Safety and Resilience Committee 8 May 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 May 2024 01:00 PM

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 8 February 2024, commencing at 11:00AM
https://www.youtube.com/live/0wwiEc53yCc?si=vXKfRNAGAy-jeYxq

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

1. WELCOME

Chairperson Somerville welcomed Councillors, members of the public and staff to the meeting at 11:00am. Staff present included Richard Saunders (Chief Executive), Anita Dawe (GM Policy and Science), Gavin Palmer (GM Operations), Amanda Vercoe (GM Governance, Culture and Customer), Kylie Darragh (Governance Support) Jean-Luc Payan (Manager Natural Hazards); Simon Robinson (Team leader Natural Hazards Analysis) Simon Cox (Geological and Nuclear Sciences Limited) and staff from Tonkin +Taylor Ltd (online)

2. APOLOGIES

Resolution: Cr Noone Moved, Cr Wilson Seconded:

That the apologies for Cr Forbes, Cr Scott, and Cr Laws (for lateness) be accepted.

MOTION CARRIED

3. PUBLIC FORUM

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

4. CONFIRMATION OF AGENDA

The agenda was confirmed as published.

5. DECLARATIONS OF INTERESTS

Councillors were reminded of their need to stand aside if any conflict arose. No changes to the Councillor Register of Interests were advised.

6. CONFIRMATION OF MINUTES

Resolution: Cr Wilson Moved, Cr Weir Seconded

That the minutes of the Safety and Resilience Committee held on 9 November 2023, be confirmed as a true and accurate record.

MOTION CARRIED

7. OPEN ACTIONS FROM RESOLUTIONS OF THE COMMITTEE

OPS2326 updated by Cr Robertson who explained that this action first needs to be considered by the joint committee in March, before any correspondence is sent.

8. MATTERS FOR CONSIDERATION

8.1. Dunedin groundwater monitoring and spatial observations (YouTube 12:40)

This report sought 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. Simon Robinson (Team leader Natural Hazards Analysis) Jean-Luc Payan, (Manager Natural Hazards) and Gavin Palmer (General Manager Operations) presented a PowerPoint of supporting material from GNS and answered questions.

Resolution SRC24-101: Cr Kelliher Moved, Cr McCall Seconded

That the Committee:

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

MOTION CARRIED

8.2. Clutha Delta Natural Hazards Adaptation (YouTube 56:40)

This report on progress with the Clutha Delta natural hazards adaptation programme including engagement planning, and the significant erosion damage at the Koau/Puerua coastal mouth. Ann Conroy, Team Leader Natural Hazards Adaptation Jamie MacKenzie (Natural Hazards Adaptation Specialist), Tim van Woerden (Senior Natural Hazards Analyst) Simon Robinson (Team Leader Natural Hazards Analysis), Jean-Luc Payan (Manager Natural Hazards), and Gavin Palmer (General Manager Operations) were available to respond to questions on the report.

Resolution SRC24-102: Cr Malcolm Moved, Cr Kelliher Seconded

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.*

MOTION CARRIED

Chair Somerville moved and Cr Robertson seconded *that the Committee adjourn for lunch from 12noon to 12:30pm.*

MOTION CARRIED

8.3. Head of Lake Whakatipu Natural Hazards Adaptation (YouTube 1:38)

This paper sought to update the Committee on progress towards development of a natural hazards adaptation strategy for the Head of Lake Whakatipu area. Ann Conroy (Team Leader Natural Hazards Adaptation) Jean-Luc Payan (Manager Natural Hazards) and Gavin Palmer (General Manager Operations) were available to respond to questions.

Resolution SRC24-103: Cr Wilson Moved, Cr Malcolm 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.* Noting the revised timetable.

MOTION CARRIED

8.4 Lower Taieri Risk Assessment (YouTube 1:49)
The report informed the Committee 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. Ellyse Gore (Project Manager – Special Projects) Brett Paterson (Team Leader Programme Management), Michelle Mifflin (Manager engineering), Jean-Luc Payan (Manager Natural Hazards) Gavin Palmer (General Manager Operations) and staff from Tonkin + Taylor Ltd (online) shared a PowerPoint of relevant slides and responded to questions on the report.

Resolution SRC24-104: Cr Weir Moved, Cr Noone Seconded
That the Safety and Resilience Committee:

1. ***Notes** this report.*
2. **Notes** the report by Tonkin + Taylor Ltd; Taieri Flood Protection Scheme, Flood bank 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 Flood bank 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.*

MOTION CARRIED

8.5 Wildfire Hazard in Otago (YouTube 2:44)
The report informed the Committee 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. Matt Alley (Manager Emergency Management) Jean-Luc Payan (Manager Natural Hazards) and Gavin Palmer (General Manager Operations).

Mr Payan noted that the figures for the Otago Region were defined by Fire and Emergency New Zealand (FENZ) for this report.

Resolution SRC24-105: Cr Weir Moved, Cr Noone Seconded
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.*

MOTION CARRIED

8.6.CDEM Partnership Report 2023 – 2024 (YouTube 3:06)
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. Gavin Palmer (General Manager Operations) and Matt Alley (Manager Emergency Management) were available to answer questions.

Resolution SRC24-106: Cr Kelliher Moved, Cr Noone Seconded
That the Safety and Resilience Committee*:*

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

MOTION CARRIED

9. CLOSURE

There was no further business and Chair Somerville thanked everyone for their attendance, their input and attention and the work that had gone into bringing the reports to the Committee. After a karakia the meeting was declared closed at 2:00 PM.

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Chairperson Date

Meeting Date	Document	Item No.	Item	Status	Action Required	Assignee/s	Action Taken	Due Date	Completed (Overdue)
08/02/2024	Safety and Resilience Committee - 8 February 2024	8.5	HAZ2303 Wildfire Hazard in Otago	In Progress	Requests that the Safety and Resilience Committee is updated on the Otago CDEM Group's discussion at its next meeting.	General Manager Operations	**26/03/2024 Governance Support Officer** Was discussed at the March 2024 CDEM Joint Committee. To be updated at next Safety & Resilience meeting on 8 May 2024	10/05/2024	

9.1. Head of Lake Whakatipu Natural Hazards Adaptation

Prepared for:	Safety and Resilience Committee
Report No.	OPS2407
Activity:	Governance Report
Author:	Ann Conroy, Team Leader Natural Hazards Adaptation Tim van Woerden, Senior Natural Hazards Analyst Jamie MacKenzie, Natural Hazards Adaptation Specialist Simon Robinson, Team Leader Natural Hazards Analysis Jean-Luc Payan, Manager Natural Hazards
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	8 May 2024

PURPOSE

[1] To update the Committee on progress towards development of a natural hazards adaptation strategy for the Head of Lake Whakatipu area, including informing the Committee of the findings of the Socio-economic Impact Assessment (Phase 1).

EXECUTIVE SUMMARY

[2] Otago Regional Council (ORC) is following the Dynamic Adaptive Pathways Planning approach (DAPP or 'Adaptation Pathways') as a framework for development of a Head of Lake Whakatipu natural hazards adaptation programme.

[3] The ORC led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing well. This paper provides an update on activities since the previous committee paper presented in February 2024.

[4] The Socio-economic Impact Assessment Phase 1 (Appendix 1) is a key document that describes the socio-economic baseline of Head of Lake Whakatipu communities and explores potential impacts of indicative natural hazard scenarios. The report identifies that 'the Head of the Lake' is a well-functioning and motivated community that self-organises to meet community aspirations. Most respondents showed a high level of preparedness and tolerance of natural hazard events. However, newcomers to the community and visitors may not be as resilient. The report also notes that the community has become more reliant on the hospitality and tourism trade over time and these industries are very susceptible to natural hazard events. A key issue for the community both socially and economically is therefore the resilience of access to/from, and within the Head of Lake Whakatipu area, as this is key to the community's social and economic wellbeing.

[5] Natural hazard investigations progressing and two significant technical studies in progress and aiming for completion in Q2 2024.

[6] This paper provides a high-level overview of completed and upcoming community engagement activities for the 2024 calendar year. Proposed engagement activities generally sit within two stages of the DAPP cyclic approach; 'what can we do about it?' and 'make it happen'. A particular focus for engagement during the second quarter is on youth engagement.

RECOMMENDATION

That the Safety and Resilience Committee:

1) ***Notes** this report.*
2) ***Notes** the report by Beca Ltd;* Socio-economic Impact Assessment – Head of Lake Whakatipu Adaptation Strategy - Phase 1*, dated 3 April 2024.*
3) ***Notes** the findings presented in the above report.*
4) ***Recommends that Council endorses** the use of the information presented in this report to inform natural hazard management and adaptation planning for the Head of Lake Whakatipu area.*
5) ***Notes** the Head of Lake Whakatipu natural hazards adaptation work programme and community engagement.*

BACKGROUND

[7] Otago Regional Council (ORC), in collaboration with project partners, is leading a programme of work to develop a natural hazards adaptation strategy for the head of Lake Whakatipu area.

[8] 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.

[9] ORC is using the Dynamic Adaptative Pathways Planning approach (DAPP, or 'Adaptation Pathways') as a framework for development of a head of Lake Whakatipu natural hazards adaptation programme. ORC is also using this approach in natural hazards adaptation planning for the South Dunedin Future[1] and Clutha Delta[2] natural hazards adaptation programmes.

[10] The adaptation project approach and work activities completed are outlined in the series of papers previously presented in 2021-2023.[3] The most recent paper, presented in February 2024, summarised progress for the three significant technical studies in progress and proposed to deliver the completed (first iteration) strategy by November 2024.

[11] Quarterly update papers to the Safety and Resilience Committee will continue through until the delivery of the strategy.

[12] This paper is focused on presenting the findings of the Socio-economic Impact Assessment Phase 1 report. It also provides updates on other current or planned activities in this work programme, including community engagement activities; natural hazard risk assessment for Glenorchy and Kinloch, and feasibility assessment for floodplain hazard management approaches for the Dart-Rees floodplain (including nature-based solutions).

[1] https://www.dunedin.govt.nz/council/council-projects/south-dunedin-future

[2] 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.

[3] Reports to Council (27 May 2021), the ORC Data and Information Committee (9 June 2022) and the ORC Safety and Resilience Committee (10 May 2023, 10 August 2023, 9 November 2023, and 8 February 2024)

[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 third phase "*What can we do about it?"* and building towards delivery of a first iteration of the strategy document. Figure 1 updates the similar figure presented in the previous committee papers.

DISCUSSION

[14] The ORC-led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing well, with the Socio-economic Impact Assessment Phase 1 findings now available (see Appendix 1), and two other significant technical studies in progress and aiming for completion in Q2 2024.

[15] ORC is proposing to deliver the completed (first iteration) strategy by November 2024, with timing subject to feedback on the draft documents. A draft of the strategy document is likely to be available for community/public consideration and feedback in Q3 2024. The Strategy will include Action Plans that describe adaptation responses that are underway or in progress.

ADAPTATION STRATEGY DEVELOPMENT

[16] 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) – timing is subject to the feedback on the draft documents

[17] 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.

[18] Adaptation strategy development is currently focussed on drafting potential pathways, including suitable signals, triggers, and thresholds, to support community discussion and input.

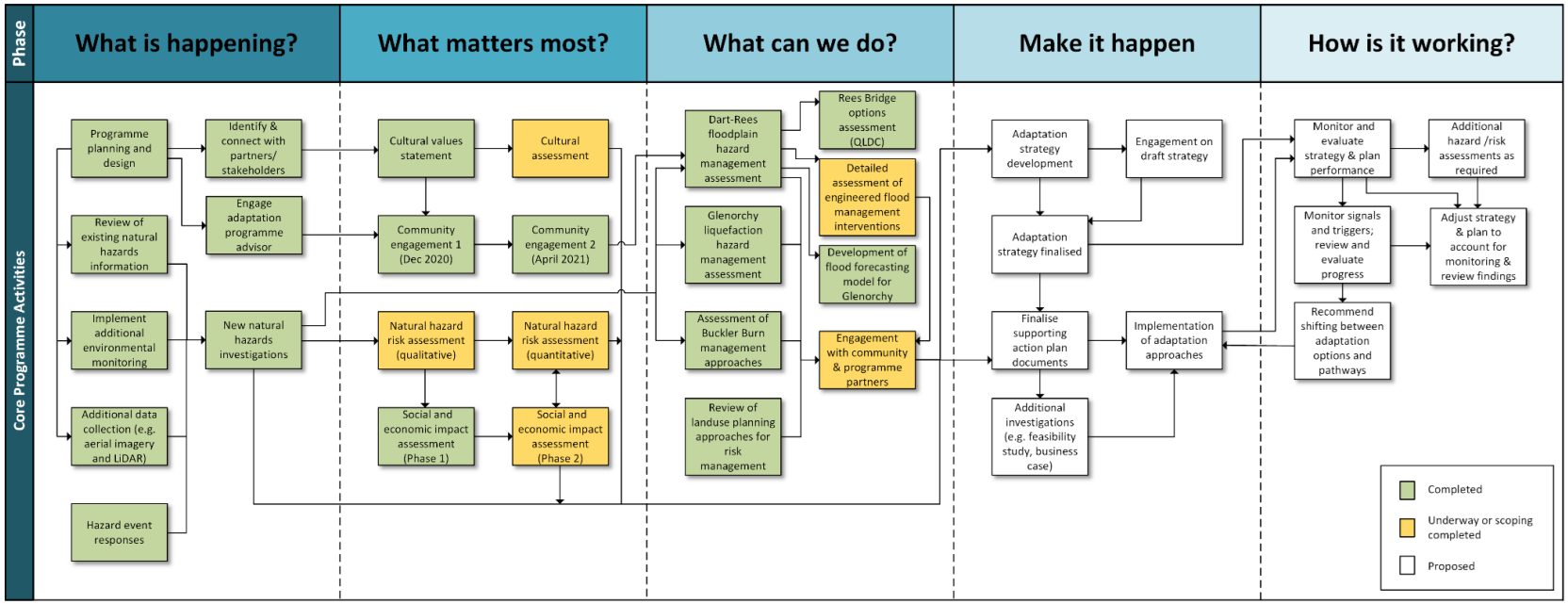

Figure 1: Head of Lake Whakatipu programme overview of key activities. This diagram updates from the previous (February 2024) and earlier committee papers.

SOCIO-ECONOMIC IMPACT ASSESSMENT

[19] The report by Beca Group Limited is titled Socio-economic Impact Assessment – Head of Lake Whakatipu Adaptation Strategy – Phase 1, dated 3 April 2024 and is attached as Appendix 1.

[20] The SEIA Phase 1 examines the socio-economic baseline of the local community. It also explores the potential social and economic consequences of three indicative natural hazard scenarios in relation to the "status quo". The "status quo" is the current community and the natural hazard management measures currently in place.

[21] The assessment process from a socio-economic perspective is detailed in Figure 2.

[22] The SEIA Phase 1 methodology involved a combination of primary and secondary research to enhance the understanding of the local communities' social and economic baseline. Primary research involved collecting new data through interviews and surveys. Secondary research involved gathering and synthesising existing data.

[23] In November 2023, a number of interviews, and several focus groups were undertaken with stakeholders, residents and businesses in the Head of Lake Whakatipu, both in-person and online. This was followed up with an online residents and businesses survey from 24 November to 8 December 2023.

[24] This SEIA Phase 1 identifies that 'the Head of the Lake' is a well-functioning and motivated community that self-organises to meet community aspirations. The natural environment is the major reason why people want to live in the area, and why tourists visit.

[25] The community is largely aware of the unpredictability of nature and that living in the area means being susceptible to natural hazard events. Most research participants demonstrated a high level of preparedness. However, the SEIA Phase 1 notes that some newcomers to the community may not be as resilient in terms of preparedness and tolerance of natural hazard events, compared to long standing residents with experience of more isolated times.

[26] The SEIA Phase 1 also notes that the community has become more reliant on the hospitality and tourism trade over time and these industries are very susceptible to natural hazard events, as the environment and access are often impacted and take time to recover. A major natural hazard event also has a potential to impact visitor confidence to return to the area. A key issue for the community both socially and economically is therefore the resilience of access to/from, and within the Head of Lake Whakatipu area, as this is key to the community's social and economic wellbeing.

[27] The SEIA Phase 1 is a key piece of work to support decision making. The information can be used to consider both the adaptation needs of the Head of the Lake community, and the consequences of potential adaptation responses under consideration as part of ORC's programme of work to develop the Strategy.

[28] The SEIA Phase 1 should be read alongside other technical reports that support the development of the Strategy, such as the complementary Natural Hazard Risk Assessment (paragraphs 40-45).

