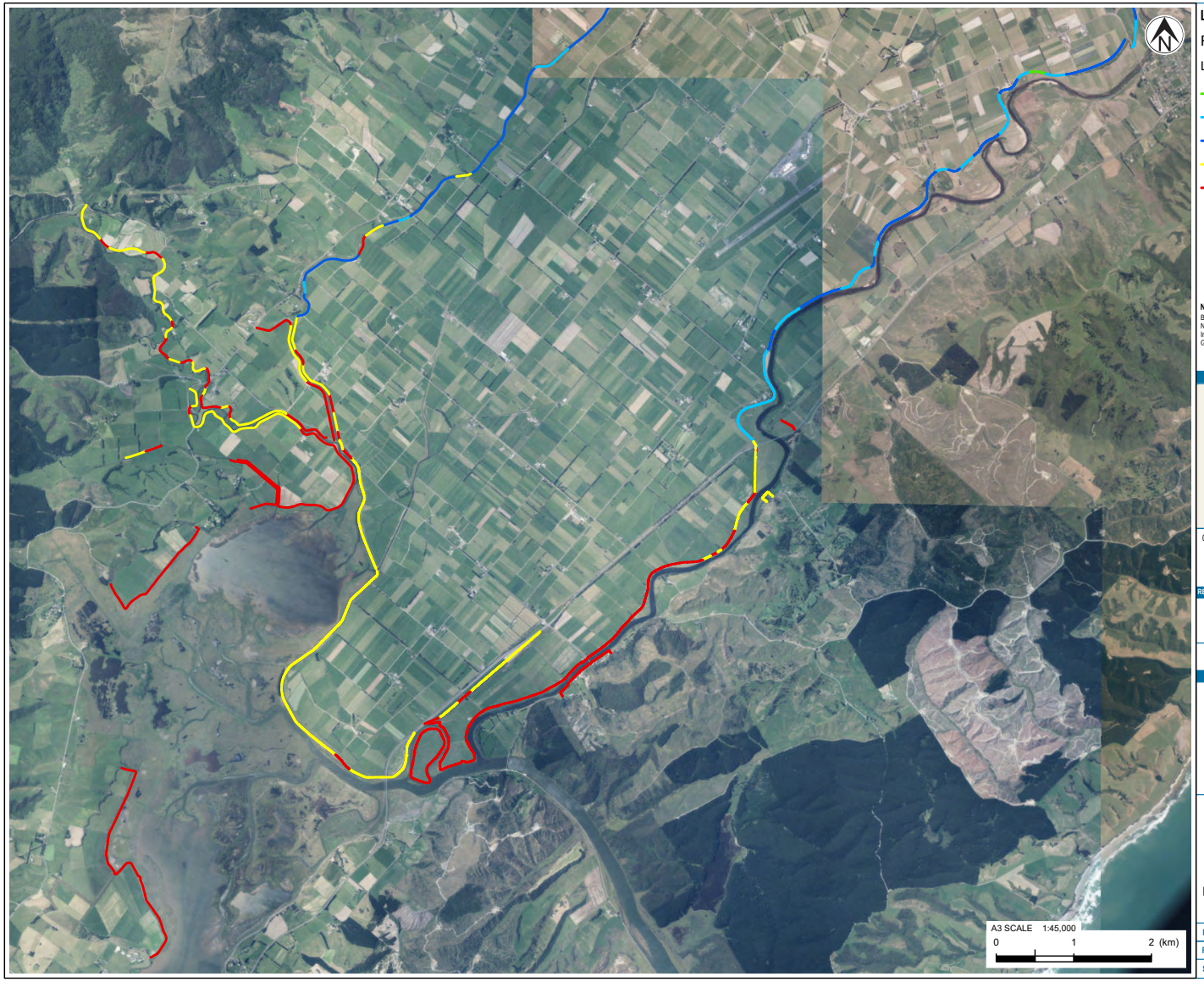
# Appendix C Risk rating result maps

- Likelihood Rating: Figures C1.1 and C1.2
- Consequence Rating: Figures C2.1 and C2.2
- Risk Rating: Figures C3.1 and 3.2

T:\Christchurch\TT Projects\1001453\1001453.0153\WorkingMaterial\04 GIS\MapDocuments\Taieri_StopbankRiskReassessment_102023_DASO.aprx Layout: Taieri Scheme Review Floodbank Risk Assessment 2023-Nov-08 6:31 pm Drawn by DASO

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**LEGEND**

Floodbank Section Rating

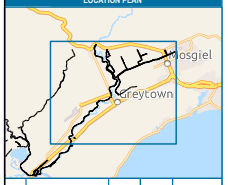
Likelihood Rating

- Very Low
- Low
- Medium
- High
- Very High

**NOTES**

Basemap: NZ Navigation Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors, NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

LOCATION PLAN




| REV | DESCRIPTION | GIS | CHK | DATE |
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| 0 | First version | DASO | ACAM | 06/10/23 |

| | | | |
|---|---|---|---|
| DESIGNED | DASO | NOV.23 |
| DRAWN | DASO | NOV.23 |
| CHECKED | ACAM | NOV.23 |

| APPROVED | DATE |
|---|---|
| TGM | 23/11/23 |

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**OTAGO REGIONAL COUNCIL**

**TAIERI SCHEME REVIEW - FLOODBANK RISK ASSESSMENT**

LIKELIHOOD RATING - EAST

| | |
|---|---|
| PROJECT No. | 1001453.0153 |
| FIG No. | FIGURE C1.2 |
| SCALE (A3) | 1:45,000 |
| REV | 0 |

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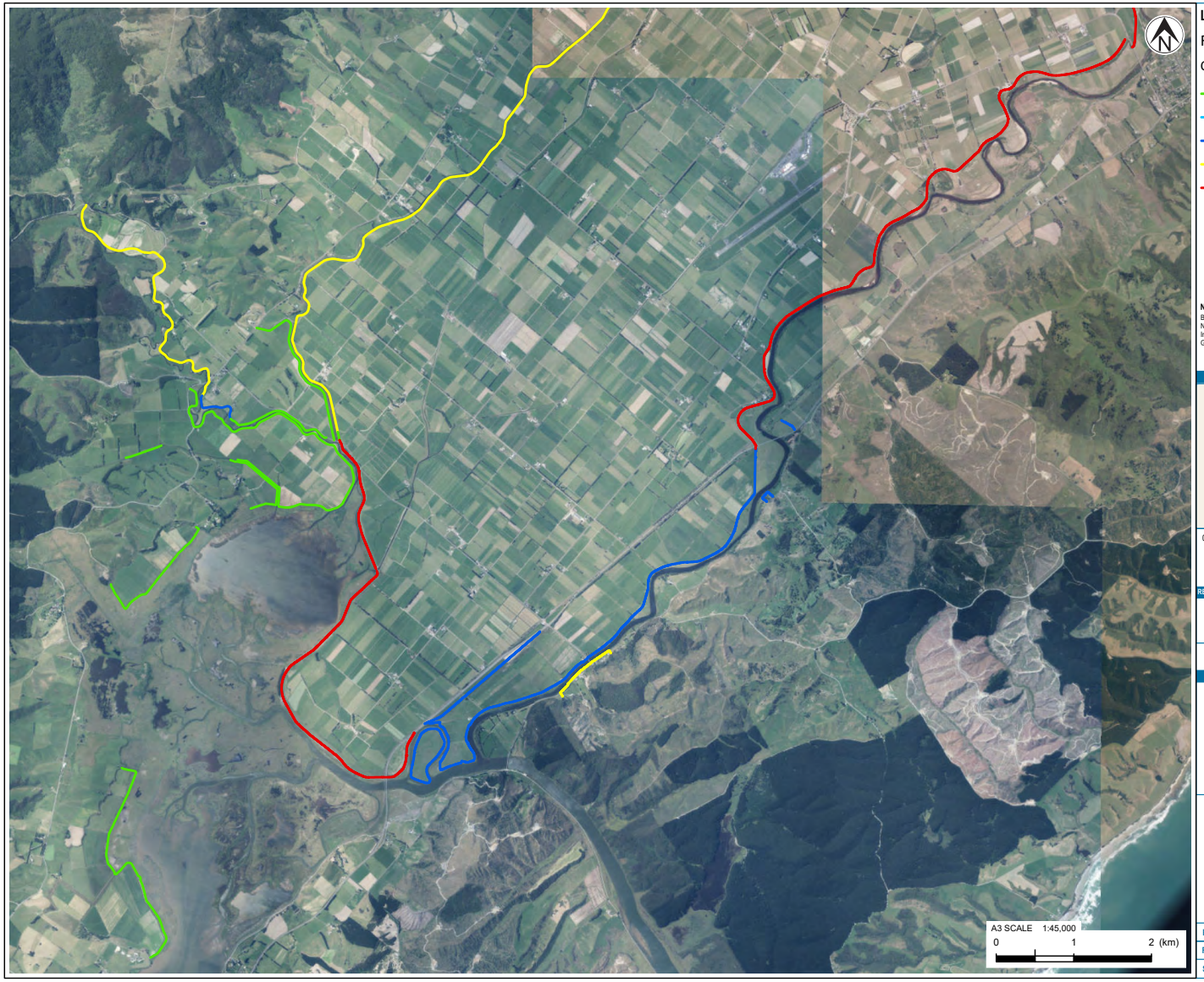


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**LEGEND**

Floodbank Section Rating

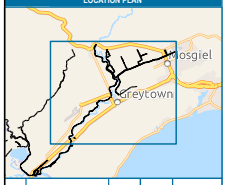
Consequence Rating

- Insignificant
- Minor
- Moderate
- Major
- Catastrophic

**NOTES**

Basemap: NZ Navigation Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors. NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

LOCATION PLAN

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| DESIGNED | DASO | NOV.23 |
| DRAWN | DASO | NOV.23 |
| CHECKED | ACAM | NOV.23 |

| APPROVED | DATE |
|---|---|
| TGM | 23/11/23 |

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**TAIERI SCHEME REVIEW - FLOODBANK RISK ASSESSMENT**

CONSEQUENCE RATING - EAST

| | |
|---|---|
| PROJECT No. | 1001453.0153 |
| FIG No. | FIGURE C2.2 |
| SCALE (A3) | 1:45,000 |
| REV | 0 |

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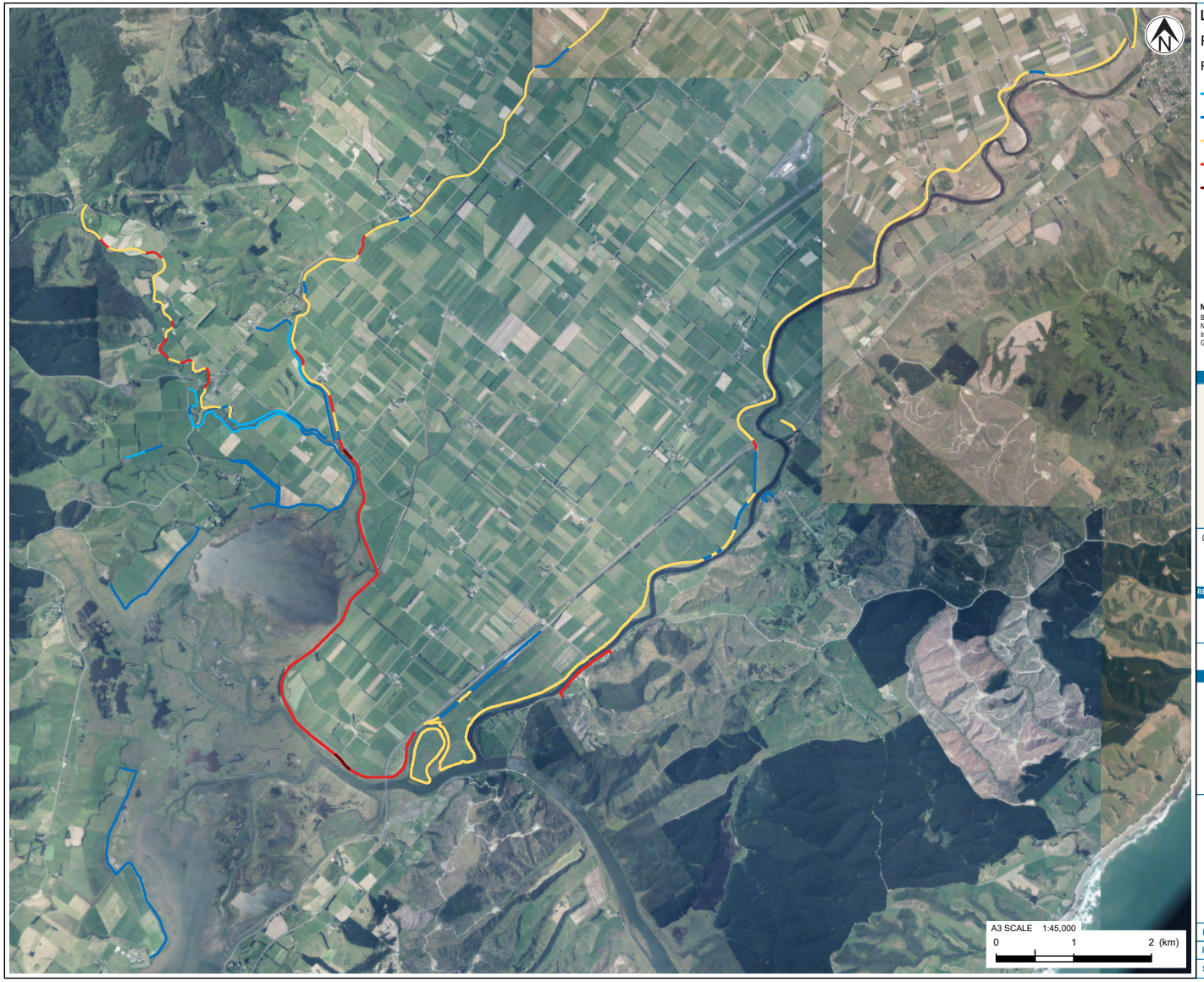