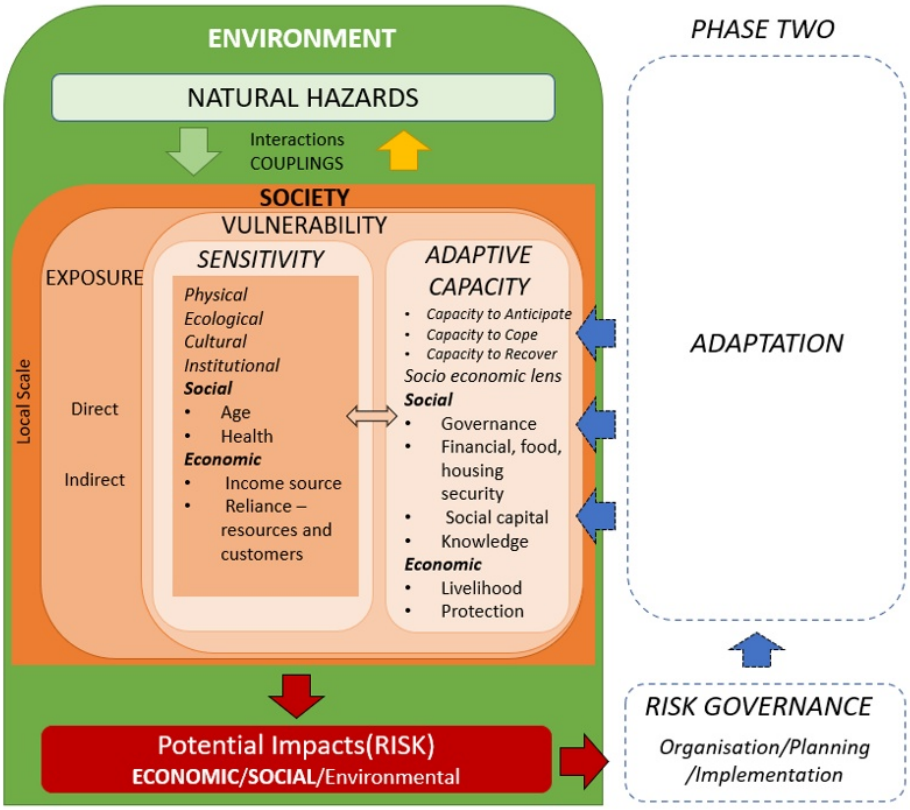

Figure 2: Assessment process from a socio-economic perspective (adapted from Birkmann[4]) (BECA, 2024)

[29] Phase 2 will identify potential social and high-level economic impacts of a long-list of possible adaptation responses. Phase 2 will be a screening-level, desktop assessment, based on Phase 1 data and other available information. Work is underway and results are expected in Q2 2024.

[30] Potential social and high-level economic impacts of possible adaptation responses, identified in Phase 2, will inform pathways development, along with other building blocks such as:

- partner inputs;
- Aukaha's cultural screening assessment;
- community preferences;
- technical and risk assessments..

COMMUNITY ENGAGEMENT

[4] Birkmann, et al. (2013). Framing vulnerability, risk and societal responses: the MOVE framework. Natural Hazards. 67(2). 193-211.

[31] Planning is underway for engagement activities in 2024. NIWA[5] 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.

[32] Proposed engagement activities for the 2024 calendar year are outlined in Table 1. In addition to these activities, regular programme updates are provided through the monthly newsletter (see Appendix 2) and programme webpage.

Table 1: High level overview of proposed engagement activities for the 2024 calendar year.

Engagement activity (and level of participation*)	**Purpose**	**Q1 2024**	**Q2 2024**	**Q3 2024**	**Q4 2024**
Invite GCA to comment on the draft phase 1 socio-economic impact (SEIA) assessment ➢ *'Involve'*	Opportunity for community feedback on the SEIA Phase 1 draft report				
Collaborate with Enviroschools to facilitate learning activities at Glenorchy Primary School ➢ *'Involve'*	Build youth understanding of hazardscape and adaptation approaches				
Head of the Lake youth art competition ➢ *'Involve/Collaborate'*	Involve youth in Strategy design and help the community to 'see themselves' in the Strategy				
Share SEIA Phase 1 findings ➢ *'Inform'*	Update the community on the findings of technical studies, in an accessible way				
Share risk assessment and feasibility assessment findings ➢ *'Inform'*	Update the community on the findings of technical studies, in an accessible way				
Discuss preferred adaptation responses and pathways ➢ *'Involve/Collaborate'*	Build understanding and generate ideas on signals, triggers, trade-offs, preferred pathways and how to monitor changes				
Gain feedback on draft strategy document ➢ *'Consult'*	Gain input on the Strategy document and strategic framework for adaptation so that the Strategy works for this community				

* IAP2 Spectrum of Public Participation (as committed to in He Mahi Rau Rika) describes levels of participation that define the public's role in any public participation process: INFORM > CONSULT > INVOLVE > COLLABORATE > EMPOWER

[33] Engagement activities planned for the 2024 calendar year generally sit within two stages of the DAPP cyclic approach; 'what can we do about it?' and 'make it happen'. A particular focus for engagement during the second quarter is youth engagement.

[34] The programme team are collaborating with Enviroschools to facilitate two sessions with senior students at Glenorchy Primary School, during April and May. The April session focused on landscape changes over time and how people have adapted to these changes in the past and present, linking to the school focus on gold mining history. The complementary May session aims to play an educational climate adaptation game,

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

introducing key concepts around adaptation, and what adapting could look like now and in the future.

[35] From 8 April to 9 May 2024, we held the 'Head of the Lake Youth Art competition'[6]. Winners and runner ups will be announced on Winners' art will be incorporated into the design of the Head of Lake Whakatipu Natural Hazards Adaptation Strategy document.

[36] Councillors and community members are invited to join ORC staff and the SEIA Beca consultant team for an online presentation and Q&A on 7pm Wednesday 22 May. The aim of the session is to share the findings of the SEIA report and provide an opportunity for local community members to ask questions of the consultant team. The session will be recorded and uploaded to the programme webpage.

[37] Looking forward to the remainder of the 2024 calendar year, engagement activities are planned to share the findings of technical reports (detailed below), discuss preferred pathways and to engage on the draft Strategy document (see Table 1).

[38] Risks relating to engagement and proposed mitigation actions have been identified as part of the engagement planning process.

[39] Engagement planning also considers other community engagement programmes across Queenstown Lakes District, or that local communities may be interested in over the same time period (i.e. engagement on the ORC Long Term Plan). This aims to avoid engagement fatigue and better support alignment across ORC community engagement programmes.

NATURAL HAZARD RISK ASSESSMENT

[40] A natural hazard risk assessment for Glenorchy and Kinloch is being undertaken by Beca Group Limited (Beca). The study involves review and analysis of natural hazards characterisation work completed by ORC and others and conducting qualitative and quantitative risk analyses based on this information.

[41] The findings of this study will be used to inform decision-makers and the community of the relative levels of natural hazard risk, and to inform future risk management and adaptation activities. This work aligns with the Adaptation Pathways approach developed by the Ministry for the Environment[7] where an understanding of natural hazards and risk is used to identify pathways that best manage, reduce or avoid risk.

[42] The assessment comprises a qualitative and then quantitative risk analysis. The qualitative assessment phase is nearing completion and is currently being externally reviewed. Based on findings of the qualitative analysis, a more detailed quantitative analysis is being completed for the following hazard types;

- Liquefaction and lateral spreading (Glenorchy)
- Rees and Dart River flooding
- Lake Whakatipu flooding

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

[7] Ministry for the Environment (2017). Preparing for coastal change – a summary of coastal hazards and climates changes guidance for local government. (https://environment.govt.nz/assets/Publications/Files/coastal-hazards-summary.pdf accessed 06.03.2024).

- Buckler Burn flooding
- Multiple source flooding

[43] The qualitative phase of assessments indicates that the main flooding sources in Glenorchy (the Dart River, Rees River, Buckler Burn and Lake Whakatipu) are identified as 'significant' risks.[8] To aid the quantitative assessments of these risks, further investigations have been procured and are underway. They include:

- Hydrological analysis for the Buckler Burn and Bible Stream catchments
- Development and hydraulic modelling of combined “all source” flooding scenarios.

[44] The study is being externally peer reviewed to provide assurance of the robustness of findings.

[45] All risk assessment findings will be presented to both the community and to councillors once they have been externally reviewed and finalised. This is expected to be by early June 2024.

FLOOD MITIGATION AND NATURE-BASED SOLUTIONS FEASABILITY ASSESSMENTS

[46] Damwatch Engineering Ltd (Damwatch) are currently conducting a technical feasibility study to explore potential floodplain hazard management approaches for the Dart-Rees floodplain.

[47] For the lower Rees floodplain and Glenorchy township flood hazard, the investigation is progressing well, and includes assessment of the following engineered flood management interventions;

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.

[48] The second stage assessments investigating the Dart floodplain (including along Kinloch Road), and the upper Rees floodplain (upstream of the road bridge) have also commenced. These will include assessments 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.

[49] 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.

[8] Assessed using the qualitative risk assessment process outlined in the proposed Otago RPS (Steps 1-3 of APP6).

d. Assessment of the technical challenges and constraints for implementation of design concepts, potential environmental impacts, consenting requirements and indicative costings.

[50] 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*.

[51] The study is being externally peer reviewed to provide assurance of the robustness of findings.

[52] 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 early June 2024.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[53] 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.*

[54] The proposed Otago Regional Policy Statement June 2021[9], notified in late March 2024, 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."[10]

Financial Considerations

[55] 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.

[56] 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.

[57] 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

[58] Engagement planning considers and is designed to be consistent with organisational commitments made through He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy.

[9] Section HAZ-NH-M1

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

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] Central government has repealed the Natural and Built Environment Act and the Spatial Planning Act. 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 email newsletter[12].

[65] A communications plan has been developed as part of this work programme. The programme team is working closely with the Communications team to ensure communications and engagement planning is integrated, complementary and build off each other.

NEXT STEPS

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

[67] 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 Q2	Deliver technical studies:	Focus of community engagement:

[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-intouch-be-involved

	• Socio- economic impact assessment • Cultural assessment • Natural hazard risk assessment for Glenorchy and Kinloch • Flood management interventions and nature-based solutions for floodplain hazard management Strategy development and design	• Technical studies update • Discussion of adaptation pathways • Youth engagement
2024 Q3	Deliver draft strategy and action plans (for comment)	Focus of community engagement: • Draft strategy
2024 Q4	November – deliver final Strategy (timing subject to feedback on the draft documents)	Focus of community engagement: • Final strategy

[68] Second quarter community engagement includes youth-focussed activities, and activities to inform about the results of technical assessments, as they become available.

[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. Lake Whakatipu Natural Hazard Adapatation Strategy - SEIA Phase 1 - FINAL 3 April 2024 [**9.1.1** - 115 pages]
2. Head of the Lake newsletter update April 2024 [**9.1.2** - 7 pages]

Socio-economic Impact Assessment - Head of Lake Whakatipu Adaptation Strategy - Phase 1

Prepared for Otago Regional Council
Prepared by Beca Limited

3 April 2024

Contents

Appendices

Glossary of defined terms and acronyms

ADT	Annual Daily Travel
DAPP	Dynamic Adaptive Planning Pathways
DoC	Department of Conservation
CDEM	Civil Defence Emergency Management
CRG	Community Response Group
CRP	Community Response Plan
IAIA	International Association of Impact Assessment
IPCC	International Panel for Climate Change
EMO	Emergency Management Otago
GDP	Gross Domestic Product
ORC	Otago Regional Council
QLDC	Queenstown Lakes District Council
SA2	Statistical Area 2
SAR	Search and Rescue
SEIA	Socio-economic Impact Assessment
The Head of the Lake	The area that is the focus of the Head of Lake Whakatipu Natural Hazard Adaptation Strategy
The Strategy	The Head of Lake Whakatipu Natural Hazard Adaptation Strategy

Revision History

Revision N°	Prepared By	Description	Date
1	Jo Healy, Kaitlyn Stringer, Danielle Goodall	Draft issued for client comment	15 December 2023
2	Jo Healy, Kaitlyn Stringer, Danielle Goodall	Draft issued for client comment	15 March 2024
3	Jo Healy, Kaitlyn Stringer, Danielle Goodall	Final copy issued	3 April 2024

Document Acceptance

Action	Name	Signed	Date
Prepared by	Jo Healy, Kaitlyn Stringer, Danielle Goodall		3 April 2024
Reviewed by	Jerry Khoo, Charlotte Lee and Laura Robichaux		3 April 2024
Approved by	Charlotte Lee		3 April 2024
on behalf of	Beca Limited		

Executive Summary

The Otago Regional Council (ORC), in collaboration with Queenstown Lakes District Council (QLDC), iwi, Department of Conservation (DoC) and local communities, is developing a Natural Hazards Adaptation Strategy (the Strategy) for the Head of Lake Whakatipu. The Head of Lake Whakatipu area and its communities are exposed to multiple natural hazard risks, including floods and earthquakes. The landscape is also dynamic and some of the risks are evolving over time. An "Adaptation Pathways" framework called Dynamic Adaptive Planning Pathways (DAPP) is being used to develop the Strategy.

Beca Ltd has been engaged to undertake Phase 1 of a Socio-economic Impact Assessment (SEIA). Specifically, the SEIA examines the social and economic baseline of the local community, and the potential social and economic consequences of three indicative natural hazard scenarios in relation to the status quo (the current community and the natural hazard management measures currently in place).

The SEIA is a key piece of work to support decision making pertaining to the Strategy, by contributing to answering the first two question within the DAPP framework:

- What is happening?
- What matters most?

The SEIA involved a combination of primary and secondary research to enhance the understanding of the local communities' social and economic baseline. In November 2023, a number of interviews, and several focus groups were undertaken with stakeholders, residents and businesses in the Head of Lake Whakatipu, both in-person and online. This was followed up with an online residents and businesses survey from 24 November to 8 December 2023.

This SEIA identifies that 'the Head of the Lake' is a well-functioning and motivated community that self-organises to meet community aspirations. The natural environment is the major reason why people want to live in the area, and why tourists visit.

The community is largely aware of the unpredictability of nature and that living in the area means being susceptible to natural hazard events. Most research participants demonstrated a high level of preparedness. However, the SEIA notes that some newcomers to the community may not be as resilient in terms of preparedness and tolerance of natural hazard events, compared to long standing residents with experience of more isolated times.

The SEIA also notes that the community has become more reliant on the hospitality and tourism trade over time and these industries are very susceptible to natural hazard events, as the environment and access are often impacted and take time to recover. A major natural hazard event also has a potential to impact visitor confidence to return to the area. A key issue for the community both socially and economically is therefore the resilience of access to/from, and within the Head of the Lake area, as this is key to the community's social and economic wellbeing.

The information in this SEIA can be used to consider both the adaptation needs of the Head of the Lake community, and the consequences of potential adaptation responses under consideration as part of ORC's programme of work to develop the Strategy. The SEIA should be read alongside other technical reports that have been prepared to support the development of the Strategy.

1 Introduction

The Head of Lake Whakatipu area and its communities are exposed to multiple evolving natural hazard risks. ORC, in collaboration with QLDC, iwi, DoC, and local communities, is leading a programme of work to develop a Natural Hazards Adaptation Strategy (the Strategy) for the area at the Head of Lake Whakatipu. As part of the programme of work being undertaken to develop the Strategy, Beca Ltd has been engaged to undertake Phase 1 of a Socio-economic Impact Assessment (SEIA). This report examines the social and economic baseline of this community, and the potential social and economic consequences of three indicative natural hazard scenarios in relation to the status quo (the current community and the natural hazard management measures currently in place).

1.1 Project Description

1.1.1 Location

The Head of Lake Whakatipu is an area located at the northern end of Lake Whakatipu. It includes the township of Glenorchy, as well as the surrounding rural areas of Kinloch, Paradise, Routeburn, Caples, Greenstone and the Dart and Rees Valleys (refer to Figure 1-1). This area is the focus of the Strategy and is collectively referred to as the Head of Lake Whakatipu, or more informally as 'the Head of the Lake'. Throughout this report, the project area is referred to as 'the Head of the Lake'.

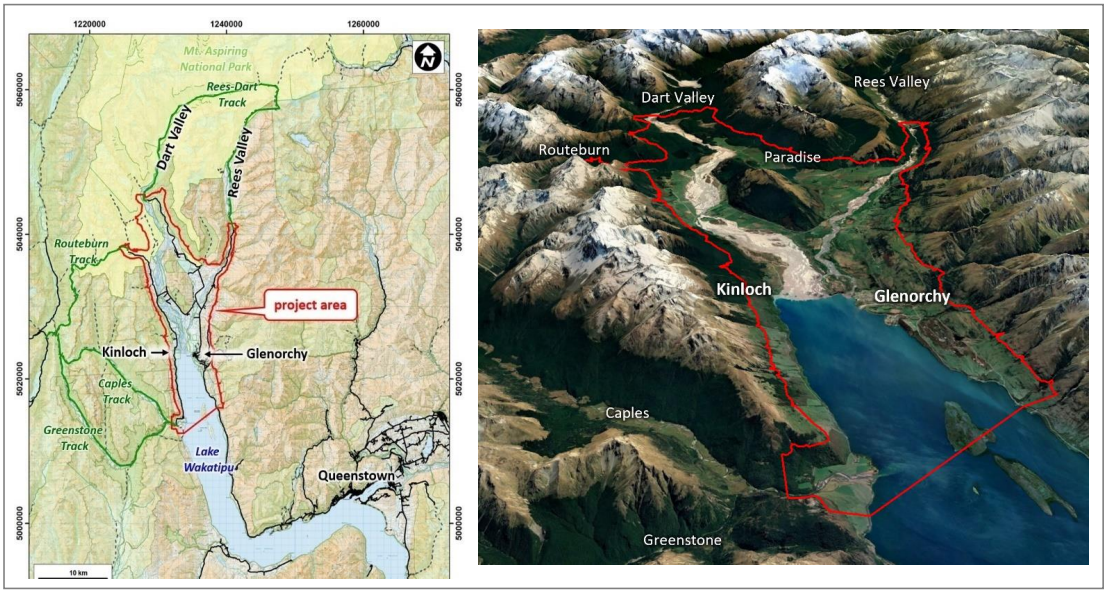

Figure 1-1: Geographic context of the SEIA study area (referred to as "the project area" in the figure). Source: (ORC Project Documentation, 2023)

1.1.2 Natural Hazards

ORC reports that the Head of the Lake are exposed to a complex range of flooding, slope-related and seismic hazard events (Tonkin & Taylor, 2021). The occurrence of some of these natural hazards are

relatively frequent and can be disruptive to the community. Future climate change and landscape changes will also increase the potential frequency and severity of consequences.

In regard to seismic risks, a specific study (Tonkin & Taylor, 2023) on the susceptibility of the Head of the Lake concluded that significant damage due to liquefaction and lateral spreading could be expected at “50 to 100 year” level earthquake shaking (40-60% chance of occurring over the next 50 years).

Damwatch Engineering (Webby, 2022) reported that the floodplains and delta associated with the Dart and Rees Rivers at the Head of the Lake are subject to both flooding and erosion hazards which impact on the townships of Glenorchy, Kinloch and Greenstone through disruption to road access. These hazards are increasing over time due to landscape-scale geomorphic changes and future climate change effects. Glenorchy township is also subject to flooding from Lake Whakatipu and Buckler Burn.

1.1.3 Adaptation Strategy Background Information

ORC has selected an “Adaptation Pathways” framework called Dynamic Adaptive Planning Pathways (DAPP) to develop the Strategy. The DAPP approach helps communities to plan and adapt for situations where the future is uncertain by enabling flexible and adaptive decision-making as conditions change.

The DAPP approach in Aotearoa New Zealand, as defined in the 2017 Ministry for the Environment Coastal Hazards and Climate Change Guidance for Local Government, consists of a 10-step decision cycle centred around 5 phases/questions, as per Figure 1-2 below:

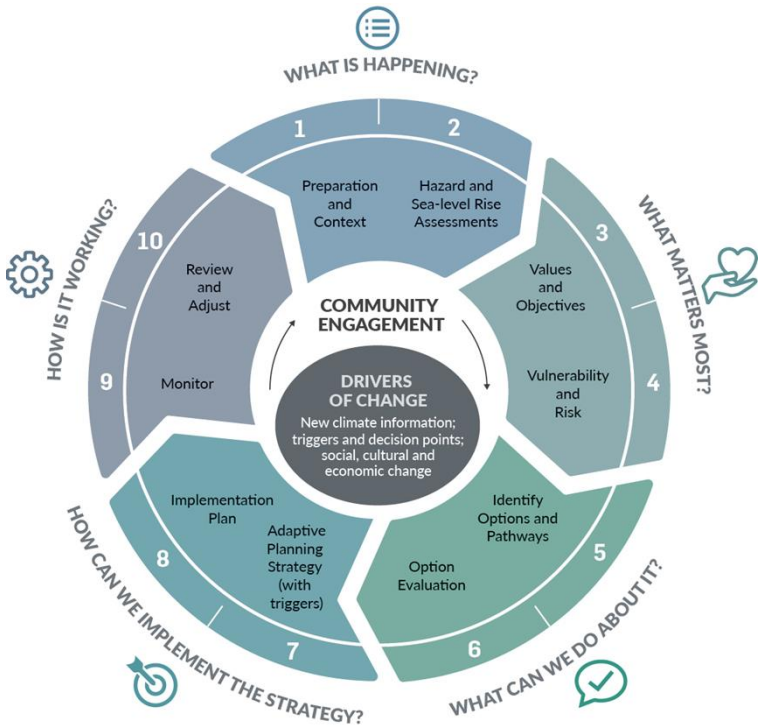

Figure 1-2: Dynamic Adaptive Planning Pathways (DAPP) 10-step decision cycle group around 5 questions. Source: (Ministry of Environment, 2017)

Figure 1-3 below shows how the Strategy's key activities are arranged around answering the five questions of DAPP.

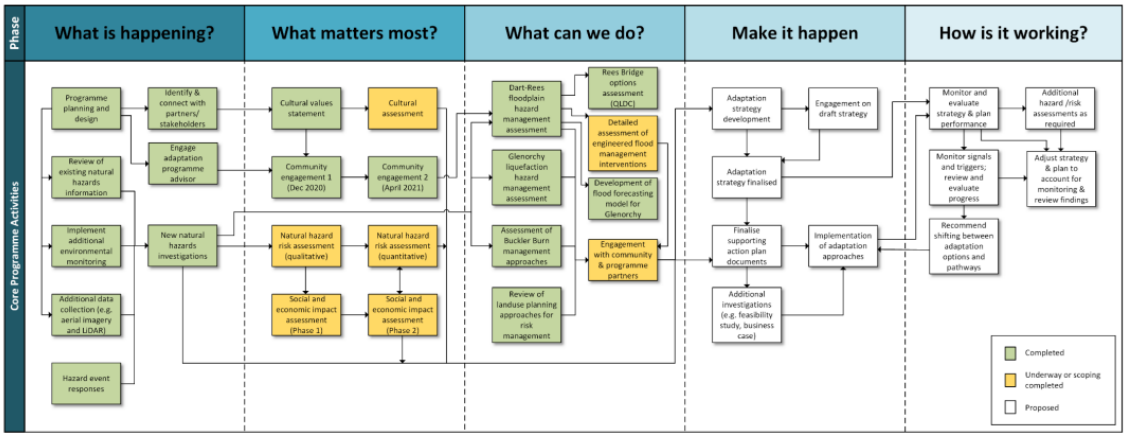

Figure 1-3: Dynamic Adaptive Planning Pathway Process key activities for the Head of Lake Whakatipu Natural Hazards Adaptation Strategy programme – updated February 2024. Source: (Otago Regional Council, 2024)

The Strategy's development and decision-making process is underpinned by an extensive programme of supporting technical work and community engagement. A large number of studies have been completed over the last few years, and others are in progress.

The first iteration of the Strategy is expected to be delivered in November 2024.

1.2 Socio-economic Impact Assessment

As part of the programme of work being undertaken to develop the Strategy, Beca Ltd has been engaged to undertake Phase 1 of a SEIA. The scope of Phase 1 is to better understand the social and economic baseline, and the potential impacts of potential natural hazard scenarios on the wellbeing of people and communities at the Head of the Lake. Phase 1 of the SEIA is based on indicative natural hazard scenarios (specified by Otago Regional Council) which assume status quo measures are in place for managing natural hazards.

The SEIA is a key piece of work to support decision making for creating the Strategy. Within the DAPP framework, the SEIA will contribute to answering the first two questions:

- What is happening?
- What matters most?

This report should be read alongside the other technical reports that have been prepared to support the development of the Strategy. Programme information and reports are published on the ORC website[1].

[1] https://www.orc.govt.nz/managing-our-environment/natural-hazards/head-of-lake-whakatipu

1.3 Report structure

The report is structured to assist in assessing the potential social impacts of the potential natural hazard scenarios on the relevant receiving community. To do this, the assessment is structured as follows:

- Methodology
- Assumptions and limitations
- Social area of influence
- Community baseline
- Assessment
- Conclusion.

2 Socio-economic Impact Methodology

In accordance with the International Association of Impact Assessment (IAIA) best practice guidelines, a social impact assessment includes "the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions" (IAIA, 2015).

While social impact assessment and economic impact assessment are often undertaken separately and use specific methods, they are complementary and sometimes overlap (Australian Government 2005). A SEIA is therefore a useful tool to help understand the potential range of social **and** economic consequences if a 'change' occurs.

In this case, the SEIA methodology has been developed to enhance the understanding of the Lake Whakatipu communities' social **and** economic baseline; and to identify the key social and economic impacts of the indicative natural hazard scenarios (specified by ORC) under status quo conditions. 'Status quo' conditions can be understood as the current community and the natural hazard management measures currently in place.

The following guidelines have been used to inform the methodology:

- Dynamic Adaptive Planning Pathway Framework (Ministry for the Environment, 2017)
- Social Impact Assessment: Guidance for Assessing and managing the Social Impacts of Projects (International Association of Impact Assessment, 2015)
- MOVE framework (Birkmann et al., 2013)
- Intergovernmental Panel on Climate Change – Sixth Assessment Report (2023).

The sections below outline the key steps in the methodology, and how these steps work alongside and within the DAPP to support the work completed to date, and the work to be undertaken proceeding Phase 1 of this SEIA.

2.1 Step 1: Understand the ORC Adaptation Programme for the Head of Lake Whakatipu

The objective of this step is two-fold; firstly, to fully understand the work to date on the Strategy, and secondly, to fully understand the broader community and hazard context (from a socio-economic[2] perspective). This process included a review of:

- Reports completed as part of the Strategy's programme of work
- Social and economic reports on the area
- Media coverage of the area in relation to natural hazards
- Literature pertaining to the socio-economic impacts of natural hazards, focusing on New Zealand, flooding and earthquakes (where available)
- Community plans and policies (e.g., the Glenorchy Community Plan 2001, and Glenorchy Community Visioning Report 2016).

2.2 Step 2: Identify the preliminary socio-economic area of influence

Using the data gathered at the previous step, the socio-economic area of influence was identified. The socio-economic area of influence is the area in which there are likely to be social and economic impacts from both natural hazards and the potential adaptation pathways. This included scoping and developing an understanding of the social and economic reach of potential impacts, including interdependencies with the wider area. In this case, the socio-economic area of influence includes both local and regional impacts:

- **Local Community**: Includes the Glenorchy township, and the surrounding rural areas of Kinloch, Paradise, Routeburn, Greenstone and the Dart and Rees Valleys
- **Regional**: This primarily refers to Queenstown (as the nearest town) but also in terms of the social and economic interdependencies, such as Queenstown-based tourist operations and other services.

Once the socio-economic area of influence was identified, a stakeholder mapping exercise was undertaken to inform the data collection method. This involved identifying the stakeholders, groups, and communities likely to experience social and economic impacts. This list was tested and refined with ORC staff, a Glenorchy-based Councillor, and a representative of the Glenorchy Community Association with local knowledge of the Head of the Lake community.

2.3 Step 3: Understand the social and economic baseline

A range of qualitative research methods were undertaken to develop an understanding of the social and economic baseline at the Head of the Lake. The social research team spent five days gathering primary data at the Head of the Lake (9-10th November and 12-14th November 2023). This was supplemented by a follow up resident and business survey, and a desktop review of secondary data.

The primary data methods included:

- **Interviews** with:

[2] The term socio-economic in the context of this report relates to the interaction of social and economic factors. Where the report focuses on just social or economic factors, the central focus is that factor, rather than the interaction between the two.

  - Key stakeholders (e.g., QLDC staff, Emergency Management Otago staff, DoC, emergency services providers, Glenorchy Community Nurse, Glenorchy Primary School Principal, Glenorchy Community Association).
  - Community organisation/club/group representatives.
  - Business owners/operators.
- **Semi-structured 'drop-in' interviews** with residents.
- **Focus groups** with:
  - Queenstown-based businesses operating at the Head of the Lake[3]
  - community representatives (e.g., residents and representatives of community organisations/clubs/groups)
    Glenorchy Primary School students.
- **Survey** of residents and businesses.
- **Site observations**.

The social research team spoke to 70 people (summarised in Table 2-1 below), accounting for instances where people participated in more than one research method.

Table 2-1: Primary data

Research method	Detail	Number of participants
Interviews	Key stakeholders (e.g., QLDC staff, Emergency Management Otago staff, DoC, emergency services providers, Glenorchy Community Nurse, Glenorchy Primary School Principal, Glenorchy Community Association)	17
	Community organisation/club/group representatives	5 (3 also attended a focus group)
	Business owners/operators	4 (1 also interviewed as a resident)
	Semi-structured 'drop-in' interviews with residents	14
Focus groups	Queenstown-based businesses operating at the Head of the Lake	2
	Community representatives (e.g., residents and representatives of community organisations/clubs/groups)	7
	Glenorchy Primary School students	14
TOTAL		59
Survey	Survey of residents and businesses	23 responses (11 businesses, 12 residents)[4]

[3] Businesses based at the Head of the Lake were also invited to participate in an online focus group, however there was no uptake.

[4] Four people also participated in an interview or focus group.

The focus groups were all undertaken in-person, while the interviews included a mix of online and in-person meetings. Both research methods were conducted in a semi-structured manner, guided by key themes and questions (provided in Appendix A) to help explore:

- who makes up the community,
- how the community functions,
- what they need to remain living and/or operating in the community, and
- vulnerabilities and resilience (social and economic) to natural hazards.

The focus group with Glenorchy Primary School Students included a mapping exercise, using sticky notes and a map of Glenorchy township. The students were asked to brainstorm and identify on a map what they like about living in the area (refer to Figure 2-1).

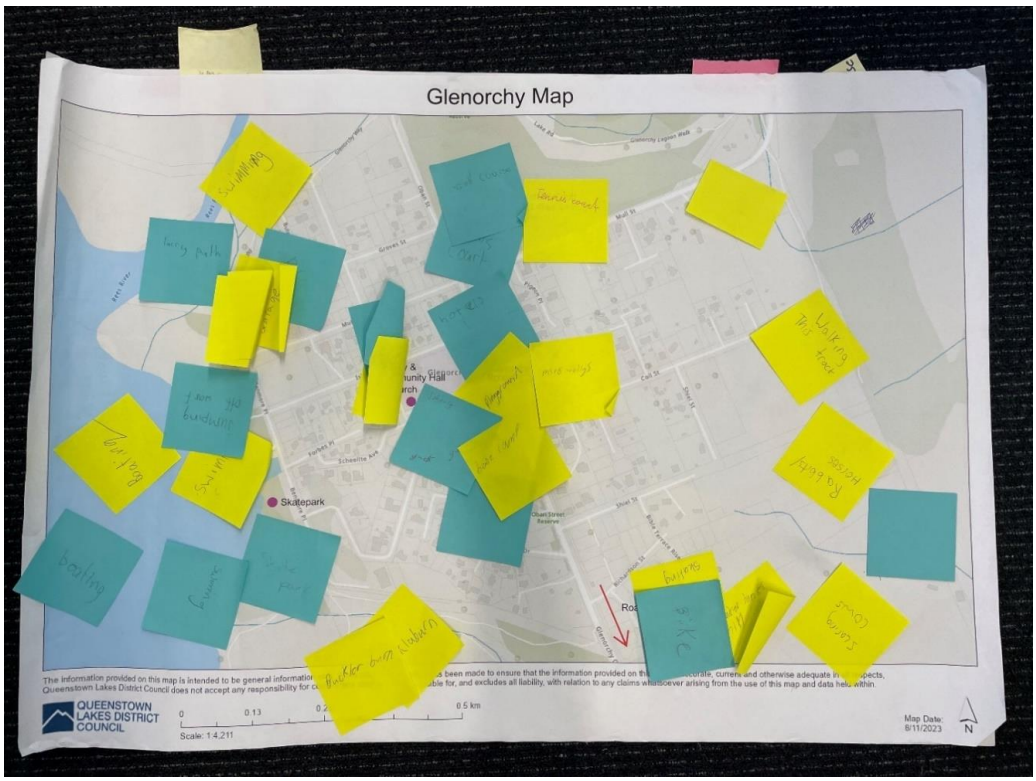

Figure 2-1: One of the maps produced at the focus group with Glenorchy Primary School students.

The semi-structured 'community drop-in' interviews were a mix of interviews at dedicated times, which were pre-arranged through an online booking system, and interviews conducted at the Glenorchy Playgroup, which the social research team attended on 14th November 2023.[5]

[5] The social research team also made themselves available for Glenorchy Primary School parents to 'drop-in' for an interview at the School on 13th November, however there was no uptake.

Figure 2-2: Push chairs parked outside the Community Hall for the Glenorchy Playgroup on 14th November 2023

The resident and business survey was undertaken from 24th November – 8th December 2023. The survey questions explored resident's and businesses' reliance on accessing wider areas such as Queenstown, and their vulnerabilities and resilience to natural hazards (refer to Appendix B for a copy of the survey questions). The survey was designed to supplement the research that had been undertaken to date and gather additional insights from the community. The survey also asked business questions to develop a stronger understanding of the business community (e.g., number of employees, revenue).

The secondary social and economic data sources that were used are summarised in Table 2-2 below.

Table 2-2: Secondary social and economic data

Social secondary data	Economic secondary data
• 2018 Census data • Social reports about the area (e.g., local history) • Community plans (e.g., the Glenorchy Community Plan 2001, and Glenorchy Community Visioning Report 2016) • GIS maps	• Queenstown Infometrics data (e.g., number of jobs, number of business units, GDP for Industry, GDP for Tourism) • Glenorchy Infometrics data (e.g., number of jobs, number of business units, GDP for Industry) • Visitor Survey data • QLDC population and visitor projections 2023-2053 • QLDC visitor spending data by sub-area

Social secondary data	Economic secondary data
	• QLDC tourism data • QLDC transport data (e.g., daily road/trip numbers in and out of Glenorchy township) • Destination Queenstown tourism data • DOC track and hut estimates

2.4 Step 4: Identify and evaluate social and economic impacts of indicative natural hazard scenarios (specified by Otago Regional Council)

The International Panel for Climate Change (IPCC) provides a framework to identifying risks in relation to climate change and natural hazards. Part of this processes is understanding how the community currently experiences natural hazards in terms of exposure, sensitivity and adaptive capacity.

This step is an assessment of the potential socio-economic consequences of indicative natural hazard scenarios (specified by Otago Regional Council) under status quo conditions. Status quo conditions can be understood as the current community and the natural hazard management measures currently in place.

Figure 2-3 details the assessment process from a socio-economic perspective and how it fits into the Strategy's wider process. This framework has been adapted from Birkmann et al. (2013).