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**LEGEND**

Floodbank Section Rating

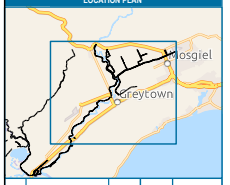
Risk Rating

- Low
- Medium
- High
- Very High
- Extreme

**NOTES**

Basemap: NZ Navigation Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors, NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

LOCATION PLAN

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| DRAWN | DASO | NOV.23 |
| CHECKED | ACAM | NOV.23 |

| APPROVED | DATE |
|---|---|
| TGM | 23/11/23 |

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**OTAGO REGIONAL COUNCIL**

**TAIERI SCHEME REVIEW - FLOODBANK RISK ASSESSMENT**

RISK RATING - EAST

| | |
|---|---|
| PROJECT No. | 1001453.0153 |
| FIG No. | FIGURE C3.2 |
| SCALE (A3) | 1:45,000 REV 0 |

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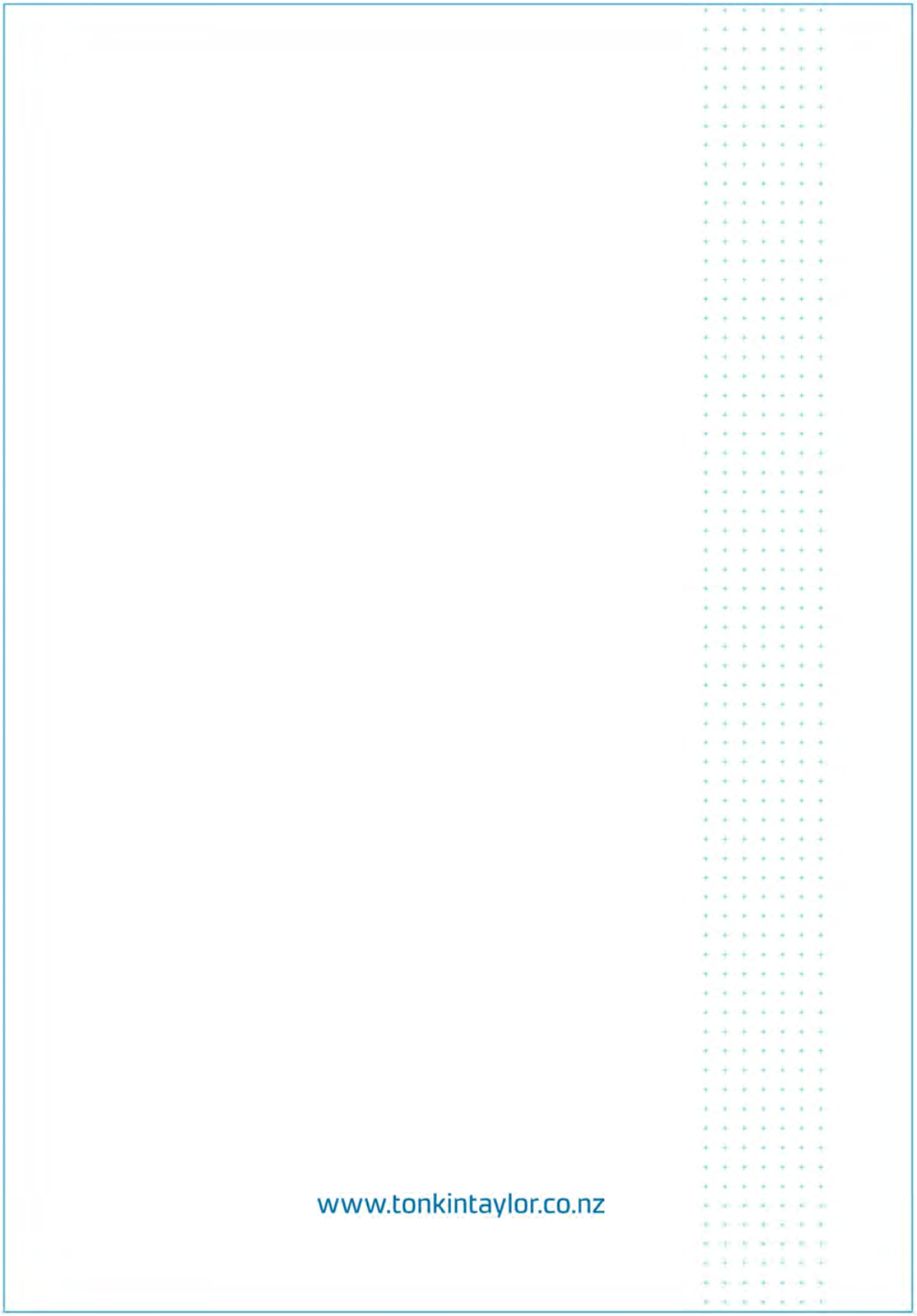
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## Appendix B: Lower Taieri Flood Protection Scheme historic flood/weather damage

**Mill Creek Pump Station July 2017**

***Photo 1: Image showing Mill Creek Pump Station during 2017 flood.***

***Photo 2: Image showing Mill Creek Pump Station during 2017 flood.***

***Photo 3: Image showing Mill Creek Pump Station during 2017 flood.***

***Photo 4: Image showing Mill Creek Pump Station after 2017 July event.***

**Contour Channel during 2006 Flood event**

***Photo 5: Image showing Contour Channel overtopping downstream of Otakia Road, April 2006.***

***Photo 6: Image showing Contour Channel overtopping downstream of Huntly Road, April 2006.***

***Photo 7: Image showing Contour Channel overtopping downstream of Huntly Road, April 2006.***

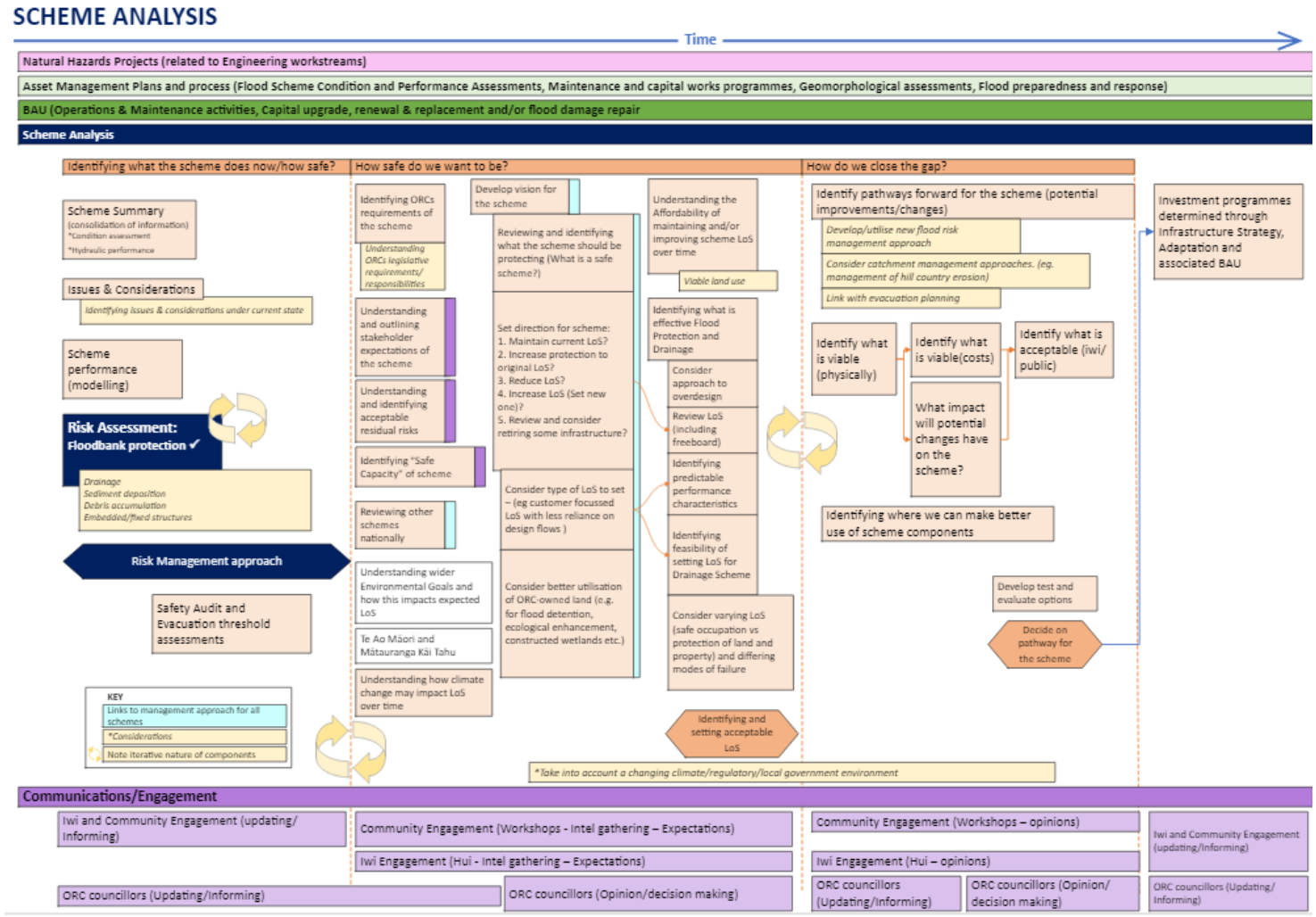
**Riverside spillway 2017 event**

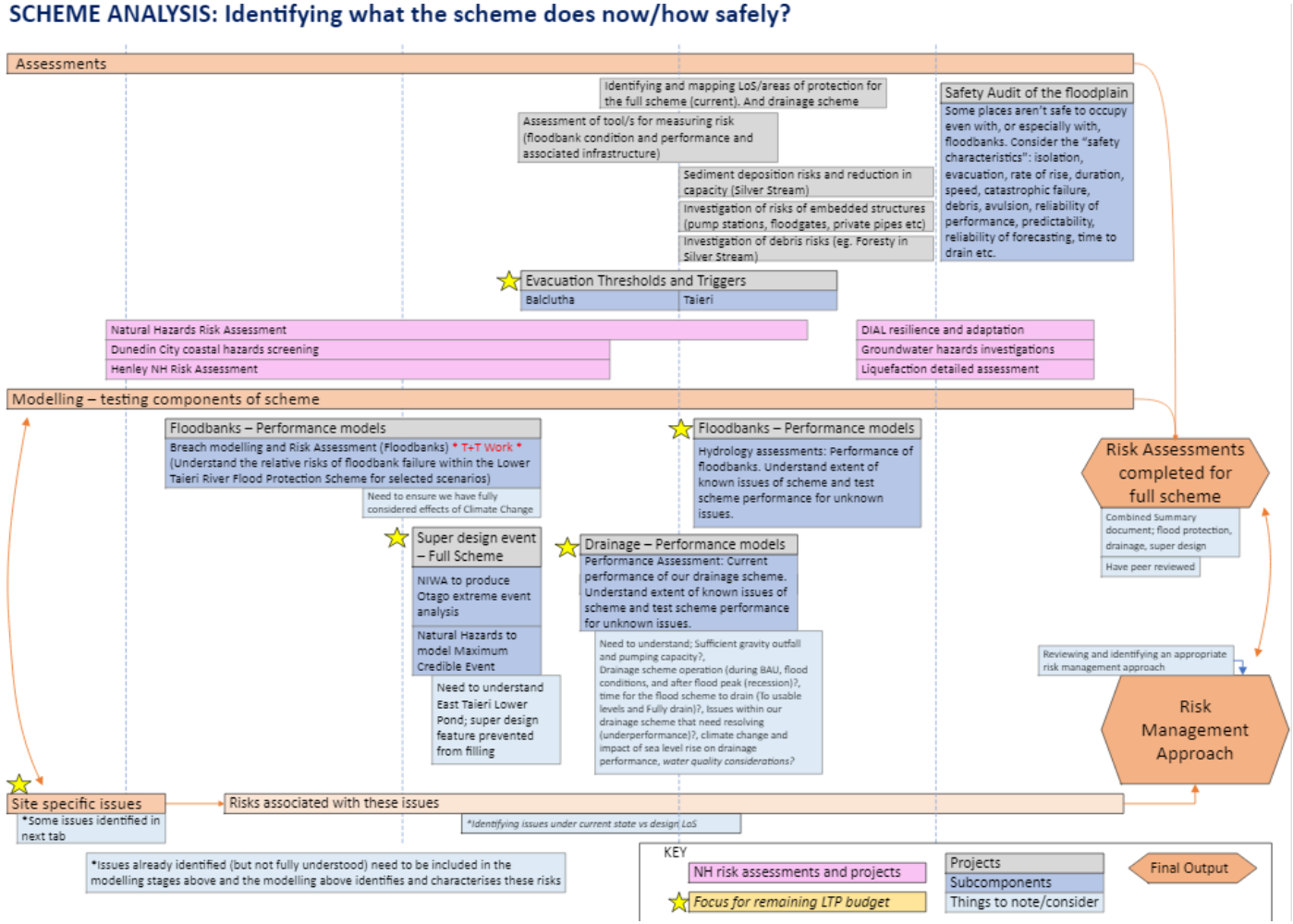
***Photo 8: Image showing crest damage to Riverside Spillway, July 2017.***