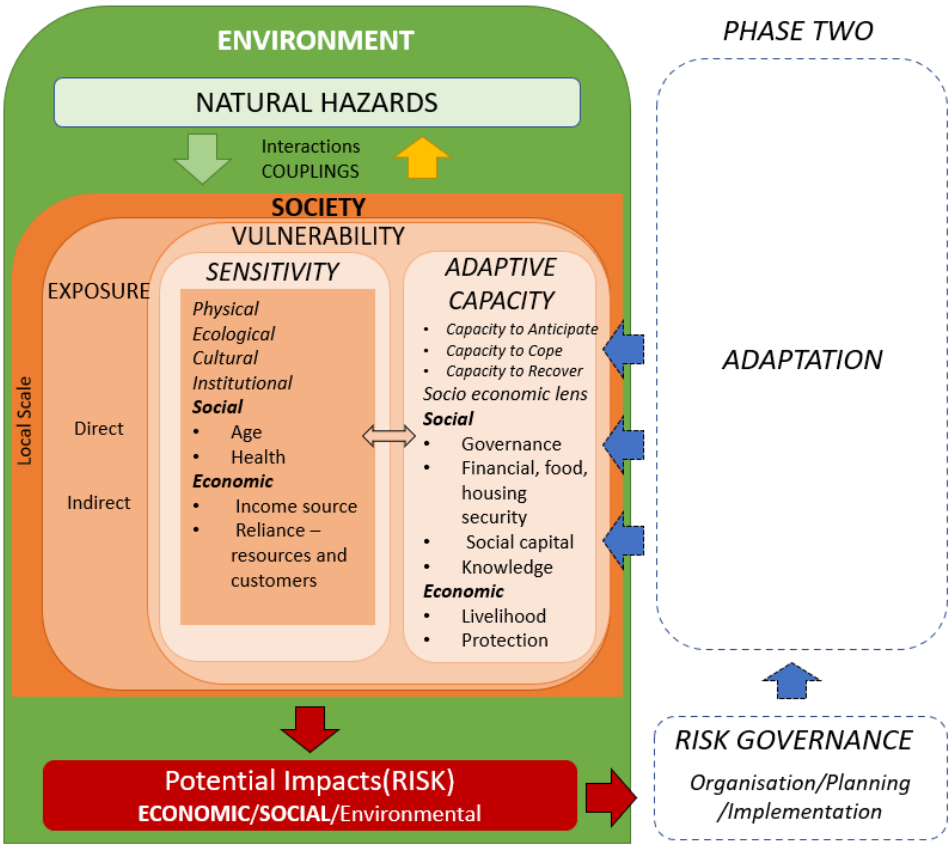

Figure 2-3: Assessment process. Source: (Adapted from Birkmann et al., 2013)

The assessment process was undertaken in two parts:

- **Part 1:** Identifying the current sensitivity and adaptive capacity of the community with regards to social and economic factors. Guidance for social and economic factors was taken from the Social Vulnerability Indicators for Flooding in Aotearoa (Mason et al., 2021) and Economic Vulnerability and Resilience (Briguglio et al., 2008).
- **Part 2:** Socio-economic impact assessment of indicative natural hazard scenarios (specified by Otago Regional Council). Three indicative natural hazard scenarios were provided by ORC, and are detailed in Appendix E.

2.4.1 Identification of potential social impacts

A high-level assessment of the potential social consequence of a natural hazard event was undertaken. The following changes were considered. According to Vanclay (2003), social impacts are changes to one or more of the following:

- People's way of life – this is how they live, work, play and interact with one another on a day-to-day basis.
- Their political systems – the level in which people are able to participate in decisions that affect their lives.

- Their environment – the quality of the air and water people use, the availability and quality of the food they eat, the adequacy of sanitation, their physical safety and their access to resources.
- Their health and wellbeing- health is a state of complete physical, mental, social and spiritual wellbeing.
- Their personal and property rights – particularly whether people are economically affected or experience choice in decision made over their property.
- Their fears and aspirations – their perceptions about their safety, their fears about their future of their community and aspirations for the future of their community.

The social impact assessment methodology considers the impact, cause, people affected, extent, duration and severity.

2.4.2 Identification of potential economic impacts

A high-level assessment of the potential economic consequence of a natural hazard event was undertaken. Economic impacts can be direct or indirect impacts. Types of direct impacts include physical infrastructure damage and loss, and displacement of crops or animal stock, while indirect impacts capture changes to economic activities as a result of these changes. The relevant economic impacts are summarised as:

- Damage to households
- Repair of capital infrastructure
- Cost of response and relief
- Short-term economic losses
- Long-term economic losses
- Employment
- Insurance losses
- Less investments.

The economic assessment methodology considers the impact, cause, people affected, extent, duration and severity.

3 Assumptions and limitations

In the process of this assessment the following assumptions have been made:

- This assessment is high level, only due to the level of information on natural hazard risks that was available at the time the indicative natural hazard scenarios (specified by ORC) were formed. A separate piece of work is being undertaken by Beca Ltd in parallel to this SEIA to quantify natural hazard risks at the Head of the Lake. This report will be finalised in mid 2024.
- This SEIA is not a cultural impact assessment; potential cultural impacts will be screened through a te ao Māori lens by Aukaha, an iwi-owned environmental consultancy group on behalf of Otago rūnaka.
- Replacement costs of the road network are estimated at 0.7 million per km for local roads, and 4.5 million per km for State Highways (Te Manatū Waka, 2023). This is an indicative cost based on the national average, and considers land, formation, pavements, drainage, traffic facilities, bridges, culverts and subways, as well as other structures.
- Median house price of $900,000 in Glenorchy in 2023 (OneRoof, 2023).

4 Socio-economic area of influence

The socio-economic area of influence is the area in which the potential social and economic impacts are considered. This area includes the communities within the SEIA study area (the Head of the Lake) and the communities within the wider area, in relation to economic and social interdependencies. The spatial approximation of these areas is outlined in Figure 4-1 below:

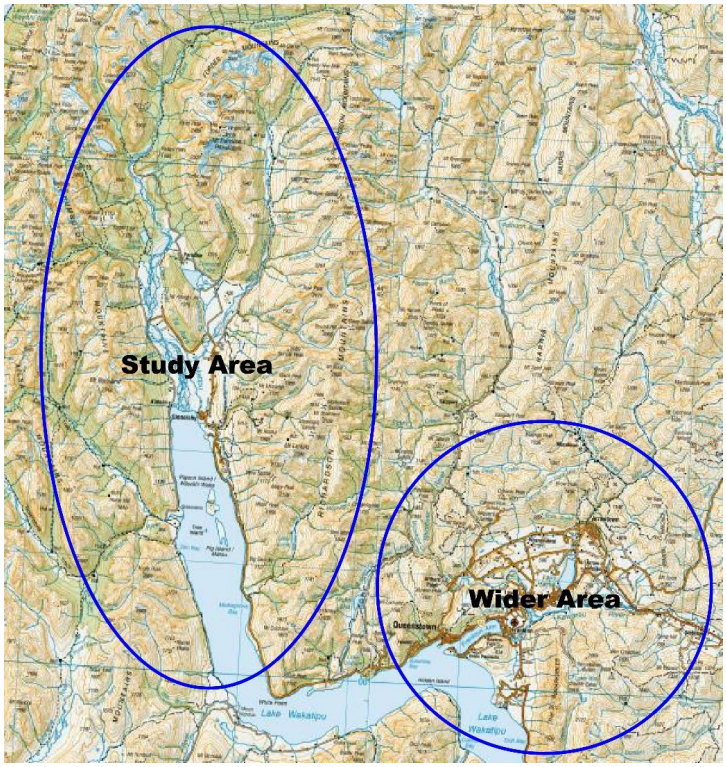

Figure 4-1: Socio-economic area of influence

- **SEIA study area** (the Head of the Lake): this includes the township of Glenorchy and the surrounding rural areas of Kinloch, Paradise, Greenstone, Routeburn, Dart Valley, and Rees Valley.
- **Wider area:** this includes the businesses (and some employees) based in Queenstown, or the wider area that are dependent on the Head of the Lake to operate their business.

5 Community baseline - Head of Lake Whakatipu – Whakatipu-wai-Māori

The SEIA study area (the Head of the Lake) comprises both the Glenorchy township and the greater Glenorchy area, also known as the Head of Lake Whakatipu, or more informally as the 'Head of the Lake'. This encompasses the surrounding rural areas of township of Kinloch, Paradise, Routeburn, Greenstone, Caples, Te Awa Whakatipu / Dart River Valley, and Puahiri/Puahere / Rees River Valley. (refer to Figure 5-1). The project area is referred to throughout this report as 'the Head of the Lake'.

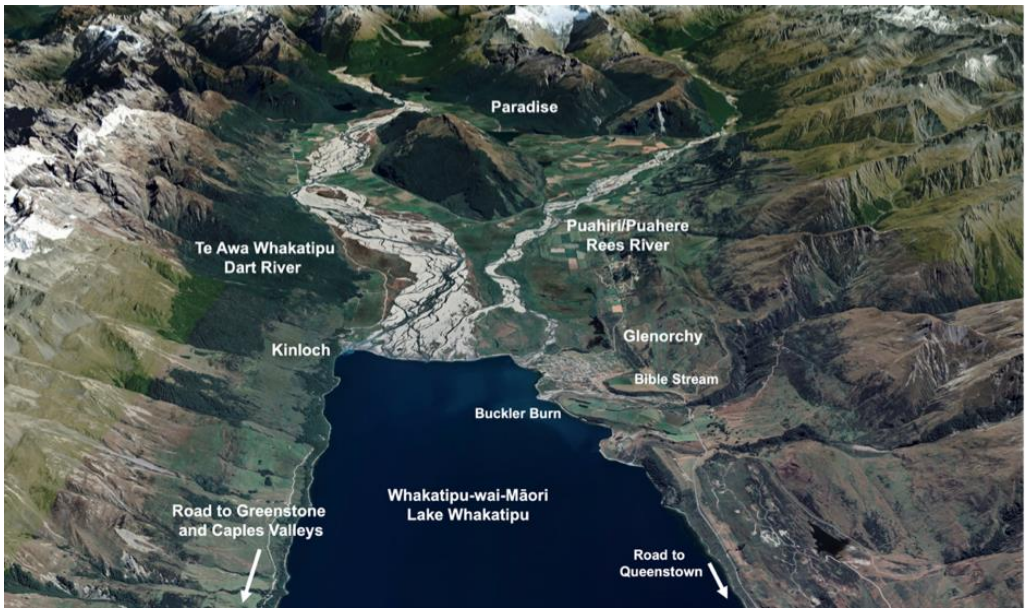

Figure 5-1: Head of Lake Whakatipu area. Source: (MacKenzie, 2023)

To the western side of the Head of the Lake is the Kinloch settlement, and the Greenstone, Caples, Routeburn, and Dart River Valleys. This side of the Head of the Lake is sparsely populated, centred around farming, outdoor pursuits (in particular notable walks such as the Routeburn track) and corresponding accommodation provisions.

The Rees and Dart River Bridges are critical pieces of infrastructure connecting the western side of the Head of the Lake with the greater Glenorchy area, via the Kinloch, Routeburn, Glenorchy-Routeburn and Glenorchy-Paradise Roads. The bridges were constructed in 1920 and 1974 respectively (Access Glenorchy, n.d.; Glenorchy Community, n.d.b). The journey from Glenorchy to Kinloch takes approximately 25 minutes.

On the eastern side of the Head of the Lake area is the Glenorchy township, with additional residences to the south (back towards Queenstown) and to the north up the Rees Valley, including Paradise.

The Glenorchy-Queenstown Road is the only road connecting the Head of the Lake with Queenstown. It was opened in 1962 and the journey from Glenorchy to Queenstown takes around 45 mins to 1 hour (46km). Access to Queenstown is also possible by boat and plane.

Table 5-1 details the road distance and travel times from Glenorchy to the main towns/cities in the wider region.

Table 5-1: Road distances and travel times from Glenorchy to the main cities/towns in the wider region

City/town	Road distance from Glenorchy	Travel time from Glenorchy
Queenstown	46 kilometres	45 mins/ 1 hour
Te Anau	217 km	3 hours
Gore	212 km	2 hours 50 minutes
Dunedin	328km	4 hours 30 minutes

5.1 Mana whenua

Information for this section has largely been sourced from the Cultural Values Assessment prepared by Takau (2021) on behalf of the rūnaka of Otago. This assessment does not assess the potential Māori cultural impacts of natural hazards in the area. This requires a specific cultural impact assessment.

Mana Whenua refers to those who hold the mana or authority over a specific area. In the Queenstown Lakes District, mana is held by seven papatipu Rūnaka:

- Otago Rūnaka
  - Te Rūnanga o Moeraki
  - Kāti Huirapa Rūnaka ki Puketeraki
  - Te Rūnanga o Ōtakou o Hokonui Rūnanga
- Murihiku Rūnaka
  - Te Rūnanga o Waihōpai
  - Te Rūnanga o Awarua
  - Te Rūnanga o Ōraka-Aparima.

These rūnaka are represented by two rūnaka-owned environmental consultancies; Aukaha (the four Otago rūnaka) and Te Ao Marama Incorporated (the three Southern rūnaka). The Cultural Values Assessment was prepared by Takau, only on behalf of the rūnaka of Otago.

5.1.1.1 Significance of the area to Mana Whenua

As described in the Takau (2021) Cultural Values Assessment, the Head of the Lake contains many landscapes and places of significance to mana whenua. Wāhi Tūpuna[6] include Te Awa Whakatipu (the Dart River) and Puahiri/Puahere (the Rees River), Ōturu (Diamond Lake) and Wāwāhi Waka (Pigeon Island) (Takau, 2021). Notably, Te Awa Whakatipu (the Dart River) and Puahiri/Puahere (the Rees River) were once well-used ara tawhito (trails), particularly to pounamu sources in the area. Te Awa Whakatipu was also part of a well-known network of ara tawhito which connected Whakatipu-wai-Māori with Whakatipu Waitai (Martins Bay). The network of trails also included Te Komama (Routeburn), Whakatipu-ka-tuku/Ōkare (Hollyford River) and Tarahaka-Whakatipu (Harris Saddle) (Takau, 2021).

As detailed by Takau (2021):

> "*Traditionally, the wider Whakatipu-wai-Māori area, along with its associated valleys and waterways*
>
> *held significance as places to recuperate in between seasons and after conflicts. There were several nohoaka (temporary camp sites) at the head of Whakatipu-wai-Māori (Lake Wakatipu) and different*

[6] Wāhi Tūpuna are landscapes and places that embody the relationship of mana whenua and their culture and traditions with their ancestral lands, water, sites, wāhi tapu (sacred places), and other taoka (treasure).

kāika (permanent settlements) located throughout the wider Whakatipui-wai-Māori area. An

extensive network of ara tawhito (traditional travel routes) followed the several awa (rivers) and roto (lakes) and these travel routes became the arteries of economic and social relationships for Kāi Tahu.

Many of today's key transportation routes follow these traditional trails. There was also an abundance of kai (food resources) in the area as well as other traditional resources such as tussock, raupō, tī

kōuka and harakeke which were often harvested to make mokihi (temporary reed rafts), for medicinal purposes, weaving and clothing."

5.2 History

5.2.1 Cultural history

According to Takau (2021), it is written that the Waitaha people arrived in Te Wai Pounamu on a great canoe called Uruao. The Uruao was captained by Rākaihautu, the son-in-law of the Waitaha chief Matiti. There is a proverb associated with Rākaihautū which reads; "Ko Rākaihautū te takata nāna i timata te ahi ki tenei motu." (It was Rākaihautū who lit the first fires on this island.)

The oral tradition of "Kā Puna Wai Karikari o Rākaihautū" tells of how the great lakes of Te Wai Pounamu (the South Island) were dug by Rākaihautū. It is said that Rākaihautū used his famous kō (Polynesian digging tool) called Tū Whakaroria to perform divination rituals and subsequently form the major lakes of Te Wai Pounamu, which included Whākatipu-Wai-Māori, Wānaka and Hāwea. Thus, the genealogies of the Waitaha people can be traced from Rākaihautu through to his living descendants, the modern day Kāi Tahu (Takau, 2021).

5.2.2 Pioneering history

Scheelite mining, gold mining, saw milling, farming and tourism are all features of the collective history of the Head of the Lake and what has contributed to the current sense of place and community.

Europeans first settled in the area during the mid-late 19th century, initially establishing farming activity. This was followed by the gold rushes of Central Otago in 1862 which brought prospectors to the district. Later, the Glenorchy township developed to a visitor industry centred around the Routeburn Track in the 1870s (Access Glenorchy, 2023). The pioneering history of the Head of the Lake is summarised in Figure 5-2 below.

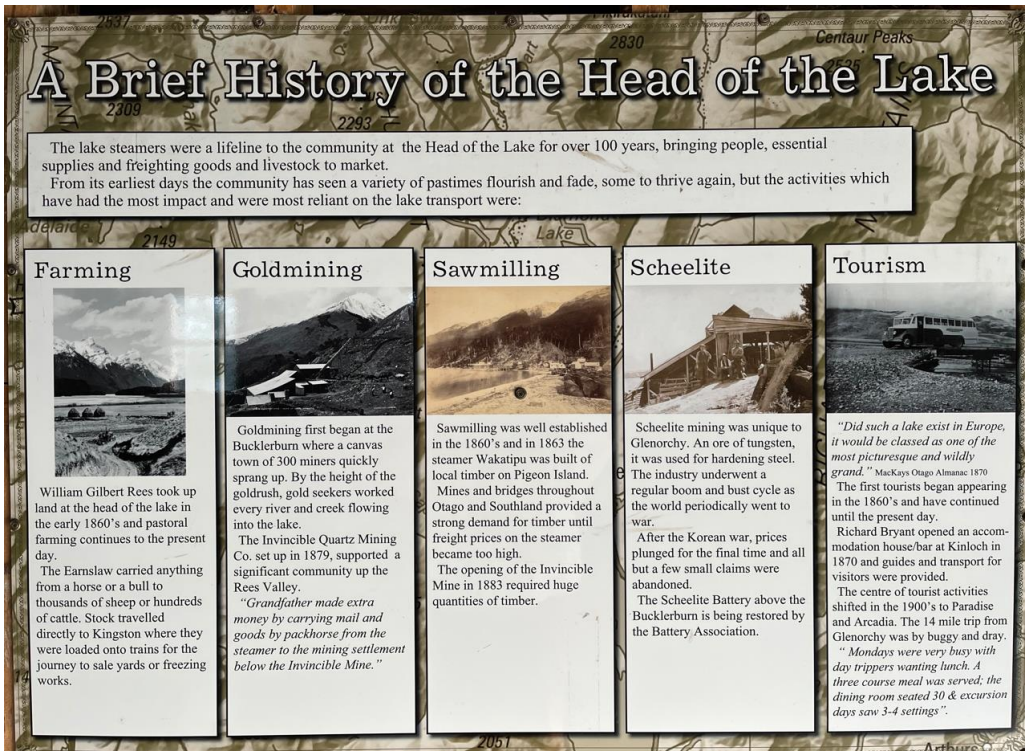

Figure 5-2: Photo of community history poster located in the Glenorchy Wharf Shed (taken during a site visit)

Glenorchy township was surveyed in 1864 and Kinloch in 1880. Initially, the Glenorchy township was a service town for local industry with just a hotel and store. The first school was established in Kinloch in 1884. After being relocated to several other locations, the Glenorchy School was established in its current location in 1939 (Glenorchy School, 2023). Glenorchy acquired its first community hall in 1943 (Access Glenorchy, 2023).