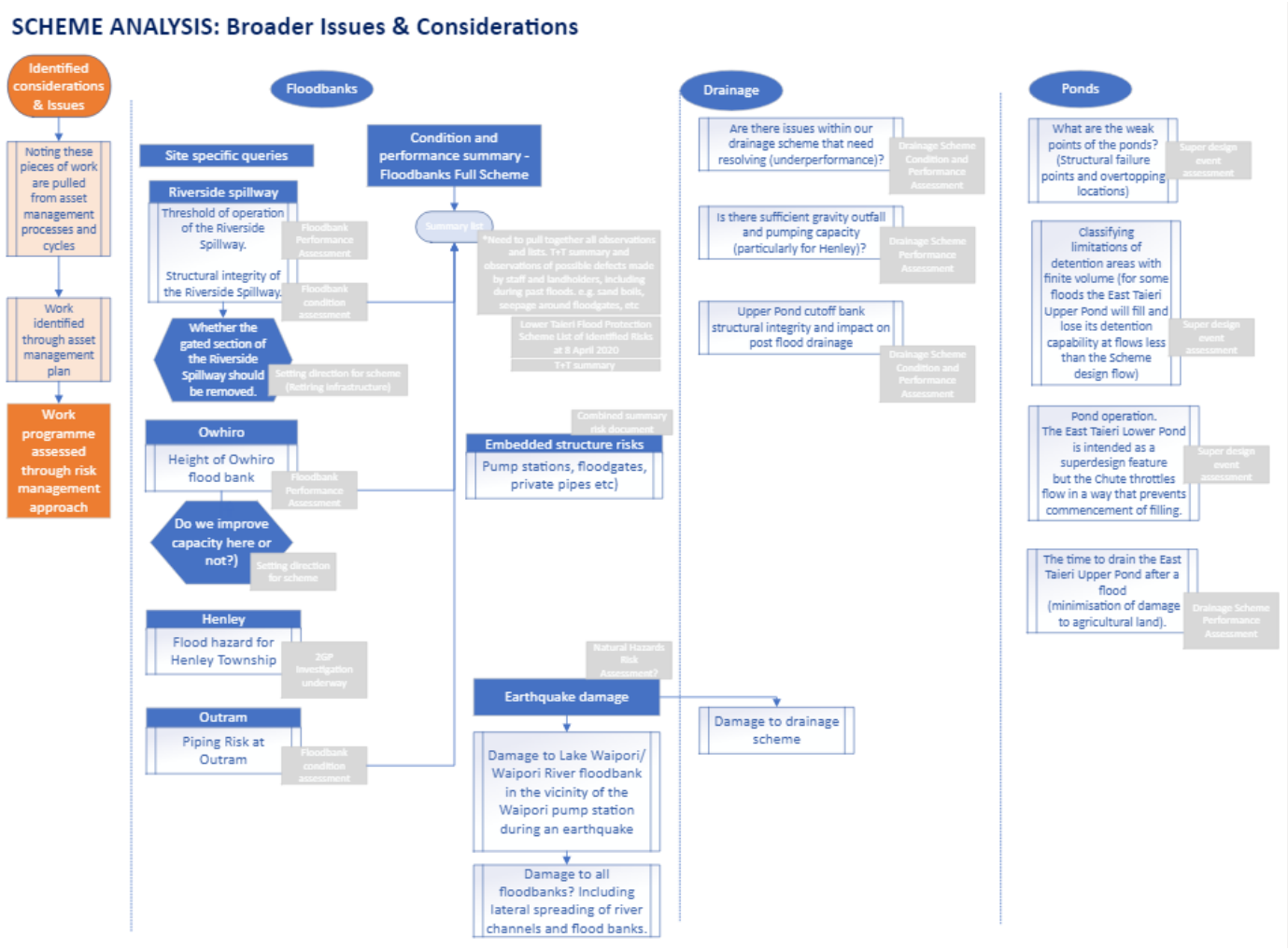
***Image 9: Scour damage downstream of Riverside spillway gated section, July 2017***

***Image 10: Crest debris, Riverside Spillway, July 2017***

# Appendix C - Scheme Analysis




SCHEME ANALYSIS: Identifying what the scheme does now/how safely?
Assessments
Identifying and mapping LoS/areas of protection for the full scheme (current). And drainage scheme
Assessment of tool/s for measuring risk (floodbank condition and performance and associated infrastructure)
Sediment deposition risks and reduction in capacity (Silver Stream)
Investigation of risks of embedded structures (pump stations, floodgates, private pipes etc)
Investigation of debris risks (eg. Foresty in Silver Stream)
Safety Audit of the floodplain
Some places aren't safe to occupy even with, or especially with, floodbanks. Consider the "safety characteristics": isolation, evacuation, rate of rise, duration, speed, catastrophic failure, debris, avulsion, reliability of performance, predictability, reliability of forecasting, time to drain etc.
Evacuation Thresholds and Triggers
Balclutha
Taieri
Natural Hazards Risk Assessment
Dunedin City coastal hazards screening
Henley NH Risk Assessment
DIAL resilience and adaptation
Groundwater hazards investigations
Liquefaction detailed assessment
Modelling – testing components of scheme
Floodbanks – Performance models
Breach modelling and Risk Assessment (Floodbanks) * T+T Work * (Understand the relative risks of floodbank failure within the Lower Taieri River Flood Protection Scheme for selected scenarios)
Need to ensure we have fully considered effects of Climate Change
Floodbanks – Performance models
Hydrology assessments: Performance of floodbanks. Understand extent of known issues of scheme and test scheme performance for unknown issues.
Risk Assessments completed for full scheme
Combined Summary document; flood protection, drainage, super design
Have peer reviewed
Super design event – Full Scheme
NIWA to produce Otago extreme event analysis
Natural Hazards to model Maximum Credible Event
Need to understand East Taieri Lower Pond; super design feature prevented from filling
Drainage – Performance models
Performance Assessment: Current performance of our drainage scheme. Understand extent of known issues of scheme and test scheme performance for unknown issues.
Need to understand; Sufficient gravity outfall and pumping capacity?, Drainage scheme operation (during BAU, flood conditions, and after flood peak (recession))?, time for the flood scheme to drain (To usable levels and Fully drain)?, Issues within our drainage scheme that need resolving (underperformance)?, climate change and impact of sea level rise on drainage performance, water quality considerations?
Reviewing and identifying an appropriate risk management approach
Risk Management Approach
Site specific issues
*Some issues identified in next tab
Risks associated with these issues
*Identifying issues under current state vs design LoS
*Issues already identified (but not fully understood) need to be included in the modelling stages above and the modelling above identifies and characterises these risks
KEY
NH risk assessments and projects
Focus for remaining LTP budget
Projects
Subcomponents
Things to note/consider
Final Output


SCHEME ANALYSIS: Broader Issues & Considerations
Identified considerations & Issues
Noting these pieces of work are pulled from asset management processes and cycles
Work identified through asset management plan
Work programme assessed through risk management approach
Floodbanks
Site specific queries
Riverside spillway
Threshold of operation of the Riverside Spillway.
Floodbank Performance Assessment
Structural integrity of the Riverside Spillway.
Floodbank condition assessment
Whether the gated section of the Riverside Spillway should be removed.
Setting direction for scheme (Retiring infrastructure)
Owhiro
Height of Owhiro flood bank
Floodbank Performance Assessment
Do we improve capacity here or not?)
Setting direction for scheme
Henley
Flood hazard for Henley Township
2GP investigation underway
Outram
Piping Risk at Outram
Floodbank condition assessment
Condition and performance summary - Floodbanks Full Scheme
Summary list
*Need to pull together all observations and lists. T+T summary and observations of possible defects made by staff and landholders, including during past floods. e.g. sand boils, seepage around floodgates, etc
Lower Taieri Flood Protection Scheme List of Identified Risks at 8 April 2020
T+T summary
Combined summary risk document
Embedded structure risks
Pump stations, floodgates, private pipes etc)
Natural Hazards Risk Assessment?
Earthquake damage
Damage to Lake Waipori/ Waipori River floodbank in the vicinity of the Waipori pump station during an earthquake
Damage to all floodbanks? Including lateral spreading of river channels and flood banks.
Drainage
Are there issues within our drainage scheme that need resolving (underperformance)?
Drainage Scheme Condition and Performance Assessment
Is there sufficient gravity outfall and pumping capacity (particularly for Henley)?
Drainage Scheme Performance Assessment
Upper Pond cutoff bank structural integrity and impact on post flood drainage
Drainage Scheme Condition and Performance Assessment
Damage to drainage scheme
Ponds
What are the weak points of the ponds? (Structural failure points and overtopping locations)
Super design event assessment
Classifying limitations of detention areas with finite volume (for some floods the East Taieri Upper Pond will fill and lose its detention capability at flows less than the Scheme design flow)
Super design event assessment
Pond operation. The East Taieri Lower Pond is intended as a superdesign feature but the Chute throttles flow in a way that prevents commencement of filling.
Super design event assessment
The time to drain the East Taieri Upper Pond after a flood (minimisation of damage to agricultural land).
Drainage Scheme Performance Assessment

**8.5. Wildfire Hazard in Otago**

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Comm |
| **Report No.** | HAZ2303 |
| **Activity:** | Safety & Hazards - Natural Hazards |
| **Author:** | Ann Conroy, Team Leader Natural Hazards Adaptation<br>Jean-Luc Payan, Manager Natural Hazards<br>Matt Alley, Manager Emergency Management<br>Simon Robinson, Team Leader Natural Hazards Analysis |
| **Endorsed by:** | Gavin Palmer, General Manager Operations |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To inform the committee of the wildfire risk for Otago and Otago Regional Council's responsibilities for managing that risk.

## EXECUTIVE SUMMARY

[2] Wildfires are defined as unplanned and uncontrolled fires. The term includes grass fires, forest fires and scrub fires be it human-caused or natural in origin[1].

[3] Common effects of wildfires include loss of life and property, health impacts of smoke and fire, economic and ecosystem services losses, and contamination of water air and soil.

[4] Wildfire is listed as a known hazard in the Otago Civil Defence and Emergency Management Group Plan where it is described as '*Vegetation fires are an annual hazard across many areas of Otago. They most commonly occur in summer and autumn but are a potential risk at any time – particularly in the "Red Zones" around Queenstown Hill and Mt Iron in Wanaka, where a total fire ban is in place year-round. The drier areas of Central Otago and Strath Taieri are also at risk.*[2]

[5] Recent international and national events have heightened community awareness of the threat of wildfire, and interest in how the risk is managed in Otago.

[6] Based on the National Climate Change Risk Assessment[3], on average, all climatological measures of wildfire risk will increase across New Zealand to the end of the century. The Otago Climate Change Risk Assessment[4] (OCCRA) considered and described the fire weather and wildfire hazard on the five domains selected for the assessment: natural environment, built environment, economic, human and governance. OCCRA has

[1] New Zealand Wildfire Threat Analysis – workbook documentation for national rural fire authority, National Rural Fire Authority, November 2011
[2] Otago CDEM Group Plan 2018-2028
[3] National Climate Change Risk Assessment for New Zealand – Arotakenga Tūraru mō te Huringa Āhuarangi o Āotearoa: Technical report – Pūrongo whaihanga. Wellington: Ministry for the Environment, 2020.
[4] Otago Climate Change Risk Assessment, prepared by Tonkin and Taylor for Otago Regional Council, March 2021

highlighted that the risk of increased fire weather will increase over time for the natural environment, built environment and economic domains.

[7] The management of wildfire across the 4Rs framework (Reduction, Readiness, Response and Recovery) is not clearly defined or contained in a single piece of legislation, rather across a broad range of instruments, including, but not limited to; Civil Defence and Emergency Management Act 2002, National Plan Order 2015, Conservation Act 1987, Defence Act 1990 and the Resource Management Act 1991. Further, decisions made under other instruments, such as the Biosecurity Act 1993 and the National Policy Statement on Indigenous Biodiversity, play a part in risk management (e.g. control of wilding conifers).

[8] Fire and Emergency New Zealand (FENZ), the Otago Civil Defence and Emergency Management (CDEM) Group, Department of Conservation and Local Authorities all have a role to play in the Reduction, Readiness, Response and Recovery (4R's) from the risk and occurrence of wildfire events.

[9] The Fire and Emergency Act 2017 defines FENZ's main functions as lead Response agency for fire. What is not as clear are the roles and responsibilities across the Reduction, Readiness, and Recovery phases.

[10] This report provides an overview of the wildfire risk for Otago and ORC's responsibilities for managing that risk. Given the complexity of the situation this report recommends that ORC, through its membership of the Otago CDEM Group, promote discussion amongst the Group on current and future wildfire risk including member roles and responsibilities for managing that risk.