The Glenorchy-Queenstown Road was constructed in 1962 (Queenstown Lakes District Council, 2005). This provided road access to and from the Glenorchy township for locals and visitors. Prior to the construction of the road, lake steam ships served as a lifeline to the community for over 100 years, transporting people, livestock, and essential supplies and freighting goods to market. Notably, early visitors to Head of the Lake would arrive on the TSS Earnslaw, which took two hours, and departed from Queenstown three times a week (Glenorchy Community History, 2023).

5.3 People

The New Zealand Census collects data per spatial area. For the Head of the Lake, the relevant spatial area is referenced as Glenorchy Statistical Area 2 (SA2), however this geographically covers the broader area outlined in Figure 5-3.

As of 2018, the median age at the Head of the Lake is 40 years[7]. This is 3 years older than the New Zealand median age of 37 years (StatsNZ, 2018). Compared to New Zealand and the Otago Region, there are fewer older (11% of the population are aged 65 years and older) and younger (11% of the population is between 0-15 years of age) members of the community. In Otago as of 2018, approximately 17% of the population are aged under 15 years, while 16% are aged over 65 years. In New Zealand 20% are aged under 15 years and 15% are aged over 65.

The largest ethnic group at the Head of the Lake is European (92%) followed by Māori (5%). Compared to the national population, the Head of the Lake has a higher portion of European (70% of the national population) and a lower portion of Māori (17% of the national population) (StatsNZ, 2018).

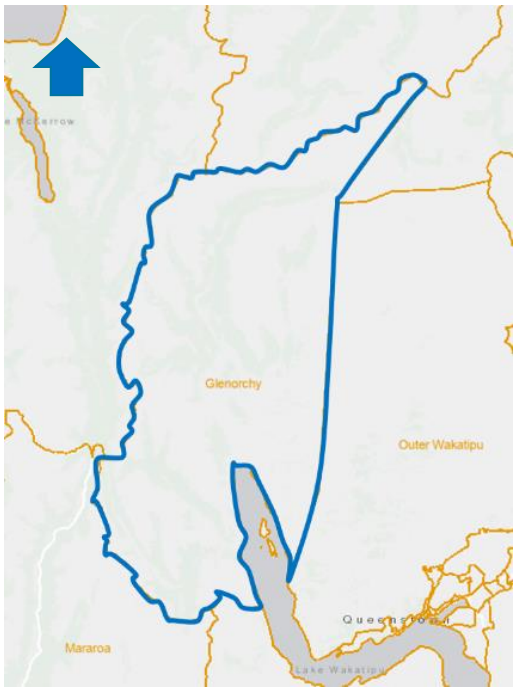

Figure 5-3: Glenorchy SA2 Statistical Area. Source: (Stats NZ, 2022)

Approximately 64% of people residing at the Head of the Lake were born in New Zealand and 36% of the population was born overseas, this is almost 10% higher than the national population, of which 27% were born overseas (StatsNZ, 2018). The locals that participated in interviews and focus groups as part of this research spoke of the community being diverse and made up of people from a range of nationalities and backgrounds.

> *"Radically different people – diverse people from many backgrounds and walks of life, however everyone respects each other" – Research participant*[8]

Based on discussions with research participants, there appears to be a relatively stable core part of the community. However, due to the nature of the work available (seasonal hospitality and tourism work), and those who live in the area part-time, there is turnover of some of the population. At the time of the 2018 Census, approximately 70% of the population had the same address as they did in 2017 (compared to 79% nationally). Of those with a different address in 2018, approximately 7% had relocated from overseas and 21% had relocated from elsewhere in New Zealand (StatsNZ, 2018). Some of the reasons for moving to the

[7] Statistical information unless specified otherwise has been sourced from the Statistics New Zealand Tatauranga Aotearoa (Stats NZ) Census Data. The last published Census data is 2018. It is acknowledged that there are limitations to this data and the population has changed since this time. Where possible more recent data has been sourced.

[8] Quotations from research participants are from the interviews and focus groups with stakeholders, residents and businesses that were conducted as part of this research.

area cited by research participants were the environment, outdoors, lifestyle and removing oneself from the stressors of an urban/busy lifestyle.

"If you are here for long enough, it gets under your skin - its a lovely place" – *Research participant*

5.3.1 Residential population growth

Between 2013 and 2018 the population grew by approximately 19%. This represents a high rate of population growth, compared to the Otago region, which grew 10% over the same period (StatsNZ, 2018). There has been steady growth over time as illustrated in Figure 5-4 below.

Population growth in the Head of the Lake 2006-2012

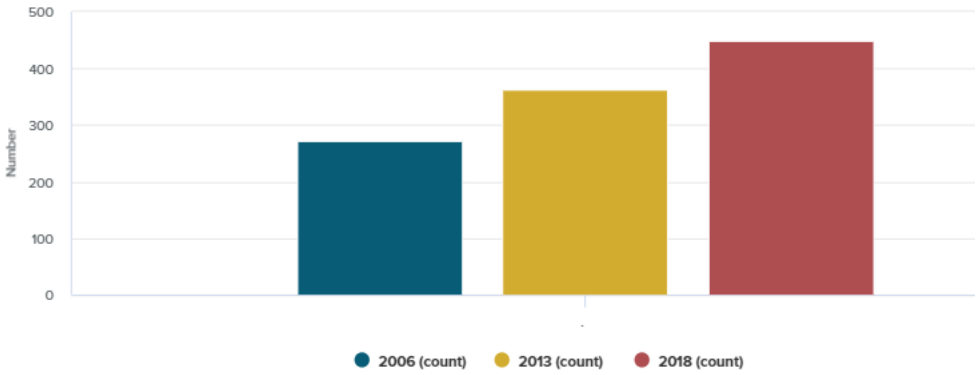

Figure 5-4: Population growth data for the Glenorchy SA2 Source: (StatsNZ, 2018)

Following the 2018 Census, the resident population in the Head of the Lake was recorded at 450 people. In 2023, it was estimated that the combined population of 'Glenorchy township' and 'Glenorchy Other' is approximately 560 residents (QLDC, 2023a). This reflects a growth of around 110 people in the last 5 years (QLDC, 2023a) (refer to Appendix D for population estimates).

From 2023 to 2053, this pattern of residential growth is expected to continue, with an annual estimated increase of approximately 2.3%. By 2053, the combined population of 'Glenorchy township' and 'Glenorchy Other' is forecasted to reach 840 residents (QLDC, 2023a).

These figures highlight a steady and anticipated growth in the resident population within the area over time, and potential for increased development and infrastructure requirements within this community should this forecasted growth occur.

5.3.2 Visiting Population and Growth

In 2023, the anticipated combined total daily visitors in the areas defined as 'Glenorchy township' and' Glenorchy Other' is estimated to be 390 people on an average day, and up to 1040 people on peak days (QLDC, 2023a). Looking ahead to 2053, there is projected growth of 2.9% annually in the number of average daily visitors, resulting in an estimated combined visiting population of about 650 people. On peak days, visitor numbers are also projected to increase by the same rate, reaching around 1690 people (QLDC, 2023a).

It is worth noting that a significant portion of the visiting population growth is expected to occur between 2023 and 2033, at a rate of 6.8% annually on average days and 6.1% annually on peak days.

5.3.3 Education

At the time of the 2018 Census, 10% of the population were in full-time study and 3% in part-time study (StatsNZ, 2018). The proportion of the population with a higher education degree (Bachelor's degree or higher) was 29%, which is higher than the than the Otago region (14%) and national population (15%) (StatsNZ, 2018).

In 2023, approximately 34 children were enrolled at Glenorchy Primary School.

5.3.4 Health

There are few indicators of health available for the Head of the Lake area. At the time of the 2018 Census, no residents aged 65 or over recorded experiencing activity limitations. However, 2.6% of the total resident population reported to have one or more activity limitations (the highest percentage being those 5-15 years of age at 11%). This represents a lower percentage when compared to the Otago region, where 6.6% of the population reported having an activity limitation (StatsNZ, 2018). Similarly, participants in the most recent QLDC Quality of Life Survey self-reported relatively high levels of physical health (74%), compared to Queenstown (61%) (Versus, 2024).

With regards to mental health, there are limited statistics for the Head of the Lake. Glenorchy participants in the QLDC Quality of Life Survey self-reported relatively high levels of mental health (63%), compared to Queenstown (43%) (Versus, 2024). However, based on discussions with research participants, there are mental health issues present amongst the population. Social isolation can be a contributor to this as it can limit the primary care interventions available. Glenorchy participants in the QLDC Quality of Life Survey cited cost (47%), time off work (18%), and location (12%) as the largest barriers to accessing health care.

Primary care at the Head of the Lake is limited to a Practice Nurse (refer to 'Services and amenities' section). Therefore, those in the area with a high level of health needs may need to move out of the area to seek the require health care. There is no public transport and limited services within the area so those with mobility limitations would require assistance to access services. Based on discussions with research participants, it appears the population is not an overly 'healthcare seeking' population and often self-manage health concerns due to the distance to many of the required health services.

5.4 Households

At the time of the 2018 Census, there were 195 occupied dwellings, 72 unoccupied dwellings and 3 under construction (StatsNZ, 2018). Since 2018, most residential growth has occurred in Alfred's Terrace; a 60-lot residential development located on the eastern side of Glenorchy on Oban Street as you enter the township from Queenstown.

Figure 5-5: Alfred Terrace Development. Source: (Alfred Terrace Website, 2023)

Some lifestyle blocks have also been developed, particularly around the Glenorchy-Paradise Road area, as well as large homes in private gated communities or estates (largely catering to overseas owners).

Based on site visit observation, the housing stock in the Head of the Lake consists of standalone homes, some tiny homes, caravans, campervans and house buses. Most homes rely on a wood burner for heating. 33% of households have heat pumps, but less would have this as their sole source of heating for the home (StatsNZ, 2018). Due to potential power cuts, most homes have alternate heat sources that are not reliant on power (e.g., wood or gas burners).

Approximately 72% of households in the Head of the Lake own or partly own their home, either privately or through a family trust. Based on discussions with research participants, a portion of these are holiday homes that are either used by the owners or rented out to holidaymakers. Historically, there has not been a large long-term rental market in the area, however this has changed slightly in response to changes to the Residential Tenancies Act 1986. Previously, property owners would rent their home on a short-term basis, to allow them to use it seasonally, or as a holiday home. However, this has not been possible in recent times due to the new regulations which increase the amount of notice landlords must give to end a tenancy.

A portion of the community are 'temporary residents', those who own holiday homes or live there part-time. Approximately 37% of privately owned homes were unoccupied as of the 2018 Census (StatsNZ, 2018).

5.5 Community

5.5.1 Values and aspirations

The Head of the Lake community has a strong and clear set of shared values and aspirations, which are documented in 'Glenorchy – Head of the Lake 2001 Community Plan' and 'Shaping our Future: Glenorchy Community Visioning Report 2016'.

As documented in the 2001 Community Plan, the Head of the Lake is:

> *"…a vibrant community where lifestyle and 'freedom' are highly valued together with the peaceful, unspoilt rural environment and the dynamic interaction of the spectacular landscape, heritage and wilderness".*

In this 2001 Community Plan, residents identified values of being safe, caring, self-reliant, working together, being welcoming to visitors, and having residents who respect the environment (QLDC, 2001). In regard to the social, cultural and natural environment, residents valued the history of the area, the rural atmosphere, peacefulness, magnificent landscape, and wilderness 'at its doorstep'. As part of the process of developing the 2016 community vision, these values were identified as still being relevant to the community.

Attendees also valued having a community that:

- is unified in maintaining and enhancing the unique, diverse and innovative characteristics of the community
- supports and embraces a local boutique economy, values their 'Head of the Lake' brand and works together to promote and protect Glenorchy's unique environment and attractions
- values all sections of its population and promotes health, wellbeing and continued education
- has the right infrastructure in the right place to support residents and their interests and businesses and allows for tourism without placing undue strain on the resident population.

These values were incorporated in the 2016 community vision for the area:

> *"A unique, inclusive community that fosters and embraces individuality, diversity and innovation, encourages resilience* and promotes community vitality and collaboration. The Glenorchy community has a collective strong voice that advocates for positive change.*
>
> *Glenorchy has the infrastructure to support a thriving boutique local economy in keeping with the rural landscape, actively respects and enhances the natural environment, collectively works towards providing their own resources (self-sufficiency)."* (Shaping our Future, 2016):

Specifically, the community vision includes (of relevance):

- All aspects of the community (including new members) are engaged in decision making, and collectively work towards achieving our vision for the future.
- A community that is largely self-sufficient in food and energy.
- The collective community voice is heard and listened to by relevant agencies e.g., QLDC.
- Glenorchy village culture is retained - safe, welcoming, communal, caring and a 'muck in together' attitude.
- A healthy village with all essential community services e.g., health, education for residents and visitors.
- Glenorchy is well connected, with viable transport options and access to the latest technology (e.g., phone and internet) (Shaping our Future, 2016).

The values and 2016 vision are consistent with the research undertaken as part of this assessment. The values cited in discussions with research participants are summarised in Figure 5-6.

Figure 5-6: What research participants said they value about the area and/or what they like about living in the area.

From discussions with research participants, residents highly value the strength of the local community, which comes together in difficult times. Community spirit is particularly strong amongst older locals and as described by a research participant, this "rubs off" on others (e.g., new residents). Community spirit is also reflected in the relatively vast number of community volunteers, groups, organisations, events, and celebrations of the European heritage of the area, cited by the research participants.

Based on discussions with research participants, residents value knowing lots of people in the community and feeling cared for by the community (e.g., a research participant recalled incidences where people checked up on ageing members of the community).

> *"Everyone helps each other out like family because if your car broke down on the road, you would hope people stopped for you, and you would stop for people".* – *Research participant*

Research participants also valued how welcoming the community is. A large proportion of residents have lived elsewhere or come from other parts of the country or world, and have been welcomed into the community. This is reflected in the results of the most recent QLDC Quality of Life Survey, whereby 92% of Glenorchy participants assessed their community as "welcoming" (Versus, 2024). Having places to come together and opportunities for connection and belonging was identified as being important to the community.

Whilst isolation, "the number eight wire", and self-sufficient lifestyles were valued, people also valued local services and amenities such as Glenorchy Motors, the Community Nurse, the School and the Library. People also valued internet access, access to the lake, river and mountains, and roading access to Queenstown; particularly to access health and medical care. Many research participants voiced the desire for local and central government to consider the importance of road connectivity (or sustainable alternatives during closures) for both the local and wider community.

5.5.2 Arts, culture and heritage

Based on discussions with research participants, arts, culture and heritage is strongly valued by the community. Community groups have done a lot of historic archiving and expressed a desire to be more collaborative and connected to other heritage groups in the Queenstown Lakes District. The community was recently involved in developing a vision for the future of arts, culture and heritage in the Queenstown Lakes District. A visual summary of engagement with the Glenorchy community is provided in Figure 5-7.

Figure 5-7: QLDC's visual representation of engagement with the Head of the Lake on a vision for the future of arts, culture and heritage in the Queenstown Lakes District. Source: (QLDC, 2023b)

The community has expressed to QLDC that they would like more space for the local museum. Research participants also shared that there is a community group working through an application to achieve 'Dark Sky' status. Based on site observations, historic monuments (e.g., the First World War Memorial) and the local cemetery are points of interest in the community, particularly in relation to the potential impacts of natural hazards.

5.5.3 Social Cohesion

Based on discussions with research participants, it appears that the community regularly comes together to achieve community goals and create the community they want for themselves. This is evident in the wide range of clubs and organisations formed (refer to the 'Clubs/Organisations section), considering the population size and component of temporary residents. Overtime, as more new members have arrived the familiarity factor of 'everyone knowing each other' is likely to have lessened, however based on discussions with research participants, most new members to the community find a way to connect in one form or another (e.g., through the play centre and school or other local interests). Some research participants

considered that the 'pioneering spirit' of the community is more evident in longer standing members of the community who have lived through higher degrees of isolation and lower levels of access to amenities. It can therefore be inferred that newer members may be more reliant on conveniences and constant connectivity with Queenstown. Information on the community website[9] provides people with advice on how to settle into the community and how to 'survive' with advice on resources and readiness required. Although it was recognised by research participants that there is a range of members within the community with different views and opinions, most agreed that the community come together when required as illustrated by some of the quotes from research participants in Figure 5-8 below.

Figure 5-8: Research participants sentiments on community cohesion and diversity

5.5.4 Governance

The Head of the Lake is situated within the Queenstown-Wakatipu Ward of the Queenstown Lakes District (refer to Figure 5-9 - left), which forms part of the Otago Region (refer to Figure 5-9 - right). It is therefore governed by the Otago Regional Council (ORC) and the Queenstown Lakes District Council (QLDC) (refer to Figure 5-10). The Mayor of the area covers the whole Queenstown Lakes District. The Member of Parliament for the area is part of the Southland Electorate.