## RECOMMENDATION

*That the* Safety and Resilience Committee*:*

1) ***Notes*** *the wildfire risk for Otago and ORC's responsibilities associated with managing that risk.*

2) ***Recommends that Council approves*** *ORC, through its membership of the Otago CDEM Group, promoting discussion amongst the Group on current and future wildfire risk for Otago including member roles and responsibilities for managing that risk.*

3) ***Requests*** *that the Safety and Resilience Committee is updated on the Otago CDEM Group's discussion at its next meeting.*

## BACKGROUND

### Wildfire hazard

[11] Wildfires are defined as unplanned and uncontrolled fires. The term includes grass fires, forest fires and scrub fires be it human-caused or natural in origin.

[12] Common effects of wildfires include loss of life and property, health impacts of smoke and fire, economic and ecosystem services losses, and contamination of water air and soil.

[13] Wildfire hazard varies with weather conditions (e.g. wind, relative humidity, precipitation, temperature), amount and condition of fuel (e.g. dry/wet vegetation) and the physical environment (e.g. topography, presence of barriers).

[14] FENZ utilise their website and social media feeds to inform the public about the wildfire risk and events. Emergency Management Otago support and augment this both at times of heightened risk and response. Locally Councils also support via social media feeds and their websites.

**Wildfire hazard in the Otago area**

[15] Because of the different fire hazard conditions that exist in different parts of Otago, FENZ has divided the region into a number of different zones (Figure 1).[5] The boundaries of these zones have been determined by their climatic features to allow for appropriate fire control measures to be applied locally. These zones are not linked to territorial authority boundaries (i.e. the Otago area defined by FENZ differs from the area administered by Otago Regional Council).

[5] Fire plan for local area – Otago, Te Kei, 25 November 2020

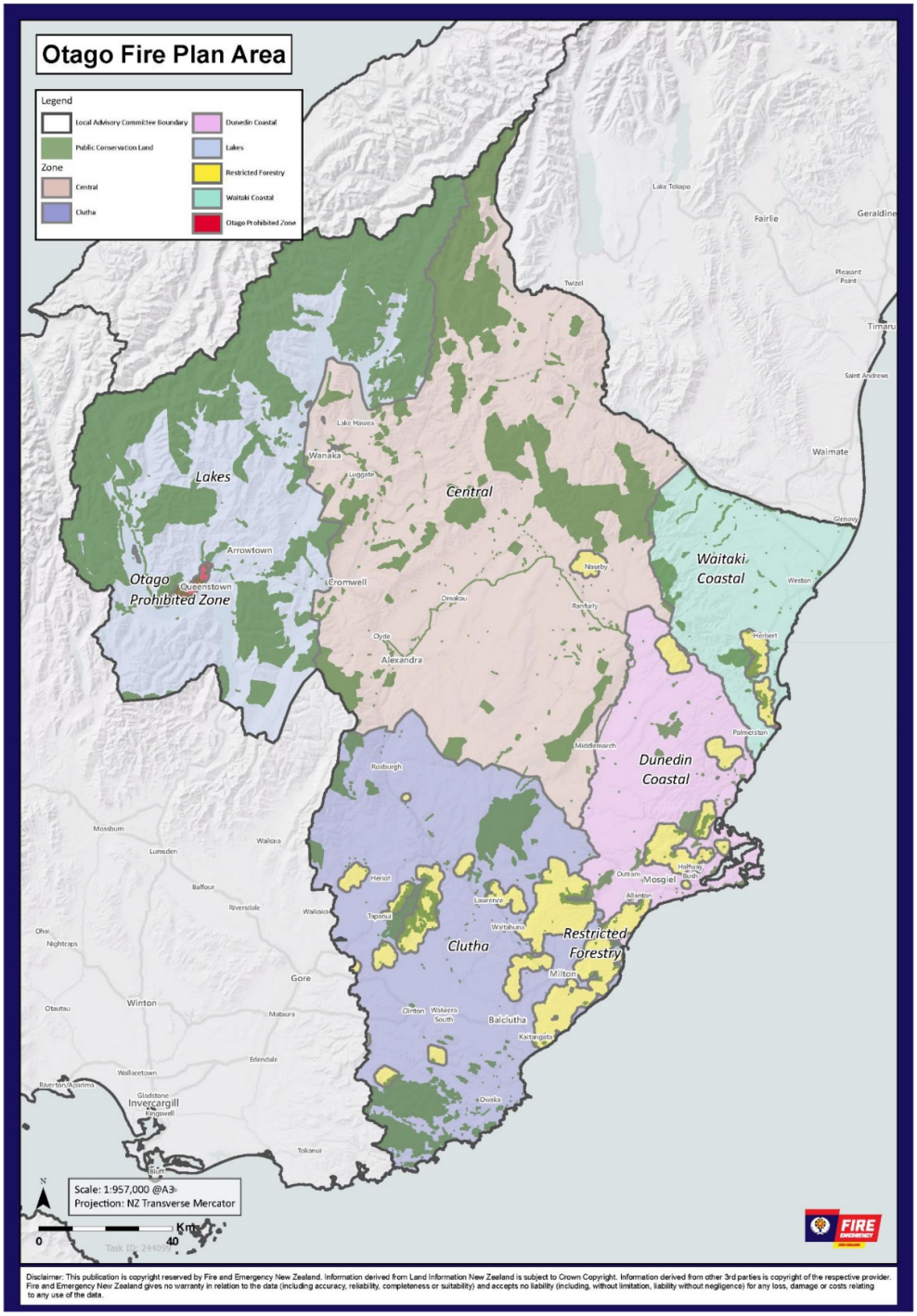



***Figure 1. Otago Fire Plan Area showing the different zones defined by FENZ based on their climatic features.***

[16] On average, the Otago area (as defined by FENZ) experiences 14.2 days[6] of "very high" to "extreme" fire danger[7] with the following variabilities for each zone:

- Central zone: 34.8 days
- Clutha zone: < 1 day
- Coastal zone (Dunedin Coastal and Waitaki Coastal): 6.4 days
- Lakes zone: 11.7 days

[17] Wildfires in the Otago area are not infrequent and are triggered by a variety of causes (Table 1)

[6] Fire plan for Otago, Te Kei, 2021-2024, Fire and Emergency New Zealand, July 2021

[7] The fire danger rating is provided by FENZ. It is calculated using a combination of four weather variables (wind speed, relative humidity, temperature and 24-hour rainfall), and a description of fuel moisture and fire behaviour. This rating system has five categories: Low, Moderate, High, Very High and Extreme. The two highest categories "Very High" or "Extreme" represent a significant risk for large wildfire outbreaks that may require considerable control efforts (Fire Risk Assessment, NIWA, 2017)

***Table 1. Known fire in recent history (until 2020) for the Otago area (from Fire plan for Otago, Te Kei, 2021-2024, Fire and Emergency New Zealand, July 2021)***

| Year | Fire | Cause |
|---|---|---|
| 1999 | Alexandra/Fruitlands | Powerlines |
| 2005 | Closeburn; 150 ha | Fireworks |
| 2006 | Remarkables; 600 ha | Escaped prescribed burn |
| 2010 | Mount Allan; 800 ha | Forestry operations - Chainsaw |
| 2012 | Berwick forest; 30 ha | Powerlines |
| 2014 | Northburn | Prescribed burn, Fatality |
| 2014 | Wilsons Bay; 3 ha | Powerlines |
| 2015 | Aurum Terrace | Campfire – Red Zone |
| 2015 | Stoneburn; 100 ha | Powerlines |
| 2015 | Waitaki rail fires | Train |
| 2016 | Waitaki Island; 72 ha | Suspicious |
| 2017 | Rat Point; 300 ha | Campfire |
| 2018 | Burnside industrial fire | Incorrect Disposal of ashes |
| 2018 | Mount Aspiring- Wanaka Road; 191 ha | Disposal of embers from BBQ |
| 2019 | Cornish Point | Explosives |
| 2019 | Dunback; 10 ha | Powerlines |
| 2019 | Duntroon; 10 ha | Escaped unpermitted burn |
| 2019 | Flagstaff | Suspicious |
| 2019 | Mount Pisa | Escaped prescribed burn - Unpermitted |
| 2019 | Mountain Track Road; 30 ha | Escaped burn |
| 2019 | Old Dunstan Road (Te Papanui) – 5400 ha | Suspicious |
| 2019 | Skippers | Unattended burn pile |
| 2019 | Waipiata | Dry lightning |
| 2020 | Ben Lomond – 1000 ha | Escaped prescribed burn |
| 2020 | Gold Bar Road; 100 ha | Escaped burn |
| 2020 | Hyde-Middlemarch; 80 ha | Camp cooker |
| 2020 | Lake Ohau; 5000 ha | Under Investigation |
| 2020 | McKenzie Road (Livingstone); 620 ha | Powerlines |
| 2020 | Pringle Gully Road; 10 ha | Escaped unpermitted burn |
| 2020 | Waipori Falls | Powerlines |

[18] Figure 2 and Figure 3 summarise the number of wildfires and area burnt during the 2019/20 and 2020/21 wildfire seasons (October to April, most recent seasons reported on). This is the most up-to-date information available.

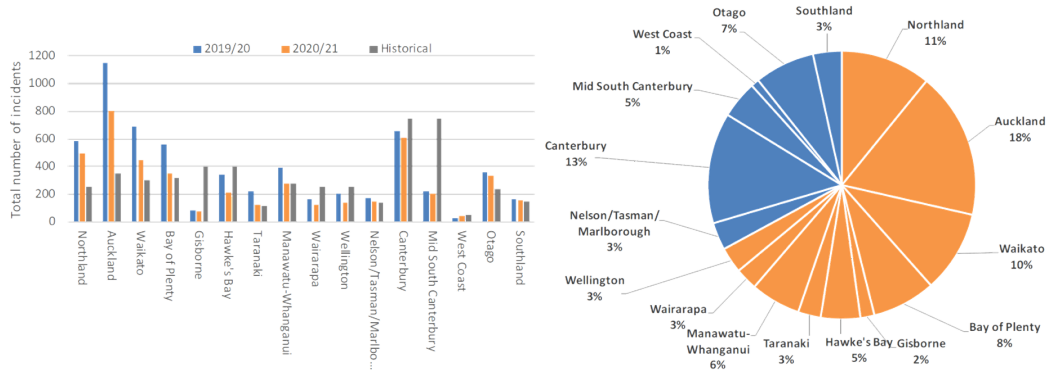



***Figure 2. Total number of wildfires by area, for the 2019/20 and 2020/21 wildfire seasons and the 30-year historical average (left); proportionally for 2020/21 season (right), where blue represents the South Island and orange the North Island (from New Zealand Wildfire Summary, 2020/21 Wildfire Season update, SCION)***

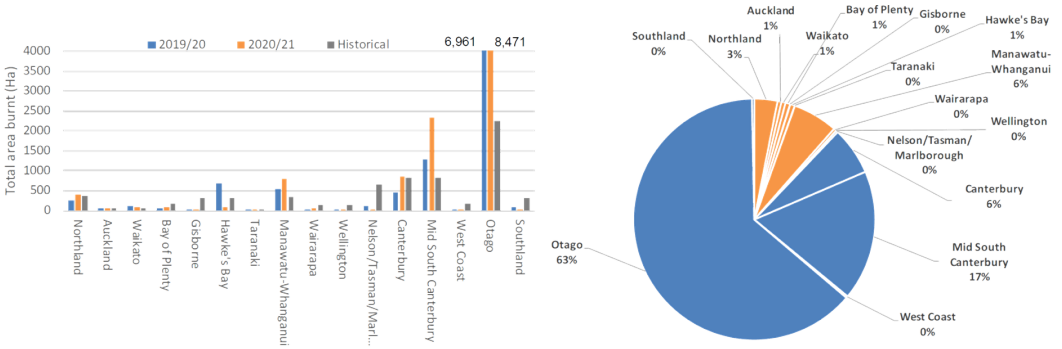



***Figure 3. Total area burnt by area, for the 2019/20 and 2020/21 wildfire seasons and the 30-year historical average (left); proportionally for 2020/21 season (right), where blue represents the South Island and orange the North Island (from New Zealand Wildfire Summary, 2020/21 Wildfire Season update, SCION)***

[19] During the 2020/21 wildfire season, the Otago area (as defined by FENZ) accounted for 7% of the total number of wildfires in the country and 63% of the total area burnt. The figures for Otago are heavily influenced by the Lake Ohau Village wildfire (October 2020, 5000 ha burnt). The Lake Ohau area is included in the Otago area as defined by FENZ. Mid-South Canterbury and Otago areas experienced the greatest area burnt in the country in 2020/21, mainly due to very large individual wildfire events occurring in each of these areas.

[20] Table 2 summarises the number of wildfires and area burnt during the 2019/20 and 2020/21 wildfire seasons for each zone within the Otago area.

***Table 2. Total number of wildfires and area burnt in the Otago area by district for the 2019/20 and 2020/21 wildfire seasons (from New Zealand Wildfire Summary, 2020/21 Wildfire Season update, SCION)***

| Zones | 2019/20 Number of fires | 2020/21 Number of fires | 2019/20 Area burnt (ha) | 2020/21 Area burnt (ha) |
|---|---|---|---|---|
| *Central Otago District* | *66* | *52* | *202* | *24* |
| *Clutha District* | *43* | *50* | *37* | *88* |
| *Dunedin City* | *120* | *110* | *5,162* | *285* |
| *Queenstown-Lakes District* | *47* | *52* | *1,331* | *790* |
| *Waitaki District* | *85* | *67* | *229* | *7,285* |
| *Otago (total) ** | *361* | *331* | *6,961* | *8,472* |

** On average, Otago experiences approximately 240 wildfires annually, and a total area burnt of approx. 2,240 ha (based on 30 years of historical records, 1991/92 – 2020/21).*

## Consequence of wildfires in the Otago area

[21] Land use for meat or wool production, conservation land and land use for dairy experienced the greatest impact by wildfires during the 2020/21 wildfire seasons (Table 3).

***Table 3. Area burnt by land use category in the Otago area (from New Zealand Wildfire Summary, 2020/21 Wildfire Season update, SCION)***

| Fire season | Dairy Area (Ha) | Arable Area (Ha) | Meat/Wool Area (Ha) | Forestry Area (Ha) | Horticulture Area (Ha) | Conservation Area (Ha) | Others Area (Ha) |
|---|---|---|---|---|---|---|---|
| **2019/20** | 74 | 2 | 615 | 50 | 1 | 5,192 | 1,027 |
| **2020/21** | 1,264 | 0 | 4,471 | 213 | 0 | 2,247 | 277 |

[22] Urban/rural interfaces are areas where homes and other structures are near forest, bush, scrub or grasslands. Properties in these areas are at greater risk of wildfire due to the increased presence of nearby vegetation.

[23] FENZ has identified special risk locations within the Otago area where fires in these areas in moderate or higher fire conditions will exhibit very high fire intensity and will threaten lives, homes and important conservation and investment values[8], including but not limited to:

- Mount Iron (high risk rural/urban interface)
- Queenstown Red Zone (high risk rural/urban interface)
- Albert Town Recreation Reserve (high risk rural/urban interface)
- Shag Point (high risk rural/urban interface)
- Ruby Island (high value conservation areas)
- Stevensons Island (high value conservation areas)
- Mou Waho (high value conservation areas)
- Mou Tapu Island (high value conservation areas)
- Pig and Pigeon Island (high value conservation areas)
- Coronet Forest (high value forest)

[24] The Regional Wilding Conifer Control Cost Benefit Analysis commissioned by ORC considered the costs and benefits of reduced wildfire risk and hazard for Otago, including potential effects of future climate change[9]. The benefits from reduced fire risk

[8] Fire plan for Otago, Te Kei, 2021-2024, Fire and Emergency New Zealand, July 2021

[9] Regional Wilding Conifer Costs Benefit Analysis and Business Case, Report to Environmental Implementation Committee, Report No. OPS2226, 8 November 2023.

are estimated to be $83.5M under the maximum investment option[10]. Future climate change accounts for half of the avoided fire risk costs.

**Change in the wildfire risk in the Otago area**

***Climate change effects***

[25] Based on the National Climate Change Risk Assessment[11], on average, all climatological measures of wildfire risk will increase across New Zealand to the end of the century. The four main drivers of wildfire are all expected to change to promote an increase in wildfire risk:

- increased temperature
- decreased relative humidity
- increased wind speed
- decreased rainfall

[26] Recent research[12] is indicating that, "*on average fire risk will increase, both in season length of fire weather conditions and the intensity of fires that may take hold, until at least mid-century, regardless of climate mitigation efforts. The highest fire dangers have been found in the seasonally drought-prone and arid locations of Aotearoa New Zealand. For many regions, it was found that compared to the last two decades the fire risk is expected to become appreciably worse through the rest of the century. For the first time, it has been predicted that conditions that led to the devastating 'Black-Summer' fires in Australia will occur every 3-20 years in areas of the Mackenzie Country, Central Otago and Marlborough*".

[27] The Otago Climate Change Risk Assessment[13] (OCCRA) considered and described the fire weather and wildfire hazard on the five domains selected for the assessment: natural environment, built environment, economic, human and governance. The rating of the risk is presented in the tables below.

[10] Benefits and Costs of Additional Investment in Wilding Conifer Control in the Otago Region, Sapere, Prepared for Boffa Miskell on behalf of Otago Regional Council, 12 October 2023.

[11] National Climate Change Risk Assessment for New Zealand – Arotakenga Tūraru mō te Huringa Āhuarangi o Āotearoa: Technical report – Pūrongo whaihanga. Wellington: Ministry for the Environment, 2020.

[12] Adapting and mitigating wildfire risk due to climate change: extending knowledge and best practice, SCION, July 2021

[13] Otago Climate Change Risk Assessment, Prepared by Tonkin and Taylor for Otago Regional Council, March 2021

***Table 4. Risk rating or description for the selected domains (built environment, economic, natural environment, human and governance) as assessed by the Otago Climate Change Risk Assessment. Fire weather risks are shown in blue boxes. The fire weather risk was not rated for the human and governance domain.***

| Risks | | Risk Rating* (highest per category) | | |
|---|---|---|---|---|
| | | Present | 2040 | 2090 |
| B1 | Risk to buildings and open spaces from climate change hazards including inland and coastal flooding, coastal erosion, and sea level rise and salinity stress | H | E | E |
| B2 | Risk to flood management schemes from inland and coastal flooding, and sea level rise and salinity stress | M | E | E |
| B3 | Risk to water supply infrastructure and irrigation systems due to drought, fire weather, flooding and sea level rise and salinity stress | H | E | E |
| B4 | Risk to stormwater and wastewater networks from increased temperature, sea level rise and salinity stress, extreme weather events and flooding | H | H | E |
| B5 | Risks to linear transport (roads and rail) from flooding, coastal erosion, extreme weather events and landslides | M | E | E |
| B6 | Risk to airports and ports from flooding and extreme weather events | M | E | E |
| B7 | Risk to solid waste (landfills and contaminated sites) to flooding and sea level rise and salinity stress | M | E | E |
| B8 | Risks to electricity (generation, transmission and distribution) networks from changes in rainfall, extreme weather events and flooding | M | H | E |
| B9 | Risks to telecommunications infrastructure due to sea level rise and salinity stress and extreme weather events | L | M | H |

*Highest risk rating per category and hazard relationship highlighted (L=low, M=medium, H=high, E= extreme). Refer to individual risk discussions for detailed, hazard specific ratings.

**Built environment domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| B3.1 | Risk to municipal water supply due to drought. | M | H | E | H | H | H | L | H | E | E |
| B3.2 | Risk to municipal water supply due to inland flooding. | M | H | E | M | M | H | L | M | H | E |
| B3.3 | Risk to municipal water supply due to sea level rise and salinity stress. | L | M | H | M | M | M | L | L | M | H |
| B3.4 | Risk to rural water supply due to drought. | M | H | E | M | M | M | L | M | H | E |
| B3.5 | Risk to rural water supply due to increased fire weather. | L | M | H | L | H | H | L | L | H | E |
| B3.6 | Risk to irrigation systems due to drought. | M | H | H | M | M | H | M | M | M | H |

**Built environment domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| B8.1 | Risk to generation due to change in rainfall. | L | M | H | L | L | M | L | L | M | H |
| B8.2 | Risk to generation due to reduced snow and ice. | L | M | M | L | L | M | L | L | M | M |
| B8.3 | Risk to distribution due to increased fire weather. | M | H | E | H | H | H | M | M | H | E |
| B8.4 | Risk to distribution due to coastal flooding. | L | M | H | H | H | H | M | L | M | H |
| B8.5 | Risk to distribution due to inland flooding. | L | M | H | H | H | H | M | L | M | H |
| B8.6 | Risk to distribution due to extreme weather events. | L | M | H | H | H | H | M | L | M | H |

**Built environment domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| B9.1 | Risk to telco assets due to extreme weather events. | L | M | H | M | M | M | H | L | L | M |
| B9.2 | Risk to telco assets due to increased fire weather. | L | M | H | H | H | H | M | L | M | H |
| B9.3 | Risk to telco assets due to sea level rise and salinity stress. | L | M | H | M | M | M | H | L | L | M |
| B9.4 | Risk to telco assets due to inland flooding. | L | M | H | L | L | L | H | L | L | M |

**Built environment domain**

| Risks | | Risk Rating* (highest per category) | | |
|---|---|---|---|---|
| | | Present | 2040 | 2090 |
| E1 | Risks to the livestock farming sector from climate change hazards including drought, increased fire weather, inland flooding, and increased landslides | M | H | E |
| E2 | Risks to horticulture and viticulture from climate change hazards including temperature, drought, changing rainfall patterns and extreme weather | M | H | E |
| E3 | Risks to the forestry sector from climate change hazards including temperature, drought, fire and extreme weather | L | M | E |
| E4 | Risks to the fisheries and aquaculture sector from climate change hazards including marine water temperature and water quality | L | M | E |
| E5 | Risks to primary sector supply chains from climate change hazards including inland flooding, coastal flooding and increased landslides | M | H | E |
| E6 | Risks to cost of doing business from climate change hazards including coastal and inland flooding, landslides, and extreme events | M | H | E |
| E7 | Risks to the tourism sector from climate change hazards including higher temperatures, reduced snow and ice, inland and coastal flooding, landslides and erosion | M | H | E |

* Highest risk rating per category and hazard relationship highlighted (L=low, M=medium, H=high, E= extreme). Refer to individual risk discussions for detailed, hazard specific ratings.

**Economic domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| E1.1 | Risk to sheep, beef and deer farming due to drought. | M | M | H | M | H | H | L | M | H | E |
| E1.2 | Risk to sheep, beef and deer farming due to increased fire weather. | L | M | M | M | H | E | M | L | M | H |
| E1.3 | Risk to sheep, beef and deer farming due to inland flooding. | M | H | H | M | M | H | M | M | M | H |
| E1.4 | Risk to sheep, beef and deer farming due to increasing landslides and soil erosion. | M | H | E | M | H | H | M | M | H | E |
| E1.5 | Risk to sheep, beef and deer farming due to higher temperature. | L | M | H | L | L | M | M | L | L | M |
| E1.6 | Risk to dairy farming due to drought. | L | M | H | M | M | H | L | L | M | E |
| E1.7 | Risk to dairy farming due to inland flooding. | M | H | E | M | M | H | L | M | H | E |
| E1.8 | Risk to dairy farming due to increasing landslides and soil erosion. | L | M | H | L | M | H | M | L | M | H |
| E1.9 | Risk to dairy farming due to higher temperature. | L | M | H | L | L | M | M | L | L | M |

**Economic domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| E3.1 | Risk to forestry due to higher temperature. | L | M | H | L | M | M | M | L | M | M |
| E3.2 | Risk to forestry due to drought. | M | H | E | L | M | H | M | L | M | E |
| E3.3 | Risk to forestry due to increased fire weather. | L | M | M | M | H | E | M | L | M | H |
| E3.4 | Risk to forestry due to extreme weather events. | L | M | H | M | M | H | M | L | M | H |

**Economic domain**

| Risks | | Risk Rating* (highest per category) | | |
|---|---|---|---|---|
| | | Present | 2040 | 2090 |
| N1 | Risks to the terrestrial ecosystems from increasing temperatures, changes in rainfall and reduced snow and ice. | H | E | E |
| N2 | Risks to the freshwater (rivers and lakes) ecosystems from increasing temperatures and extreme weather events. | M | H | E |
| N3 | Risks to the coastal and marine ecosystems from climate change hazards including ocean acidification and marine heatwaves. | L | H | E |
| N4 | Risks to coastal, inland and alpine wetland ecosystems from drought, higher temperatures, changes in rainfall and reduced snow and ice. | H | E | E |
| N5 | Risks to Otago water quality and quantity from changes in rainfall, higher temperatures, flooding, drought and reduced snow and ice. | M | E | E |
| N6 | Risks to native ecosystems posed by increasing threats from invasive plants, pests and disease due to climate change. | M | M | E |

*Individual risk rating per category and hazard relationship highlighted. Refer individual risk discussions for detailed ratings.

**Natural environment domain**

| Risk No. | Risk statement | Exposure | | | Vulnerability | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sensitivity | | | Adaptive Capacity | | | |
| | | Present | 2040 | 2090 | Present | 2040 | 2090 | Constant | Present | 2040 | 2090 |
| N1.1 | Risk to native ecosystems and species due to higher temperature. | L | M | H | L | H | E | M | L | M | E |
| N1.2 | Risk to native ecosystems and species due to change in rainfall. | L | M | H | L | H | H | M | L | M | H |
| N1.3 | Risk to native ecosystems and species due to drought. | M | M | H | L | M | H | M | L | M | H |
| N1.4 | Risk to native ecosystems and species due to increased fire weather. | L | M | M | L | M | H | L | L | M | H |
| N1.5 | Risk to montane and hill country environments due to drought. | M | M | H | L | M | H | M | L | M | H |
| N1.6 | Risk to montane and hill country environments due to increased fire weather. | L | M | H | L | M | H | M | L | M | H |
| N1.7 | Risk to montane and hill country environments due to change in rainfall. | L | M | H | L | M | M | M | L | M | M |
| N1.8 | Risk to alpine and high country environments due to reduced snow and ice. | M | H | E | M | H | E | L | M | E | E |
| N1.9 | Risk to alpine and high country environments due to extreme weather events. | L | M | H | L | L | M | L | L | M | H |
| N1.10 | Risk to alpine and high country environments due to higher temperature. | M | H | E | M | H | E | L | M | E | E |
| N1.11 | Risk to alpine and high country environments due to change in rainfall. | M | H | E | H | E | E | L | H | E | E |

**Natural environment domain**

| Risks | |
|---|---|
| H1 | Risks to Kāi Tahu sites, identity and practices, and non-Kāi Tahu cultural heritage sites, due to climate change. |
| H2 | Risks to community cohesion and resilience from climate change. |
| H3 | Risk to mental wellbeing and health from climate change. |
| H4 | Risk to physical health due to climate change. |
| H5 | Risk to increased inequities and cost of living due to climate change. |

**Human domain**

| Risks | | Local vs central government influence |
|---|---|---|
| G1 | Risk that existing planning, decision making, and legislative frameworks are inadequate for responding to long-term climate change risks and result in maladaptive responses, and potential liability. | Combination of local and central influence. |
| G2 | Risk of local authorities lacking capacity to effectively respond to climate change. | Local direct influence. |
| G3 | Risk that the national, regional and local governance/institutional structures for managing climate change are inadequate. | Combination of local and central influence. |
| G4 | Risk that a low level of community awareness and engagement hinders communication of climate risk and uncertainty, and leads to de-prioritisation. | Local direct influence. |
| G5 | Risk that climate change will result in increasing damage costs, with insufficient financing for adaptation and risk reduction. | Combination of local and central influence. |
| G6 | Risk that public services will be impacted by climate change. | Combination of local and central influence. |

**Governance domain**

[28] For the built environment domain, the risk due to increased fire weather to the rural water supply, electricity distribution and telecommunication asset has been identified in the OCCRA. The risk is rated as high for the mid-century and extreme for the end of century time horizons for the rural water supply and electricity distribution. It is rated as medium for the mid-century and high for the end of century time horizons for the telecommunication asset.