[9] https://www.glenorchycommunity.nz/

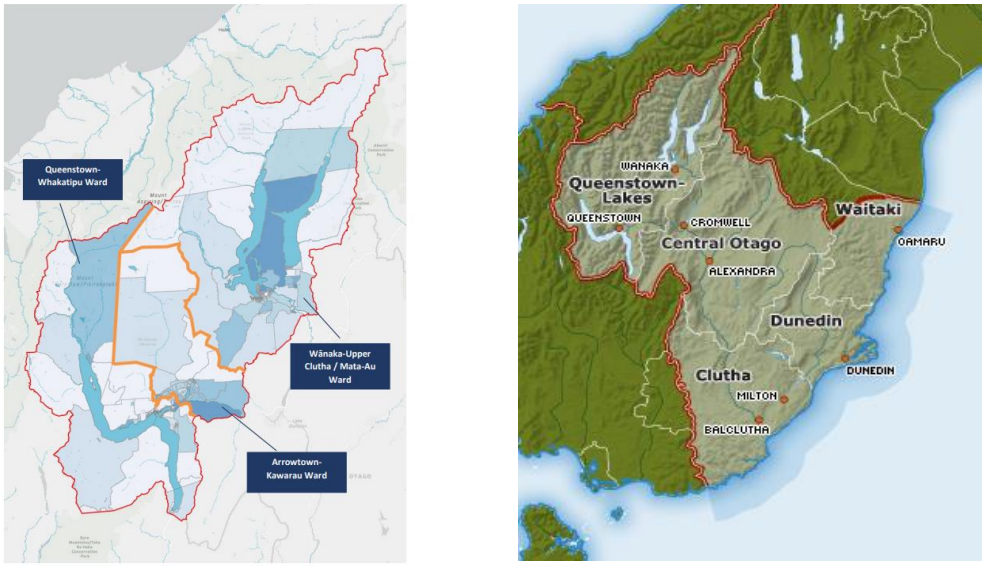

Figure 5-9: Left: Queenstown-Wakatipu Ward within the Queenstown Lakes District (QLDC, n.d.), Right: Otago Region boundary. Source: (localcouncils.govt.nz, n.d.)

This governance structure is illustrated in Figure 5-10 and discussed in further detail below.

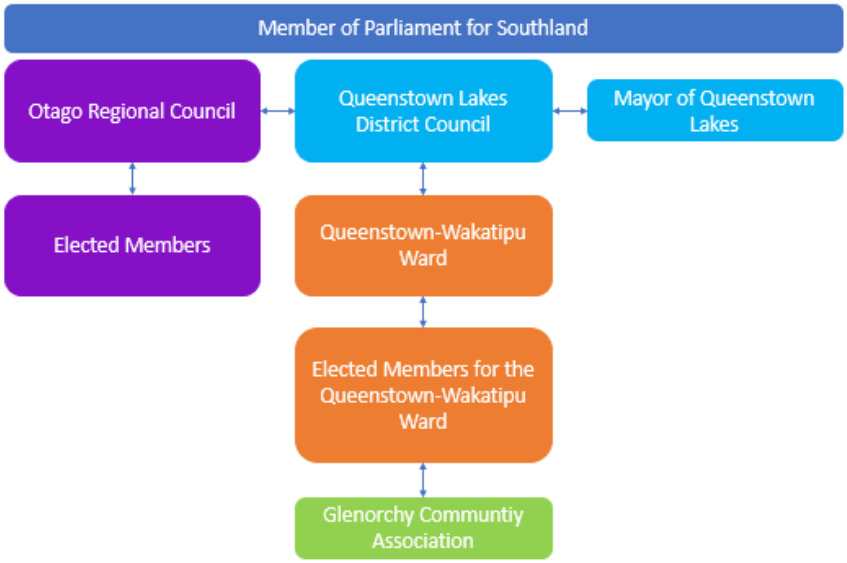

Figure 5-10: Governance structure of the Head of the Lake (figure created for the purposes of this report)

5.5.4.1 Otago Regional Council

As a Regional Council, ORC is responsible for sustainably managing Otago's natural resources of land, air and water on behalf of the community. ORC is also responsible for promoting the economic, social, cultural and environmental wellbeing of the region (Otago Regional Council, n.d.)

ORC is governed by 12 councillors, who are elected by residents every three years to represent the regions four constituencies. There are currently three councillors for the Dunstan constituency which covers the Central Otago District and Queenstown Lakes District territorial areas (Otago Regional Council, n.d.).

In relation to natural hazard management, ORC administers the Otago Civil Defence Emergency Management (CDEM) Group as part of its Civil Defence Emergency Management responsibilities. There are six partner councils who make up the CDEM Group:

- Otago Regional Council
- Central Otago District Council
- Dunedin City Council
- Clutha District Council
- Waitaki District Council
- Queenstown Lakes District Council.

The Group has Emergency Management Advisors in each of these councils, who are responsible for development and delivery of emergency management activities to their communities (Emergency Management Otago, n.d.a).

5.5.4.2 Queenstown Lakes District Council

As a Territorial Authority, QLDC is responsible for roading, reserves, sewerage, building consents and land use and subdivision. It also has a general duty to monitor the state of the environment of the district, the efficiency and effectiveness of policies and methods in policy statements and plans, the efficiency and effectiveness of local authority processes (including timeliness, cost, and overall satisfaction) and the exercise of resource consents within the district (Environment Guide, n.d.).

QLDC is governed by Councillors and Community Board Members, which are elected every three years. Whilst the Head of the Lake area does not have a designated QLDC Councillor, currently one of the four elected members for the Queenstown-Wakatipu Ward is Glenorchy-based.

In relation to natural hazard management, QLDC is required under the Civil Defence Emergency Management Act 2002 to provide a coordinated and integrated approach to the way significant risks and hazards are managed in the district across the 4R's (reduction, readiness, response, recovery). The Otago CDEM group works closely with QLDC, emergency services and the Head of the Lake community to prepare for civil defence emergencies, such as floods and earthquakes (Emergency Management Otago, n.d.b).

5.5.4.3 Glenorchy Community Association

The Glenorchy Community Association (GCA) is a community-based incorporated society. The GCA's primary function is to promote the interests, needs and well-being of the Glenorchy community to decision makers, including government and other local decision makers. The GCA also supports community initiatives and collects community views to advocate and negotiate specific matters on behalf of the community, when requested. Membership is made up of residents and property owners living in the Glenorchy township and the Head of the Lake. The Board is annually elected, and anyone can attend the GCA's monthly meetings, held at the Community Hall on the first Thursday of each month (except January). The Board consists of duty elected officers, being a Chairperson, Treasurer/Secretary and general committee members.

a. Glenorchy Community Response Group

A Glenorchy Community Response Group (CRG) has been convened which comprises a number of CDEM trained community volunteers, coordinated by an Otago Emergency Management Advisor (EMA) (refer to 'Services and amenities' section for further detail).

The Head of the Lake's emergency management governance structure is illustrated in Figure 5-11 below.

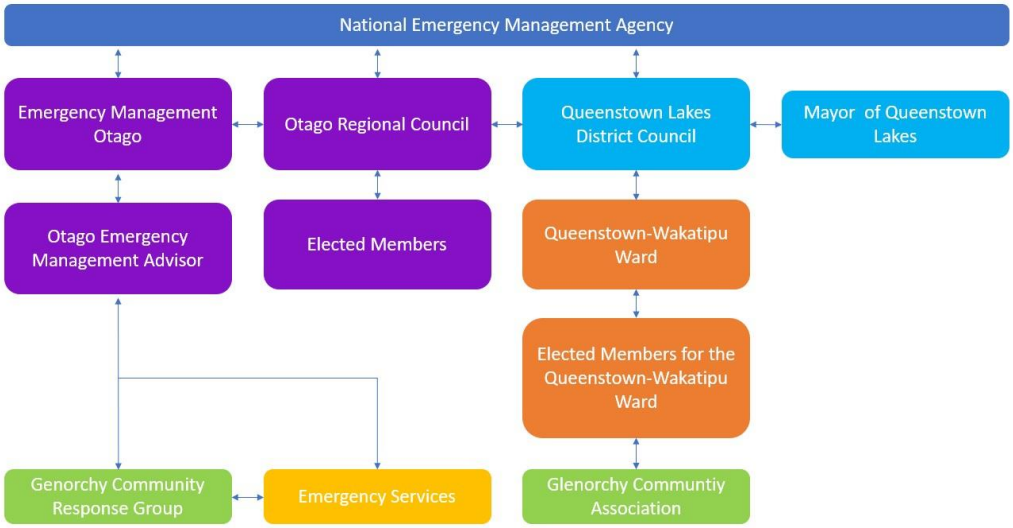

Figure 5-11: Emergency Management governance Structure (figure created for the purposes of this report)

5.5.5 Clubs/Organisations

Glenorchy is a vibrant community that offers a variety of amenities and activities for residents and visitors. Among these are a golf course, skate park, marina, scenic reserve, playground, library, waterfront, and community hall. The town is also home to a number of sporting, social, and environmental clubs that contribute to the community's culture and lively atmosphere. The clubs on offer have changed as the community has grown and evolved. Current clubs/groups/organisations include, but are not limited to:

Lakeside Rugby Club	Darts Club	Rural Women's Group
Netball Club	Community Nursery	Women's Book Club
Golf Club	Heritage & Museum Group	Coffee Club
Riding Club	Dark Skies Sanctuary Group	MenzShed
Home Brew Club		

Different clubs/organisations take on responsibility for community events and raising funds and distributing funds or providing financing for community projects. Major events include the annual Glenorchy Races, the Glenorchy Flower Show and the Glenorchy Fishing Competition.

> *"Culture of volunteering is an invisible but pervading characteristic of the community."* – *Research participant*

5.5.6 Services and amenities

Most services and amenities at the Head of the Lake are located in the Glenorchy township. These include:

Glenorchy Primary School	Glenorchy Fire Station	Glenorchy Cemetery
Glenorchy Museum	Glenorchy Skate Park	Glenorchy Marina
Glenorchy Information Centre	Glenorchy Petrol Station	Glenorchy Community Hall
Glenorchy School Playground	Glenorchy St John's Ambulance	Mission Hall (Head of the Lake Community Church)
Glenorchy Motors	Glenorchy Waterfront Reserve	Glenorchy Library
Glenorchy Community Native Plant Nursery	Glenorchy Post Office	

Basic grocery items can be purchased from the Mrs Woolly's General Store. However, people need to travel further afield (e.g., Queenstown) for other household items or order in.

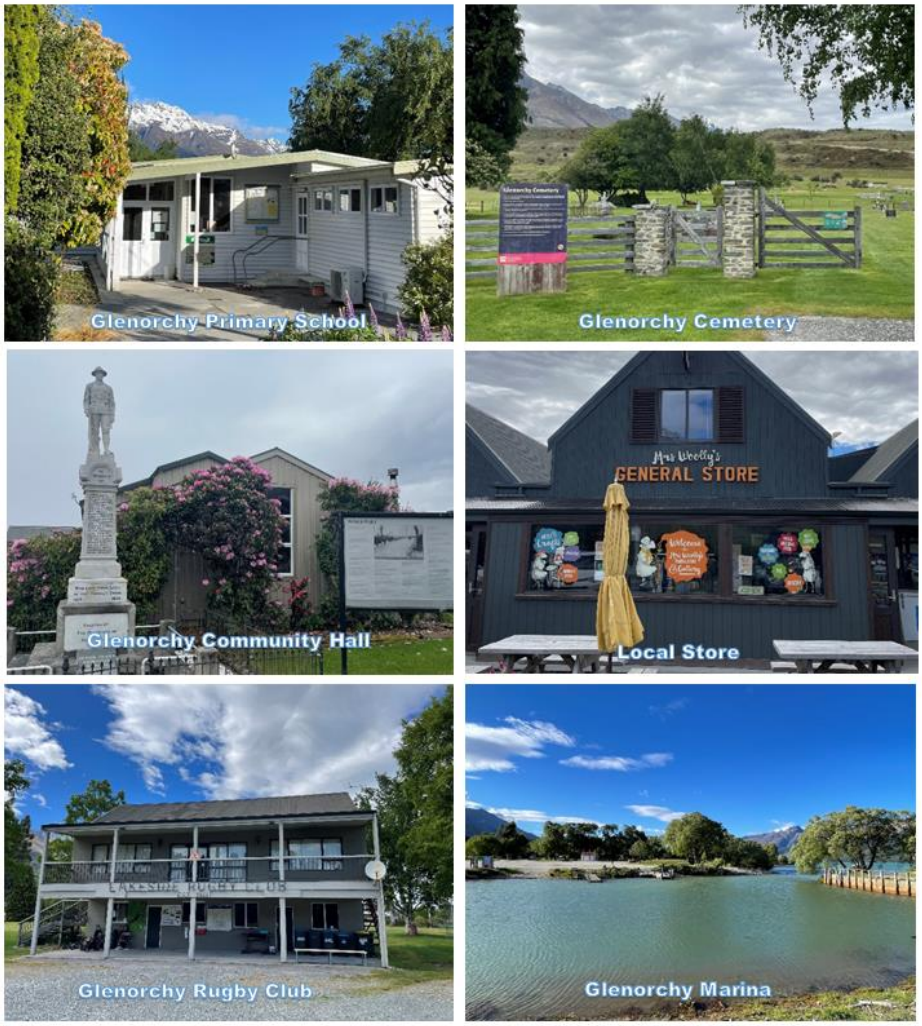

Figure 5-12: Images of community assets/services in the Glenorchy township

Figure 5-13 provides a high-level map of these services and amenities. It excludes any services and amenities outside the Glenorchy township.

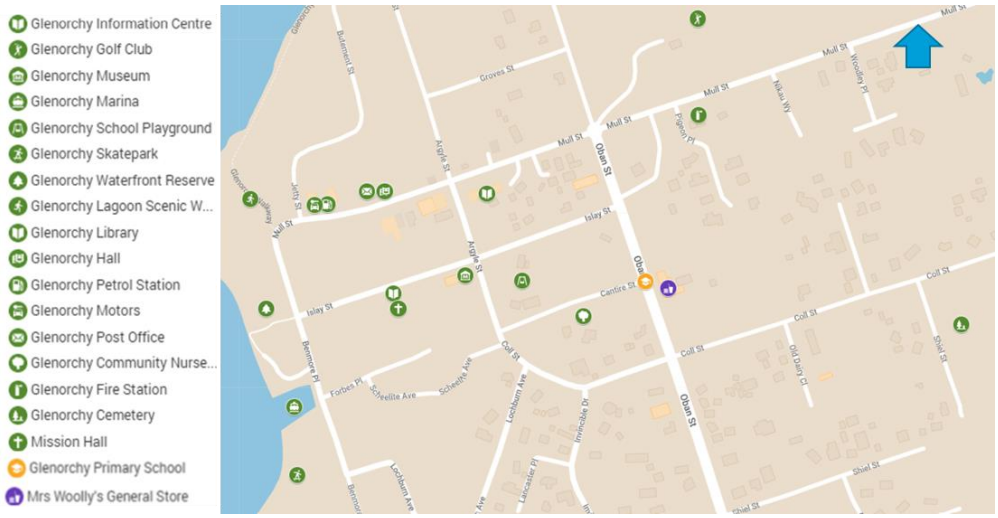

Figure 5-13: Community services/assets in the Glenorchy township (map created for the purposes of this report using data sourced from Google Maps (Google, n.d.) and confirmed by site visits

5.5.6.1 Health services

A Practice Nurse currently operates a non-funded, Registered Nurse-led Health Clinic in Glenorchy for one hour every second Wednesday (this time can vary depending on the Nurse's availability). Home visits are also available before or after clinic times by prior arrangement with the Nurse.

The Practice Nurse has been operating the Health Clinic in Glenorchy for 8 years. Services include, but are not limited to, providing medications, wound assessments, taking bloods, wellbeing checks (e.g., detox patients), and coordinating transport for patients to attend appointments outside the area.

The clinic is a non-funded service; however, the Nurse currently receives an annual Community Trust grant for petrol costs. The Glenorchy Branch of Rural Women New Zealand played a key role in sourcing local funds when the Clinic was threatened with disestablishment in 2011. The Southern Primary Health Organisation (PHO) previously funded the service; however, funding was ceased in 2011.

In addition to the Practice Nurse, a pharmacist occasionally attends the fortnightly Health Clinic. Glenorchy also has a visiting Chiropractor and Hospice Nurse.

A few St John's first responders also live in the area and provide urgent medical care. If the patient requires a hospital, the Lake District Hospital in Queenstown is closest (approximately 1 hour drive - 54km) More extensive primary care is available in Queenstown, including doctors, nurses, psychologists, physiotherapists, and other health providers. Residents must travel to Clyde, Dunedin, or Invercargill for specialist services.

5.5.6.2 Education

a. Playgroup

There is a Glenorchy Playgroup for under-fives that meets every Monday and Thursday from 10am-12pm. The Playgroup provides a place where pre-school children and parents can regularly meet, with the aim of giving parents and caregivers the opportunity to learn new ways to encourage their children's learning in a friendly, supportive, and fun group. Approximately 30 children are registered to attend the Play Group.

b. Early & After School Childcare

There are currently no services at the Head of the Lake that provide early or after school childcare. Currently, parents and caregivers that require some childcare support 'must make it work' outside of formal childcare arrangements. From discussions with research participants, it appears some parents and caregivers have arrangements with other parents and caregivers, where they share childcare responsibilities. 'Glenorchy Early Childhood Centre Project' is currently fundraising to build an Early Childcare Centre on some land in the Glenorchy township, which is owned by the Glenorchy Play Group.

c. Primary School

There is one Primary School in the Head of the Lake, situated in the Glenorchy township. Glenorchy Primary School is a public school, providing education for student's years 1 - 8.