[29] For the economic domain, the risk due to increased fire weather to sheep, beef and deer farming, and forestry has been identified in the OCCRA. The risk is rated as medium for the mid-century and high for the end of century time horizons for both elements at risk.

[30] For the natural environment domain, the risk due to increased fire weather to native ecosystems and species and to montane and hill country environments has been identified in the OCCRA. The risk is rated as medium for the mid-century and high for the end of century time horizons for the native ecosystems and species. It is rated as medium for both time horizons for the montane and hill country environments.

[31] The risk specific to increased fire weather has not been rated for the human and governance domains. The risk is qualitatively described and has been incorporated in wider elements at risk. For example, for the human domain, the risk of being injured by fire is described under the risk to physical health due to climate change element (risk H4 in the table above).

[32] OCCRA has also identified research gaps around wildfire, the impact of climate change on wildfire and factors specific to Otago.

***Land use change effects***

[33] Wildfires on the margins of urban areas in New Zealand are becoming more common[14]. Land use at the rural/urban interface is changing as subdivisions are developed. This is increasing the number of people and homes in the rural/urban interface, increasing the risk of wildfires starting, and increasing the risk of fires spreading into suburban areas. In Otago, this is the case for example for the Mount Iron area near Wānaka.

[34] Managing the wildfire risk in those areas is requiring more focus from the relevant organisations.

## DISCUSSION

**Roles and responsibilities for managing the wildfire risk in Otago**

[35] New Zealand's approach to emergency management (including the management of the wildfire risk) is based on four activities: reduction, readiness, response and recovery (the '4Rs'[15]).

[36] Reduction aims at Identifying and analysing long-term risks to human life and property from hazards; taking steps to eliminate these risks if practicable, and, if not, reducing the magnitude of their impact and the likelihood of their occurring.

[37] Readiness aims at developing operational systems and capabilities before a civil defence emergency occurs, including self-help and response programmes for the general public, and specific programmes for emergency services, lifeline utilities and other agencies.

[38] Response is the series of actions taken immediately before, during or directly after a civil defence emergency to protect and preserve lives, prevent or limit injury, reduce damage to land or property, and to help people and communities begin recovery.

[39] Recovery is the coordinated efforts and processes to bring about the immediate, medium-term and long-term holistic regeneration of a community following a civil defence emergency.

[40] By its nature, the management of the wildfire risk within the full range of the "4Rs" requires multiple agencies to be involved with varying level of responsibilities, either mandatory or discretionary.

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[14] Preparing homeowners and communities in the rural-urban interface for increasing wildfire risk, SCION, June 2021. https://www.ruralfireresearch.co.nz/__data/assets/pdf_file/0004/78664/RFR_tech_note_45.pdf

[15] https://www.civildefence.govt.nz/cdem-sector/the-4rs

[41] The management of wildfire across the 4Rs framework is not clearly defined or contained in a single piece of legislation, rather across a broad range of instruments, including, but not limited to; Civil Defence and Emergency Management Act 2002, National Plan Order 2015, Conservation Act 1987, Defence Act 1990 and the Resource Management Act 1991. Further, decisions made under other instruments, such as the Biosecurity Act 1993 and the National Policy Statement on Indigenous Biodiversity, play a part in risk management (e.g. control of wilding conifers).

[42] FENZ is, under current legislation, the principal agency responsible for managing the wildfire risk throughout New Zealand. Under the Fire and Emergency New Zealand Act, FENZ is the body with responsibility for managing the prevention and suppression of wildfires. However, other organisations, such as the Otago Civil Defence and Emergency Management (CDEM) Group, the Department of Conservation and local authorities all have a role to play in the '4Rs' from the risk and occurrence of wildfire events.

***Otago Regional Council***

[43] ORC as landowner or occupier and asset owner has liabilities and obligations to consider the fire hazard under different legislation. This is also applicable when ORC is conducting its work operationally (e.g. using vehicles and engaging contractors to use machinery).

[44] Regional councils, however, do not have any powers or obligations under the FENZ Act (unless served by FENZ with a notice to cut firebreak or remove fire hazard, refer to the previous paragraph).

[45] Fire is included in the definition of natural hazards in the Resource Management Act[16] (RMA):
"*natural hazard means any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment*".

[46] The RMA makes the management of significant risks from natural hazards a matter of national importance and requires particular regard to be given to the effects of climate change. It places high value on natural resources which can be adversely affected by wildfire, including natural character, natural features and landscapes, indigenous biodiversity, historic heritage and the relationship of Māori, their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga.

[47] There are no directly applicable national planning instruments related to wildfires. Consultation on the Proposed National Policy Statement for Natural Hazards Decision-Making (NPS-NHD) did not make express reference to wildfire but did seek feedback on which natural hazards should be in the scope of the proposed NPS-NHD[17].

[48] At a regional level, the partially operative Otago Regional Policy Statement (RPS) 2019 and the proposed Otago Regional Policy Statement 2021 (as notified) cover natural hazards and climate change and share the same definition of natural hazards as the RMA. The proposed RPS mentions the potential effect of climate change on wildfire. The

[16] Resource Management Act, version as at 24 August 2023 – Part 1 Interpretation and application
[17] Ministry for the Environment. 2023. Proposed National Policy Statement for Natural Hazard Decision-Making: Discussion Document. Wellington: Ministry for the Environment.

Hazards and Risks section contains policies and methods related to natural hazards (including wildfire) but does not have specific policies or methods for wildfire.

[49] Section 35 of the RMA (Duty to gather information, monitor, and keep records) requires:

*Every local authority shall keep reasonably available at its principal office, information which is relevant to the administration of policy statements and plans, the monitoring of resource consents, and current issues relating to the environment of the area, to enable the public—*

*(a) to be better informed of their duties and of the functions, powers, and duties of the local authority; and*

*(b) to participate effectively under this Act.*

[50] More specifically for natural hazards information, the RMA requires that the information to be kept by a local authority shall include records of natural hazards to the extent that the local authority considers appropriate for the effective discharge of its functions.

[51] To fulfil this RMA requirement, since 2011, ORC has made natural hazards information easily accessible to the public through the Otago Natural Hazards Database [18]. The database does not presently include information on wildfire hazards.

[52] ORC is undertaking a natural hazard risk assessment work programme, designed as a review and high-level assessment of natural hazard risks for the full Otago region[19]. The purpose of the natural hazards risk assessment is to work towards a comprehensive, regional-scale, spatial understanding of Otago's natural hazards and risks. The wildfire risk was not included in the first iteration of the risk assessment as the assessment has focussed on the more significant hazards. It will be added to the next iteration of the assessment which is presently underway.

[53] Long term and annual plans (as defined in the Local Government Act 2002) can, but are not required, to provide for wildfire prevention and response. ORC's 2023-24 Annual Plan and 2021-31 Long Term Plan do not specify a level of service or performance measure for managing wildfire risk.

[54] Wildfire is listed as a known hazard in the Otago CDEM Group Plan where it is defined as '*Vegetation fires are an annual hazard across many areas of Otago. They most commonly occur in summer and autumn but are a potential risk at any time – particularly in the "Red Zones" around Queenstown Hill and Mt Iron in Wanaka, where a total fire ban is in place year-round. The drier areas of Central Otago and Strath Taieri are also at risk.*[20]

[55] ORC is a member of the Otago CDEM Group. ORC (and also the group and the other constituent local authorities) must be planning and preparing for emergencies involving wildfire and be capable of implementing necessary responses if serious wildfire events occur. The Otago CDEM Group does not have a policy that defines roles and

[18] https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=b24672e379394bb79a32c9977460d4c2

[19] Otago Region Natural Hazards Risk Assessment, Report to Safety and Resilience Committee, Report No. OPS2305, May 2023

[20] Otago CDEM Group Plan 2018-2028

responsibilities across the 4Rs framework for managing this hazard and there is no specific wildfire risk management plan. Under the Group's Partnership Agreement, ORC has responsibilities for hazard and risk management.

[56] In its description of the pest and adverse effects for wilding conifers, the Otago Pest Management Plan 2019-2029 states[21]; "*wilding conifers can also increase the risk posed by wild fires*". There are no rules in the Plan that expressly seek to achieve a reduction in fire risk. The good neighbour rules are intended to control the spread of trees between properties rather than control the spread of fire.

[57] The Otago Regional Wilding Conifer Strategy 2023-2029[22] states that the "*adverse effects resulting from wilding conifer infestation include ... increasing the risk of wildfire*". The strategy and implementation plan do not include objectives and actions specific to wildfire risk. However, many of the actions will have an indirect effect on risk reduction such as the regional surveillance programme and the creation of spatial records for infestation areas, along with ORC's delivery of the Otago part of the National Wilding Conifer Control Programme[23].

[58] As noted above, the costs and benefits of reduced wildfire risk and hazard, including potential effects of future climate change were incorporated into the Regional Wilding Conifer Control Cost Benefit Analysis OBJ OBJ

**Clarifying and confirming roles and responsibilities**

[59] As noted above, responsibility for managing wildfire risk is shared across organisations, including ORC. Given the complexity of the situation it is recommended that ORC, through its membership of the Otago CDEM Group, promote discussion amongst the Group on current and future wildfire risk including member roles and responsibilities for managing that risk. This will enable ORC and other members of the Group to identify any gaps in how the risk is being managed, and the steps that need to be taken to address that.

## CONSIDERATIONS

**Strategic Framework and Policy Considerations**

[60] This paper is proactively considering the wildfire risk in regard to ORC's Strategic Directions where our vision states: communities that are resilient in the face of natural hazards, climate change, and other risks.

**Financial Considerations**

[61] No specific budget is allocated in the current annual plan and draft 2024-2034 Long Term Plan to investigate or increase ORC's role in managing the wildfire risk in Otago.

**Significance and Engagement Considerations**

[62] Not applicable.

**Legislative and Risk Considerations**

[21] p44.

[22] Wilding Conifer Strategy and Implementation, Report to Environmental Implementation Committee, Report No. OPS2306, 11 May 2023.

[23] The New Zealand Wilding Conifer Management Strategy 2015-2030 states that wilding conifers can increase the risk of wildfires.

[63] Refer to the Discussion section.

**Climate Change Considerations**

[64] Refer to the Background section.

**Communications Considerations**

[65] Refer to the Discussion section.

**NEXT STEPS**

[66] This matter will be brought to the Otago CDEM Group for discussion, probably through the Coordinating Executive Group (CEG) in the first instance. The next meeting of the CEG is in March 2024.

[67] The Safety and Resilience Committee will be updated on the Otago CDEM Group's discussion at its next meeting.

**ATTACHMENTS**

Nil

### 7.6. CDEM Partnership Report 2023 - 2024

| | |
|---|---|
| **Prepared for:** | Safety and Resilience Committee |
| **Report No.** | OPS2352 |
| **Activity:** | Governance Report |
| **Author:** | Gavin Palmer, General Manager Operations |
| **Endorsed by:** | Gavin Palmer, General Manager Operations |
| **Date:** | 8 February 2024 |

## PURPOSE

[1] To report on ORC's delivery of its responsibilities under the Otago Civil Defence and Emergency Management Agreement, for the first six months of 2023/24.

## EXECUTIVE SUMMARY

[2] ORC and the five Otago territorial authorities have responsibilities under the Civil Defence and Emergency Management Act 2002 within the Otago Civil Defence and Emergency Management Group area. Those responsibilities are delivered through Emergency Management Otago with support from each local authority, including ORC. The responsibilities of ORC and four of the five territorial authorities are recorded in the Otago Civil Defence and Emergency Management Agreement (June 2022). ORC's achievement in relation to its functions and responsibilities specified in the Agreement, for the first six months of 2023/24, is summarised as follows:

49 – Achieved
5 – Partially Achieved
1 – Not Achieved
4 – Not Applicable.