There are currently 34 students enrolled at the Glenorchy Primary School. The junior class (years 1-3) account for half the school roll, which is reflective of the growing number of young families in the area. Four new entrants are planning to start in 2024, and a further eight planned to start in 2025.

Glenorchy Primary School offers a school bus to those students who meet eligibility criteria. Eligible students are those aged under ten years, who live more than 3.2 km away from the school, and those aged over 10 years, who live more than 4.8km away from the school.

d. High School

Children years 9-13 must attend a high school outside of the area or be home schooled. From discussions with research participants, most high school aged children at the Head of the Lake attend Wakatipu High School, which is a public school approximately 1 hour drive / 55 kilometres from Glenorchy. There is a free school bus, provided by the Ministry of Education that collects and returns students to/from six different bus stops in Glenorchy.

5.5.7 Utilities

5.5.7.1 Roads

Car travel is the dominant mode of transport at the Head of the Lake. There is no formalised public transport. Bus services run for primary and secondary school students as detailed in the above sections. There are several key roads at the Head of the Lake that provide access to, from and around the community (see Figure 5-14). These include:

- Queenstown-Glenorchy Road / Oban Street,
- Mull Street / Glenorchy-Paradise Road,
- Glenorchy-Routeburn Road,
- Kinloch Road, and
- Routeburn Road.

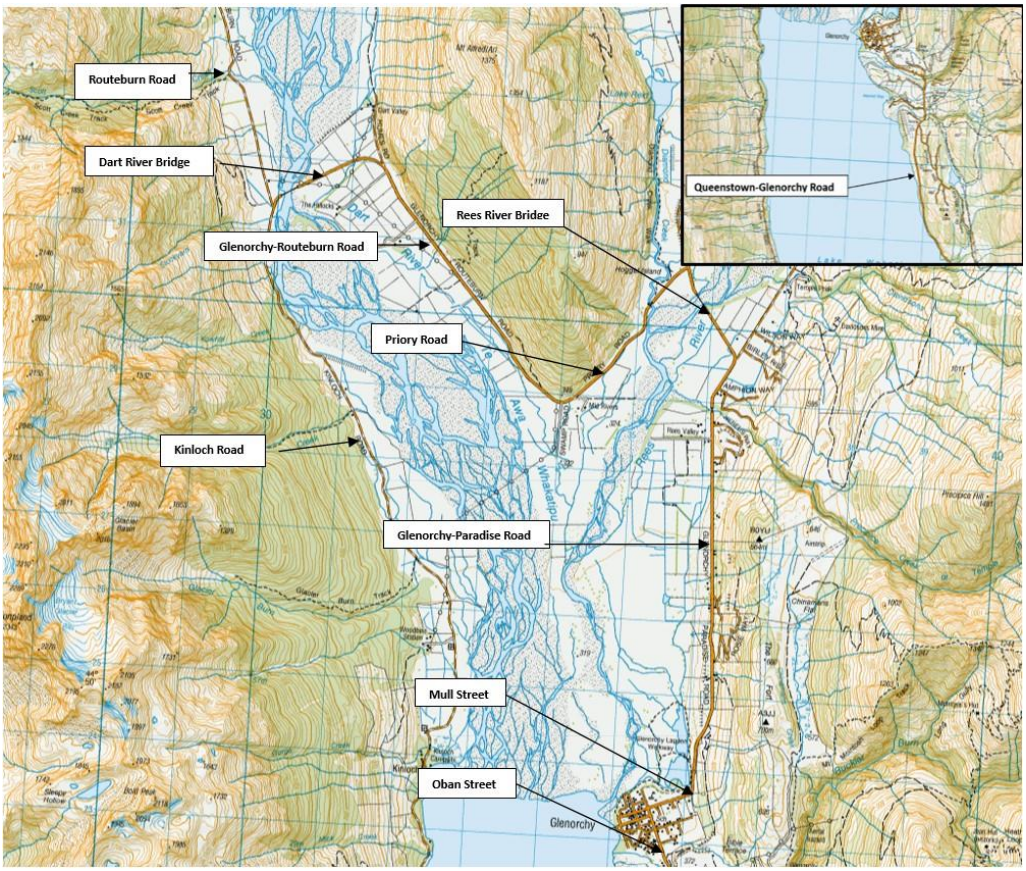

Figure 5-14: Local road network. Source: (NZ Topo Maps, 2023)

The Glenorchy-Queenstown Road is a particularly important road, as it provides the only road access in and out of Glenorchy. The community therefore relies heavily on the Glenorchy-Queenstown Road to access goods, services, employment, education, recreation, and health care outside the area.

Approximately 82% of business survey participants indicated that their business is dependent on the ability to transport people and/or resources into and/or out of the Head of the Lake, of which 66% were dependent to do so weekly. Figure 5-15 below provides a summary of what business survey participants are reliant on accessing outside the Head of Lake Whakatipu area. Participants that selected “other” cited services, parts and fuel.

What business survey participants said they are reliant on accessing outside of the Head of the Lake

Figure 5-15: Business survey response to "what are you reliant on accessing outside the Head of Lake Whakatipu area?"

25% of resident survey participants indicated that they travelled outside the Head of the Lake several times a week, 50% weekly, and 25% fortnightly. Figure 5-16 below provides a summary of the reasons why resident survey participants travel outside the Head of Lake Whakatipu area. 'Other' reasons included travelling to the Queenstown Airport, and for meetings.

The reasons why resident survey participants travel outside the Head of the Lake

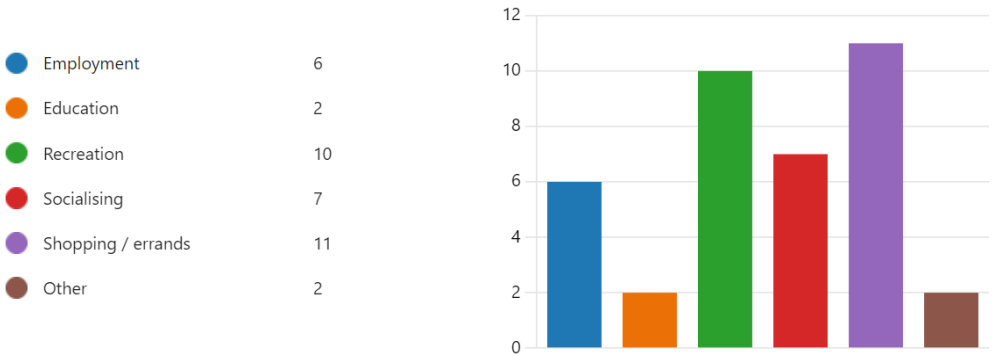

Figure 5-16: Resident survey response to "of the following, what do you and/or your household travel outside of the Head of Lake Whakatipu area for?"

In the last 10 years, the Glenorchy-Queenstown road's Average Daily Traffic[10] (ADT) ranged from approximately 705 to 5,650 (both lanes) (refer to Figure 5-17).

[10] ADT is the average 24-hour traffic volume at a given location for a period of time (e.g., a month, or a week, or several days).

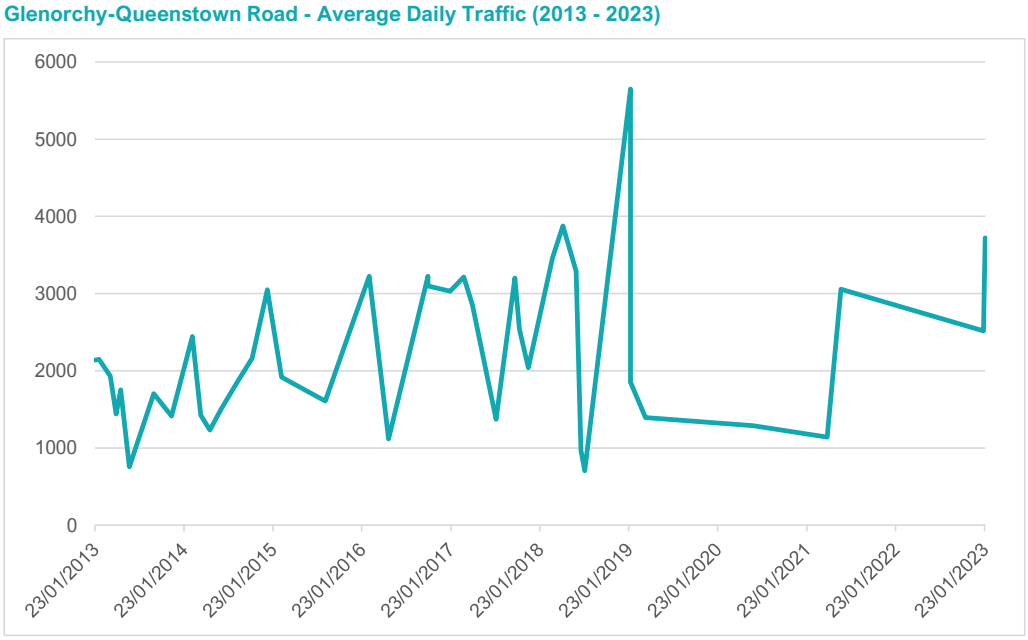

Figure 5-17: Glenorchy-Queenstown Road - Average Daily Traffic (2013-2023). Source: (QLDC, 2023c)

From discussions with research participants, the Glenorchy-Queenstown road is vulnerable to flooding. In these cases, the road can be closed for several days to clear debris. We were told that the road is also occassionally closed following vehicle crashes, other weather events (i.e. snowfalls), or for maintainance.

A number of research participants commented on the dangers of the Glenorchy-Queenstown Road. Anecdotally, there were a growing number of serious road crashes occurring on the road prior to the COVID-19 pandemic. These numbers slowed during the pandemic, but have anecdotally picked up again. This trend is evident in crash data for the Queenstown Lakes District (refer to Figure 5-18).

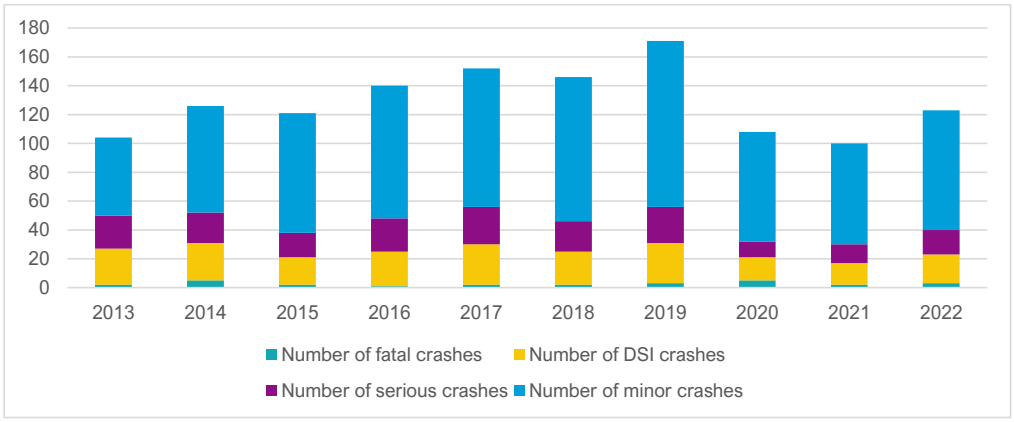

Figure 5-18: Queenstown Lakes District Crash Data. Source: (Ministry of Transport, 2023)

The Glenorchy-Paradise Road also provides an important link to people and businesses located in Paradise and the Rees Valley. It also provides access to Kinloch, and the Routeburn, Rees-Dart, Lake Sylvan, and Greenstone Caples tracks via the Glenorchy-Routeburn, Kinloch and Routeburn Roads, which are popular tourism and recreation destinations. In the last 10 years, the road's Average Daily Traffic (ADT) ranged from approximately 121 to 1,211 (both lanes) (QLDC, 2023c).

The Rees River and Dart River bridges are also important pieces of roading infrastructure, as these provide access to Kinloch and other locations on the west side of the Rees and Dart Rivers. From discussions with research participants, aggradation of silt and gravel beneath the Rees River Bridge is ongoing due to the high sediment supply from the catchment. Flooding has also been observed to flow over the approach roads (outflanking the bridge), so the bridge opening is only convey part of the flow at those times.

5.5.7.2 Power

Aurora Energy is the Head of the Lake's local electricity distribution company. Aurora Energy is partway through a large, five-year work programme investing over $500 million to upgrade the existing network in lake Whakatipu and Queenstown (Glenorchy Community, 2023). These new powerlines are intended to provide flood resilience due to stronger structures and will allow for increased electrical capacity for future growth.

As advised on the Glenorchy Community website[11]: *"With the many storms that come across the mountains, Glenorchy occasionally has power cuts. Keep a supply of candles, torches, kettle (suitable for gas or fire) and anything else you can think of that will make your time without electricity comfortable. Usually, the power is not down too long. To help preserve your cold and frozen foods, try not to open your fridge doors for longer than necessary."* (Glenorchy Community, n.d.)

5.5.7.3 Wastewater

Currently households across the Head of the Lake manage and treat their own wastewater at their properties.

[11] https://www.glenorchycommunity.nz/

5.5.7.4 Drinking water

There is town water supply and two large water reservoirs have recently been installed on Bible Terrace. Rural properties provide their own water supply.

5.5.7.5 Telecommunications

There are three telecommunication providers that service the Head of the Lake: Vodafone, Spark and Lakes Internet. The Glenorchy community website[12] notes the reliability of these services varies depending on what area you are living in (Glenorchy Community, n.d.). From discussions with research participants, it appears some residents have access to Starlink, which provides satellite internet access. Approximately 85% of the population have access to internet and 90% access to cellphones (StatsNZ, 2018). Approximately 3% have no access to communication systems (StatsNZ, 2018).

5.5.7.6 Emergency Services

Glenorchy has a Fire Station, volunteer Fire Brigade, Ambulance, and several St John's First Responders. Calling 111 will direct local help. The Fire Brigade and St John's volunteers attend regular training, usually in Queenstown but sometimes further afield.

Glenorchy also has a Community Response Group (CRG), which comprises a number of CDEM trained community volunteers, coordinated by an Otago Emergency Management Advisor (EMA). From discussions with research participants, the CRG's role is to provide information and support to the community whilst supporting Emergency Management Otago's official CDEM response. In a rapid-onset event, the CRG will provide quality local information to the EMA. During a slow-onset event, key information is likely to come from the EMA in the form of official assessments from regional and national sources.

In addition to emergency services and management, Glenorchy has several skilled volunteer Search and Rescue (SAR) personnel[13]. These people are part of the Wakatipu Area SAR team, which comprises Bush, Alpine Cliff Rescue, Avalanche and Wilderness Search dogs and Swift Water rescue teams. The team is managed by the NZ Police with assistance from NZ LandSAR volunteers. Helicopters are relied on for much of SAR's work in the area because of the mountainous and sometimes isolated nature of incidents.

Whilst SAR does not have national remit or funding to respond in natural disaster events, research participants advised that local volunteers typically respond anyway. SARs equipment can get damaged or contaminated in natural disaster events, however the repair and replacement of important PPE is not funded by local or central government due to the absence of a local or national remit to respond. This limits their ability to respond to future events. SAR volunteers are also not trained in natural disaster-related rescues, for instancefloods in urban areas. The research participants see SAR as an important part of any CDEM response, however there is nothing in place to formalise this. We are advised that this is currently being worked on between LandSAR and CDEM.

5.6 Economic overview

This economic overview primarily references Infometrics Quarterly Economic Monitoring data supplied by QLDC (Infometrics, 2023). This data source summarises a range of economic insights for the Queenstown Lakes District, including employment, spending, and GDP across the region. For clarity, Infometrics data for 'Glenorchy' is referenced as the Head of the Lake.

[12] https://www.glenorchycommunity.nz/

[13] It was noted in discussion with research participants that Glenorchy-based SAR skilled personnel are older, and no longer attend training.

Tourism spending[14] by sub-regions (Glenorchy being one of five sub-regions in the region) was supplied by Queenstown NZ (Queenstown NZ, 2023a). This has been used to disaggregate regional tourism estimates for the Head of the Lake, as the Infometrics data cited above does not include tourism statistics.

5.6.1 Employment

In 2022, an estimated 240 people were employed in the Head of the Lake (Infometrics, 2023). This figure excludes the tourism sector as tourism employment statistics were not directly available for the Head of the Lake. Using the proportional tourist spending activity within the Glenorchy sub-region relative to the Queenstown Lakes District, tourism employment for the Head of the Lake is estimated based on the total regional employment for the tourism sector[15]. In the Head of the Lake, there are approximately 149 people employed in the tourism sector. Employment over the past five years is summarised in Figure 5-19.

Estimated number of employees in the Head of the Lake 2018-2022

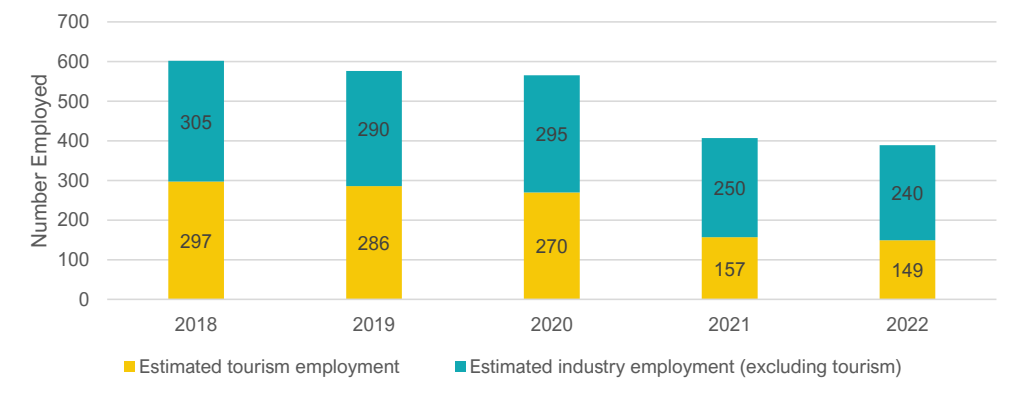

Figure 5-19: Estimated tourism and industry employment in the Head of the Lake. Source: (Infometrics, 2023; Queenstown NZ, 2023a)

As shown in Figure 5-19, tourism makes up a considerable proportion of employment in the Head of the Lake. The five largest employment industries (excluding tourism) are shown in Figure 5-20 (Infometrics, 2023). Accommodation and food service (hospitality) as well as arts and recreation services (primarily film production), also contribute significantly to employment in the Head of the Lake. Other key industries include farming and trades (i.e., transport equipment manufacturing and building construction) (Infometrics, 2023).