## RECOMMENDATION

*That the* Safety and Resilience Committee*:*

1) ***Notes** this report.*

## BACKGROUND

[3] ORC and the five Otago territorial authorities have responsibilities under the Civil Defence and Emergency Management Act 2002 within the Otago Civil Defence and Emergency Management Group area. The Group area includes the whole of Waitaki District.

[4] Whilst the Act prescribes governance and oversight arrangements for the Civil Defence and Emergency Management (CDEM) functions undertaken by local authorities, it is silent on the operational arrangements and how they should be structured. This gives the Groups discretion on how they choose to deliver the responsibilities and the associated delivery structure. For the Otago CDEM Group those responsibilities are delivered through Emergency Management Otago with support from each local

authority, including ORC (Figure 1). The responsibilities of ORC and four of the five territorial authorities are recorded in the Otago Civil Defence and Emergency Management Agreement (June 2022)[1].

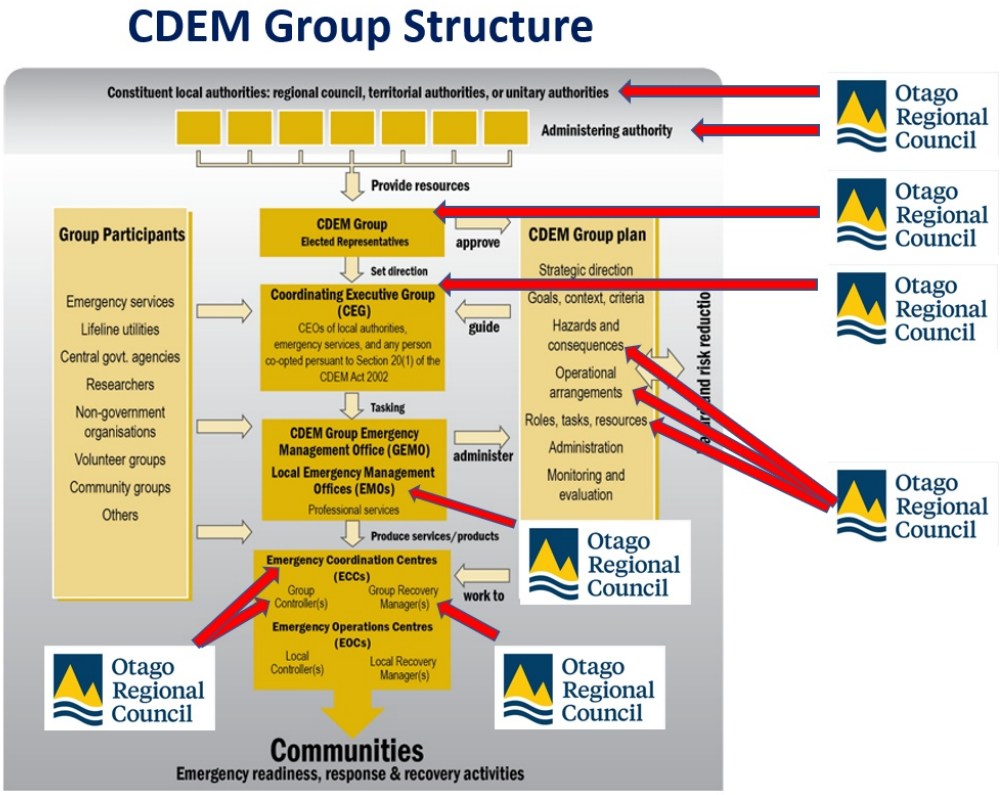



**Figure 1: ORC's participation in the Otago CDEM Group.**

[5] This report describes ORC's achievements in relation to each of its responsibilities set out in the Agreement. It also provides detail and context for reporting against the 2023/24 Annual Plan measures and targets. Those measures and targets are presented in Figure 2, for reference.

[1] *Emergency Management Otago Partnership Agreement*, Report OPS2104, Report to 25 May 2022 Council.

## Level of Service Statements, Measures and Targets

The service statements (LoS), measures and targets for this activity are defined in the table(s) below.

| **Level of Service:** Support the Otago CDEM Group in improving the resilience of Otago to civil defence emergencies. | |
|---|---|
| **Performance measure** | **Target** |
| Support is provided to the Otago CDEM Group as per the CDEM Act and Otago CDEM Partnership Agreement. | Fulfil all requirements as the administering authority |

| **Level of Service:** Provide resources to coordinate an efficient and effective region-wide response to a civil defence emergency. | |
|---|---|
| **Performance measures** | **Targets** |
| An adequate Emergency Coordination Centre (ECC) facility and staffing are available. | Adequate staff who are trained and available for any activation of the ECC |
| | An appropriate facility is available for activation at all times |
| Maintain response functionality to enable operational situational awareness when ECC activated. | Response solutions are checked as scheduled and any issues remedied |

**Figure 2: ORC Annual Plan 2023/24 targets for civil defence and emergency management.**

## DISCUSSION

[6] The functions and responsibilities of ORC under the Agreement are listed in Attachment 1. Achievement against each of those responsibilities for the first six months of 2023/24 is noted, with commentary. This is summarised as follows:

49 – Achieved
5 – Partially Achieved
1 – Not Achieved
4 – Not Applicable.

[7] The Emergency Coordination Centre (ECC) activated over two days in September 2023 to support Queenstown-Lakes District Council's local declaration. This was in response to the Severe weather event in Queenstown and localised flooding in Glenorchy.

[8] There were no Group declarations in Otago in the first six months of 2023/24.

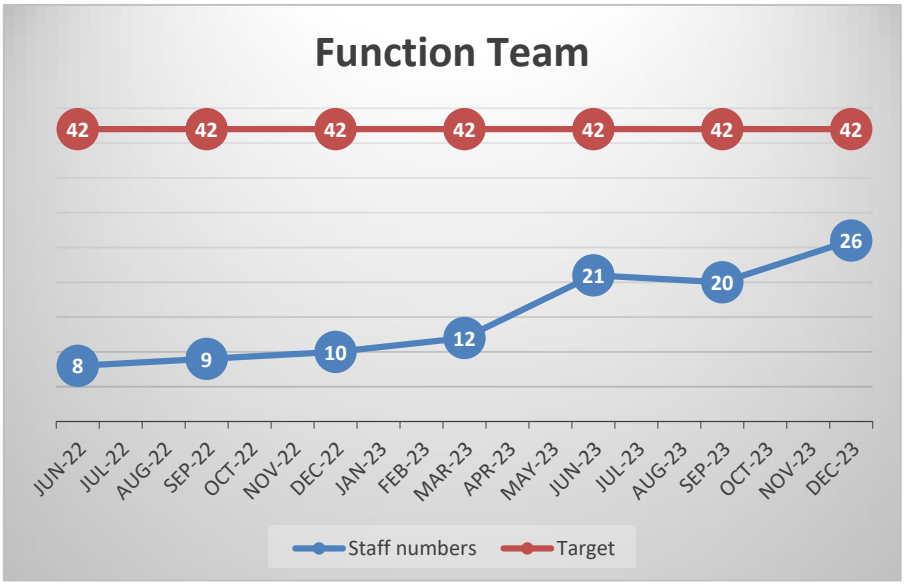
[9] ORC staff have been providing technical support to Emergency Management Otago for risk assessment and response planning for the Phoenix Dam near Lawrence. Emergency Management Otago established a D4H[2] channel specifically to facilitate information sharing between stakeholders in monitoring the dam, including developing a dam inspection reporting module to replace a paper-based reporting system.

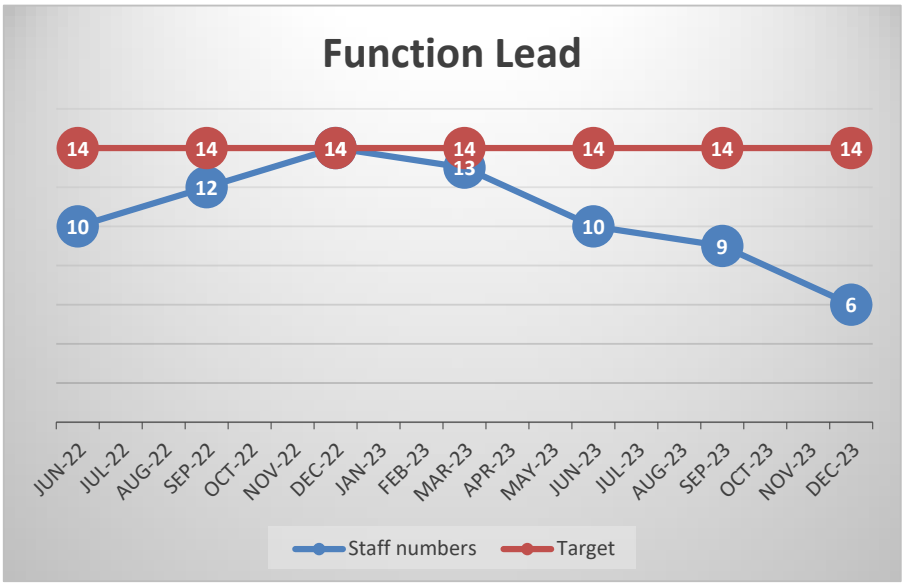
[10] An effective CDEM response is critically dependent on staff capability and capacity. EMO has a core complement of professionally trained staff with a wider pool of trained staff available from ORC. ECC staff capability throughout 2022/23 and the first six months of 2023/24 is shown in Figure 3 (available, trained staff) along with target levels recommended by Emergency Management Otago and approved by the Coordinating

[2] D4H is the proprietary system used by Emergency Management Otago and its partners to maintain a common operating picture, to manage workflows and to provide ready-access to Standard Operating Procedures.

Executive Group (CEG)[3]. There is a shortfall of 22 trained staff across the three role-types (Function Team, Function Lead, Controller).

[11] A larger number of ORC staff are potentially available to support ECC operations but not all are trained to the minimum standard. The Function Team staff numbers are the combined totals across all seven Coordinated Incident Management System (CIMS) functions. As a generalisation, ORC staff that are directly involved in responding to flood events (principally from the Engineering, Environmental Monitoring and Natural Hazards teams) are not part of the ECC and are not counted in Figure 3.




[3] A Function Lead leads one of the following functions as defined in the Coordinated Incident Management System (CIMS) model: Intelligence, Logistics, Operations, Planning, Public Information Management (PIM), Safety, Welfare.

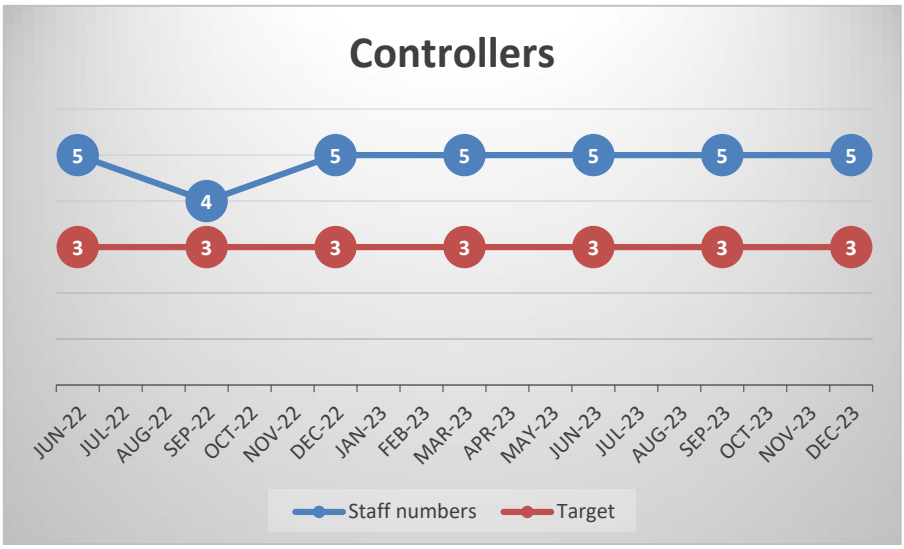



**Figure 3: ECC staff capacity and capability (trained staff) during 2022/23 and the first six months of 2023/24.**

[12] Steps taken to attain and maintain the target levels for staff trained to (or better than) the minimum standard include:

a. Pro-active recruitment within ORC of staff for the ECC.
b. Monthly reporting of ECC staffing levels to the Executive Leadership Team so that levels are actively monitored and managed by ELT.
c. Setting the expectation that ECC responsibilities will be incorporated into performance plans, for staff that fulfil ECC roles.
d. Regular (quarterly) training opportunities for staff that fulfil Function and Function Lead roles, to provide flexibility and allow training to be fitted around other work.
e. Clarity around the budgeting for staff training and exercises, and (from 1 July 2024) centralisation of the budget.

[13] Despite these steps, and the relatively low demand on ORC (less than 20% of total ORC staff), it continues to be difficult to maintain the target levels for staff trained to the minimum standard. There will be increased focus over the next quarter to place staff on the training courses that are provided.

## CONSIDERATIONS

### Strategic Framework and Policy Considerations

[14] The partnership is aligned with Council's Strategic Directions where the vision states: *communities that are resilient in the face of natural hazards, climate change and other risks*.

### Financial Considerations

[15] Financial reporting is part of the Annual Report for 2023/24, and quarterly reporting throughout the year.

### Significance and Engagement Considerations

[16] Not relevant.

### Legislative and Risk Considerations

[17] There is no legislative requirement for ORC and the rest of the Otago CDEM Group to have a written agreement however an agreement is good practice and reduces risk for all parties by ensuring respective responsibilities are clear.

[18] As noted in the report, it continues to be difficult to maintain the target levels for ORC staff trained to the minimum standard for the ECC.

**Climate Change Considerations**

[19] Robust and effective CDEM arrangements assist ORC in delivering its climate change adaptation programme of work.

**Communications Considerations**

[20] Not relevant.

**NEXT STEPS**

[21] To provide an update to the Safety and Resilience Committee in August 2024 on progress with achievement of the Partnership Agreement responsibilities, for 2023/24.

**ATTACHMENTS**

1. Otago Civil Defence Emergency Management Agreement 2022 table [**7.6.1** - 11 pages]

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

Achieved
Partially Achieved
Not Achieved
Not Applicable

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| **Business Continuity Management** Disruptions are an expected part of business, so it's important to be prepared for when they occur. Disruptions can be internal events that impact on organisation alone (e.g: IT system failure), or external events that could impact across several organisations and locations (e.g., earthquake). | Undertake business continuity planning for Otago Regional Council to be capable of delivering essential services and a functioning Group Emergency Coordination Centre (GECC) during a crisis/ emergency event and through the recovery. | | | Arrangements for the ORC flood team to operate remotely were established and tested during the 2020 pandemic lockdown. ORC does not have a Business Continuity Plan. A Business Continuity Plan is being scoped. |
| **Capability Development, Training and Exercises** Training and exercising progressively enhances individuals, local authorities and the Otago CDEM Group's capability to prepare for and manage emergencies and resources, using lessons learnt. The CDEM Group and each member of the Group are to take all steps necessary on an ongoing basis to maintain and provide, or to arrange the provision of, or to otherwise | Agree sufficient access to all ORC staff identified in CDEM roles with supervisors to ensure they're available for, attend and complete all competencies associated with training and exercises in accordance with the agreed training schedule. | | | The target number of staff for Function Leads and Function Teams have not been available. |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| make available suitably trained and competent personnel, including volunteers, and an appropriate organisational structure for those personnel, for effective civil defence emergency management. | | | | |
| **Community Resilience and Partnership**<br>Community resilience in the Civil Defence and Emergency Management context, can best be described as the community's ability to cope with, bounce back and learn from adversity encountered during and after disasters. There are activities to support in building community resilience. These activities are community engagement, community planning, public education, monitoring and evaluation to measure community resilience. The integration and inclusion of iwi in community resilience activities cements the Otago CDEM principles of Māori partnership. | Support Emergency Management Otago (EMO) and local level Community Resilience activities by commitment of staff resources and technical information to assist in local Community Resilience activities (hazard specific) as required. |  |  | |
| | Ensure whole-of-council approach to Regional Council Community Resilience activities. |  |  | |
| **Equipment** | Fit out and provide associated Information Technology (IT) equipment and infrastructure for |  |  | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| Includes all equipment to support readiness, response and recovery activities. | EMO staff and GECC facilities (and alternate sites). | | | |
| | Implement minimum equipment standards required for GECC in line with CDEM Group policy. | | | |
| | Own equipment and associated infrastructure, to cover costs to maintain it to an operational standard and to manage and conduct maintenance programme. | | | |
| | Provide EMO with furniture and equipment for staff located at Otago Regional Council offices. | | | |
| | Undertake fleet management of all Emergency Management Otago vehicles. | | | |
| | Procure any priority equipment required by the activated GECC to ensure effective operational capability of the GECC. | | | No priority equipment was required. |
| **Facilities** Includes any facility to support readiness, response and recovery activities. | Provide and maintain GECC facilities (and alternate facilities) for operational response. | | | The Philip Laing House Council Chamber has been tested as an alternative ECC during an exercise and shown to have limited functionality. The specifications developed for the ECC in the new Head Office will be used to identify suitable alterative ECC Facilities. |
| | Provide EMO with fit for purpose office space. | | | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| | | | | |
| | Support the activation of the GECC facility if required for response if requested by the Group Controller. | ● | ● | |
| **Financial Management**<br>The CDEM Group is to ensure allocation of financial budget to ensure effective delivery of the of CDEM services as outlined in the Group Plan. | Provide financial management and accounting services for CDEM Group budget. | ● | ● | |
| | Manage, administer and submit reporting to the CDEM Group of Regional Council budgets for regional CDEM delivery. | ● | ● | |
| | Provide staff time and travel and accommodation costs associated with attendance at training and exercises. | ● | ● | |
| **Governance and Management** | **Joint Committee** | | | |
| | Active participation through appointed designates. | ● | ● | |
| | As Administrating Authority provide governance and secretarial support to the Joint Committee. | ● | ● | |
| | Provide reports and recommendations on Regional Council matters to the Joint Committee. | ● | ● | A report to the Joint Committee on Otago weather radar is in preparation. |
| | Provide reports, decisions and recommendations back to Regional Council on CDEM Group matters | ● | ● | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| | **Coordinating Executive Group (CEG)** | | | |
| | Active participation through appointed designates and provide support as agreed to lead delivery of the regional CDEM work programme. | ● | ● | |
| | Develop and implement specific Regional Council Annual Plan tasking in a Regional Council CDEM work programme with alignment to CDEM Group Annual Plan. | ● | ● | |
| | **CEG Operations Sub-committee** | | | |
| | Active participation through appointed designates and support the CEG Sub-committees. | ● | ● | |
| | Ensure the alignment of CDEM Group Annual Plan and Regional CDEM work programmes. | ● | ● | |
| **Hazard and Risk Management** In relation to relevant hazards and risks: identify, assess, and manage those hazards and risks; consult and communicate about risks; identify and implement cost-effective risk reduction. Identification of the hazards and risks in a Group area that may result in an emergency that requires national-level support and co-ordination. | Lead identification of hazards (as required) in accordance with the hazard scape outlined in the CDEM Group Plan at the regional level. | ● | ● | |
| | Own and manage the hazards (as required) and risk within the appropriate area of responsibility as mandated through the Regional Policy Statement in alignment with the hazardscape detailed in the Otago CDEM Group Plan. | ● | ● | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| | Fund and manage hazard investigation within the appropriate area of responsibility as mandated through the Regional Policy Statement in alignment with the hazardscape detailed in the Otago CDEM Group Plan |  |  | |
| | Support effective planning for response through collaboration on hazard risk management for hazards with cross regional and national impacts. |  |  | |
| **Lifeline Utilities**<br>Lifeline's failures can disrupt and endanger the wellbeing of local and regional communities. Effective relationships, priority of response protocols and lead agency role definition can reduce the risk such failures may pose. Lifeline utility means an entity named or described in the CDEM Act 2002 in Part A of Schedule 1, or that carries on a business described in the CDEM Act, Part B of Schedule 1. | Lead hazard risk assessment and planning for hazard risk reduction and response activities on key Regional Council services and infrastructure. |  |  | |
| | Support lifelines projects and activities. |  |  | No support was requested as the lifelines project utilised existing information. The ORC Natural Hazards team retains the capability and capacity to assist as required. |
| **Planning**<br>Fundamental to any successful undertaking is attention to planning and preparation. Whilst we pay attention to the plans that are | **Otago CDEM Group Plan** | | | |
| | Support, the development, implementation, maintenance, monitoring and evaluation of the Otago CDEM Group Plan. |  |  | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| produced, the process of planning is important to ensure that the plans developed meet the needs of the people affected.<br><br>CDEM Groups and agencies are expected to routinely incorporate CDEM arrangements into their business planning and risk management processes, and to regularly monitor and report on their progress as appropriate. This is an important role to play in making progress towards the vision of a 'Resilient New Zealand'. | Ensure alignment between the Otago CDEM Group Plan and Regional Council Long Term Plans. |  |  | |
| | **Pre-event response action planning** | | | |
| | Support development, implementation, maintenance of CDEM response planning for Regional Council. |  |  | |
| | **Standard Operating Procedures** | | | |
| | Support the development, implementation, maintenance of CDEM Standard Operating Procedures as required |  |  | |
| | **Recovery planning** | | | |
| | Support the development, implementation, maintenance of Regional Council Recovery Plan for key council infrastructure and assets. |  |  | There is no Regional Council Recovery Plan. Event-specific recovery plans have been prepared for damage to flood protection infrastructure and assets as required.<br>A Plan will be prepared based on learnings from the North Island weather events. |
| | **Financial planning** | | | |
| | Support the development, implementation, maintenance of CDEM Group policy on the management of response and management of response and recovery claims. |  |  | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| **Public Information Management** Public information management (PIM) enables people affected by an emergency to understand what is happening and take the appropriate actions to protect themselves. This is achieved by making sure that timely, accurate, and clear information is shared with the public in an emergency. Strategic communications is a core component of Public Information Management activities. | **Public Information Management staff** | | | |
| | Alternate Group Public Information Managers provided by Regional Council. |  |  | |
| | Provide staff to support a 24/7 duty Group PIM function. |  |  | |
| | Provide communications/ media staff to receive training and support the Group and local PIM functions, including strategic communications |  |  | |
| | **Public Information Management planning** | | | |
| | Support all CDEM Communications and Social Media activities at the Group and local level as required. |  |  | |
| | Support consistent CDEM messaging across all Regional Council social media platforms and websites. |  |  | |
| | Provide communications/ media staff to support the Group and Local PIM function during response and recovery if required. |  |  | |
| **Reporting, Monitoring and Evaluation** All members of the CDEM Group must provide reports that may be required by the Group. Monitoring and evaluation provide a method for learning from experience, | **Reporting** | | | |
| | Ensure Elected Officials and Leadership Team are informed of Joint Committee and CEG resolutions, directions and decisions. |  |  | Information is made available to Elected Officials via ORC's website and, as required, through Chairperson's reports to Council. CDEM matters are included in ELT Management reports as appropriate. |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| analysing capability, planning and allocating resources, and demonstrating results as part of accountability to stakeholders. | Provide reporting to Joint Committee, CEG and CEG Sub-Committee on specific Regional Council Annual Plan tasks related to CDEM. | ● | ● | |
| | **Monitoring and Evaluation** | | | |
| | Support, contribute and implement a lessons learned/ knowledge management process for CDEM Group. | ● | ● | |
| | Support Monitoring and Evaluation process for CDEM Group. | ● | ● | |
| **Staff**<br>All staff with CDEM responsibilities including CDEM career staff, CDEM appointed staff, Regional Council and Territorial Authority staff fulfilling CIMS functions as part of an Emergency Coordination Centre (ECC) or Emergency Operations Centre (EOC) and any CDEM volunteers providing support to any CDEM function.<br><br>The CDEM Group and each member of the Group are to take all steps necessary on an ongoing basis to maintain and provide, or to arrange the provision of, or to otherwise make available suitably trained and | **CEG Operations Sub-committee** | | | |
| | Appoint a Senior Manager as CDEM designate to represent Regional Council. | ● | ● | |
| | **CDEM career staff** | | | |
| | The Otago Regional Council is the employer of CDEM career staff (EMO) to deliver CDEM outlined in the CDEM Group Plan and this Agreement. | ● | ● | |
| | **24/7 Duty staff** | | | |
| | Provide staff to support a 24/7 duty Group Controller capability. | ● | ● | |
| | **Staff for CIMS functions** | | | |
| | Group Emergency Coordination Centre Incident Management Team and alternates provided by Regional Council. | ● | ● | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| competent personnel, including volunteers; and an appropriate organisational structure for those personnel, for effective civil defence emergency management. | Provide staff to Coordinated Incident Management System (CIMS) functions within the GECC. |  |  | Staff are provided to these functions but target levels have not been met for Function Leads and Function Teams. |
| | Consult with EMO on appointments of staff to Coordinated Incident Management System (CIMS) functions for the GECC. |  |  | |
| | Ensure all CDEM GECC staff have respective CDEM role included in Job Description, KPI in annual performance plan, required training and exercising in annual professional development plan and be allocated the time for active participation. |  |  | Further work is required to include KPIs in performance plans. |
| | **Activation in response/ recovery** | | | |
| | Ensure availability and prioritisation of staff to conduct GECC operations and deliver 24/7 response. |  |  | |
| | Support the provision and deployments of surge regional council CDEM staffing to support Group and Local level response and recovery within the Otago or across New Zealand. |  |  | No deployment of ORC staff (in addition to EMO staff) was required. |
| **Warning Systems** | Ensure an effective flood event monitoring and information system. |  |  | |

## Attachment 1 - Otago Civil Defence and Emergency Management Agreement June 2022

| Function | ORC Responsibility | Achievement Q1 & Q2 2023/24 | Achievement 2022/23 | Explanation |
|---|---|---|---|---|
| When there is an imminent threat to life, health or property from hazard events the issue of official warnings is the responsibility of CDEM agencies. | Promote the flood warning system to partners, emergency services and communities. |  |  | |
| | Support the dissemination of warnings from the CDEM Group to communities. |  |  | |
| **Welfare Management**<br>Management of welfare across all welfare services and clusters: Registration, Needs Assessment, Inquiry, care and protection services for children and young people, Psychosocial support, Household goods and services, Shelter and accommodation, Financial Assistance and Animal welfare.<br><br>The objective of the welfare services function is to carry out activities across the 4Rs to provide for the needs of people affected by an emergency and to minimise the consequences of the emergency for individuals, families and whanau, and communities. | Support Group (GECC) and local (EOC) welfare activities in response. |  |  | No support was required during Group or local responses. |