[14] Tourism spending by sub-region is based on transaction data.

[15] Tourism employment data for the Head of the Lake was not provided. Instead, tourism employment was estimated based on the proportion of tourism spending activity occurring within the Head of the Lake relative to the wider Queenstown Lakes District (Queenstown NZ, 2023a). This proportion was then applied to the tourism employment estimate for the Queenstown Lakes District (Infometrics, 2023).

Industry Contribution to Employment in the Head of the Lake in 2022

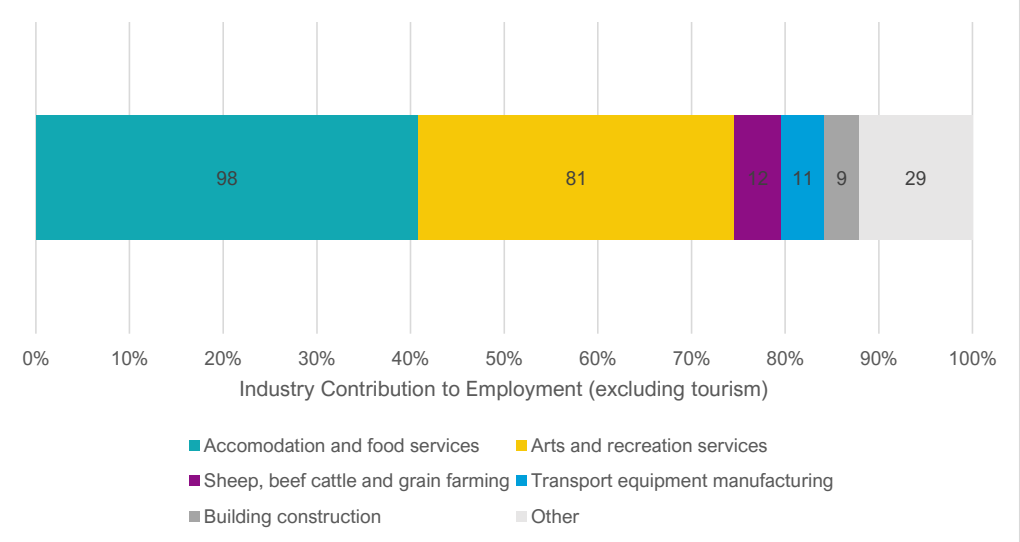

Figure 5-20: Estimated contribution to employment by industry (excluding tourism) in the Head of the Lake (Infometrics, 2023)

The New Zealand Census collects data per spatial area. For the Head of the Lake, the relevant spatial area is referenced as Glenorchy Statistical Area 2 (SA2). An outline of this area is provided in the 'People' section of this report.

As of 2018, approximately 70% of the population aged 15 years and older at the Head of the Lake are employed full time, 15% part time and 1.5% are unemployed (StatsNZ, 2018). 'Managers' made up the largest proportion of workers, followed by 'Professionals' and 'Technician and trade workers' (refer to Table 5-2 below).

The occupation profile of the area is reflected in the large proportion of people that work from home. 70% of resident survey respondents that were employed, indicated that they work from home some or all of the time. In discussion with residents, working from home or remotely has become more common in recent years.

Table 5-2: Occupation of Workers in Glenorchy. Source: (StatsNZ, 2018)

Occupation	% of the working population – Glenorchy Area
Managers	25
Professionals	15
Technician and trade workers	18
Community and service workers	12
Clerical and administrative workers	8
Sales workers	6
Machinery operators and drivers	5
Labourers	13

5.6.2 Income

As of 2018, the median income in the Head of the Lake was $38,000, which is higher than the median income of the Otago region ($30,000). However approximately 69% percent of residents aged 15 years and older in the Head of the Lake earn less than the New Zealand average ($49,000). 17.4% of the resident population aged 15 years and over earned more than $70,000, compared to 14.4% of the Otago region population (StatsNZ, 2018).

17% of resident survey participants indicated that their property generates a part of their income (e.g., from farming, horticulture, or providing accommodation). An additional 17% indicated that their property is their main source of income.

5.6.3 GDP

In the Head of the Lake, the local GDP for 2022 was estimated to be $42.42 million (Infometrics, 2023). The GDP per capita for 2022 was therefore approximately $75,735 NZD, which is consistent with the national average (Statista, 2023). Figure 5-21 compares the estimated GDP generated by the tourism industry[16], relative to all other industries for the past 5 years (Infometrics, 2023). This indicates the significance of the tourism industry to the Head of the Lake GDP.

Industry and Tourism Contribution to GDP in the Head of the Lake (2018-2022)

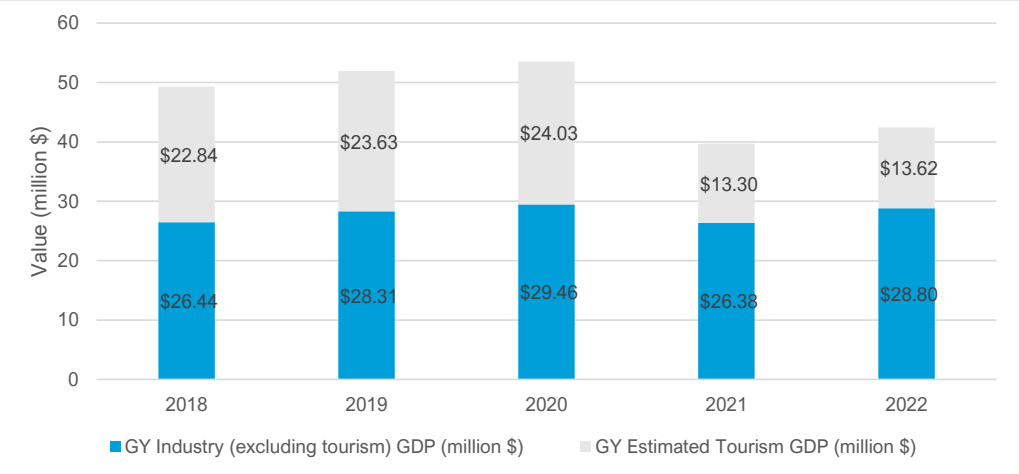

Figure 5-21: Head of the Lake industry and estimated tourism GDP (Infometrics, 2023; Queenstown NZ, 2023a)

The five largest GDP industries (excluding tourism) are shown in Figure 5-22 (Infometrics, 2023). These follow a similar pattern to employment, with key industries being hospitality, film, agriculture, and trade.

[16] Tourism GDP for the Head of the Lake was not provided. Instead, tourism GDP was estimated based on the proportion of tourism spending activity occurring within the Head of the Lake relative to the wider QLDC area (Queenstown NZ, 2023a). This proportion was then applied to the available tourism GDP estimate for QLDC (Infometrics, 2023)

Industry Contribution to GDP in the Head of the Lake (2022)

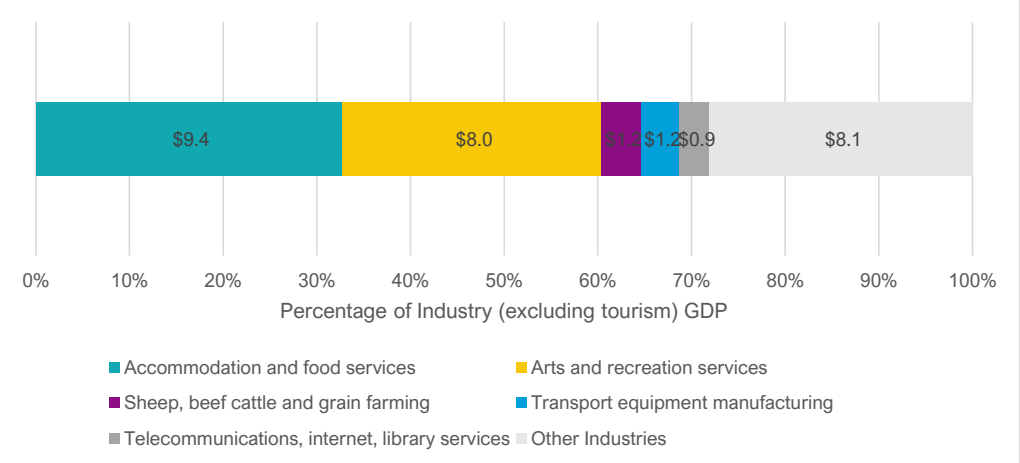

Figure 5-22: The Head of the Lake industry percentage contribution to GDP (excluding tourism) (Infometrics, 2023)

Research participants noted that spring and summer months are the busiest time of year for business whilst late autumn and winter is less busy.

5.6.4 Tourism

The Head of the Lake is a popular tourist destination that offers a range of activities for visitors to enjoy. Among these activities are jet boating, tramping (hiking), fishing, hunting, horse trekking, skydiving, farm tours, 4WD safaris, kayaking, scenic flights, photo safaris, and Lord of the Rings tours. Visitor numbers show that approximately between 300-800 people visit the Glenorchy township daily, while an additional 90-240 people visit the wider area within the Head of the Lake (e.g., Paradise, Kinloch, Routeburn) (QLDC, 2023a). Tourism operators in the Head of the Lake are based at the Head of the Lake, Queenstown, and further afield.

Many research participants voiced the desire for local and central government to acknowledge the Head of the Lake as an important location for the wider region (as a visitor destination).

From discussion with research participants, tourists are drawn to the pristine environment that looks "exactly like the set of the Lord of the Rings." The area also provides a beautiful backdrop for photos. For this reason, the Head of the Lake is a popular destination wedding venue. Hitched in Paradise, Paradise Trust, Blanket Bay, and Headwaters Eco Lodge are some of the operators catering to weddings in the area. One wedding vendor that was interviewed works with local celebrants, florists, and helicopter businesses to offer these services as part of its wedding packages.

Trekking and day walking are major activity attractions of the area:

- The Routeburn Track is a New Zealand 'Great Walk' which is accessed from the Head of the Lake. The Routeburn Track has three huts and two campsites, which must be booked well in advance during the Great Walks season. The Routeburn Track has approximately 20,000 overnight trampers per year. This excludes day visitors, which can reach 200 walkers per day over the height of the season from the entrance to Routeburn Flats (DoC, 2022).
- The Rees-Dart Track has three huts and sees approximately 1638 overnight trampers per year. It also attracts 10-20 day visitors per day (DoC, 2023).

- The Greenstone and Caples Tracks have three huts and see approximately 3861 overnight trampers per year. In high season, it also attracts 20-30 day visitors per day (DoC, 2023).
- Glenorchy day walks located close to town include the Glenorchy Walkway (5km loop), Whakaari Conservation Area (10km), and Mt Judah (6.6km). The Glenorchy Walkway sees approximately 22,000 day visitors per year (DoC, 2023).
- Lake Sylvan Track (5.3km), located slightly further from the township (22 km away), attracts 10,900 day visitors per year (DoC, 2023).

To facilitate hiking adventures in the region, there are several transport providers operating in the area that provide transportation to/from walking tracks.

5.6.5 Film

The Head of the Lake is a popular filming location for the Queenstown Lakes District's film industry. From discussions with research participants, there are not many film businesses located in the area, however a lot of film activity occurs in Glenorchy and surrounds. Arcadia Station, Paradise Trust, the Rees Valley, and locations in the Glenorchy township (e.g., the jetty and waterfront) are particularly popular filming locations.

In the last year, there were approximately 129 productions in Queenstown Lakes District. This included a mix of television content, feature film content, TV commercials, documentaries and more (QLDC, 2023d).

From discussion with research participants, most production teams are based in Queenstown, so rely on travelling in and out of Glenorchy, using the Glenorchy-Queenstown Road. However, some production teams base themselves in Glenorchy temporarily, and therefore rely on local accommodation.

5.6.6 Hospitality

Hospitality is one of the largest industry employers in the Head of the Lake, in 2023 there were 98 people employed in the industry (Infometrics, 2023). This is shown as employment for 'accommodation and food services' in Figure 22. In addition, hospitality generates approximately $9.4 million in GDP for the Head of the Lake (excluding tourism) (refer to Figure 22) (Infometrics, 2023).

Short-term accommodation providers are located across the Head of the Lake, including the Glenorchy Hotel, Glenorchy Motel, Mount Earnslaw Motel, Headwaters Eco Lodge, Glenorchy Lake House, the Great Glenorchy Alpine Base Camp, Mrs Woolly's Campground, and Kinloch Wilderness Retreat.

At the time of writing, there are several bars, restaurants and cafes in Glenorchy, including Mrs Woolly's, Mr Glens Tapas and Tap House, Queenies Dumplings, the Trading Post, and the Glenorchy Hotel Pub. The Great Glenorchy Alpine Base Camp also takes external bookings for their communal style dinners. Outside of the Glenorchy Township, the Kinloch Wilderness Retreat also has a restaurant.

5.6.7 Agriculture

Whilst many research participants described the Head of the Lake as 'rural', less than a third (approximately 27% of households: 80 households) in the Head of the Lake are located outside the Glenorchy township (QLDC, 2023a). Based on discussions with research participants and site visits, the majority are either countryside living (large residential lots) or lifestyle properties which do not rely on agriculture as a primary source of income. Farming in the area is predominately high-country station farming consisting of cattle and sheep farming, either in the beef and lamb industry or the wool industry. From discussions with research participants, there are six stations in the Head of the Lake. These stations are a mix of family and iwi owned stations. From discussions with research participants, many of the family-owned stations have been owned by the respective family for multiple generations. Most stations have diversified in some way, mostly in the

hospitality or tourism industry whether that be tours, accommodation (very few) or providing a venue for tourist activities.

Farming represents 5% of industry employment in the Head of the Lake (excluding tourism), as indicated in Figure 22. As discussed with research participants, these are largely family operated cattle and sheep farms that do not have high staffing requirements throughout the year. Instead, contract workers are used for seasonal tasks such as shearing and lambing. Approximately 4% of the Head of the Lake's GDP ($1.2 million) is produced from the agriculture industry (excluding tourism) (refer to Figure 22) (Infometrics, 2023).

5.6.8 Trade

From discussions with research participants, there are a variety of trades people operating or employed within the Head of the Lake, or who travel to Queenstown for trades work. There is a steady stream of new builds in the area including the recent residential development of Alfred Terrace. Approximately 29 industry jobs are attributed to construction in the Head of the Lake (refer to Figure 5021). GDP produced by trades is reported as part of the $8.1 million GDP for the Head of the Lake attributed to "other industries" (refer to Figure 22).

6 Natural Hazards

This section is largely a summary of the data collected through interviews and focus groups, supplemented by desk-top research where required.

6.1 Community experience of natural hazards

The Head of the Lake is at risk of several natural hazards, including seismic and flooding hazards (Tonkin & Taylor, 2021). The natural hazardscape at the Head of the Lake is illustrated in Figure 6-1).

In the last 30 years, there has been three notable flooding events: the 1994 Race Day flood, 1999 flood, and 2020 Rees/Dart River flood. Climate change is expected to exacerbate the consequences of flood events due to increased rainfall. NIWA forecasts a significant rise in the mean annual flood in parts of Otago, with projections suggesting a potential 50-100% increase by the century's end under a representative concentration pathway (RCP) 8.5 scenario[17] (NIWA, 2019).

[17] RCP 8.5 is a scientific scenario that models a future characterised by exceptionally high greenhouse gas emissions. It envisages a trajectory where reliance on fossil fuels such as coal and oil continue unabated, and efforts toward adopting renewable energy solutions are minimal.

Figure 6-1: Head of the Lake natural hazardscape. Source: (MacKenzie, 2023)

6.1.1 2020 Rees/Dart River Flood

The Rees/Dart River flooded on February 3rd and 4th, 2020. According to a report by Gardner (2022), the wetland area at the Head of the Lake filled and overflowed the Glenorchy stopbank near its eastern end, resulting in flooding of the northern part of Glenorchy township.

Residential areas at the northern ends of Oban and Argyle Streets, as well as parts of Butement Street, were affected by the flooding. This inundation led to damage and required precautionary evacuations of several houses. Landslides forced road closures and roads washing out across the Head of the Lake including the Queenstown-Glenorchy Road.

Based on discussions with research participants, the 2020 Rees/Dart River flood was a good test of the emergency management system. The community largely self-organised, as demonstrated by the following quotations.

> *"Emergency services were half an hour ahead of everyone because they had already received information and acted"* – *Research participant*

> *"A natural hierarchy kicks in"* – *Research participant*

Figure 6-2: Aerial image of the February 2020 floods, taken prior to the maximum floodwater extent at about 6:30pm of 4 February 2020. Source: Luke Hunter (Done Rite Contracting)

6.1.2 1999 Flood

In November 1999, a period of prolonged heavy rainfall resulted in extensive flooding across Otago, Southland, Canterbury, and the West Coast. This event led to high lake levels in Lake Whakatipu, causing significant inundation in the Glenorchy township. The floodwaters also resulted in road damage that isolated Kinloch from Glenorchy (NIWA, 2018). Based on discussions with research participants, this resulted in the flooding of some homes in the township. The community helped affected households with sand bagging and moving furniture.

6.1.3 1994 Race Day Flood

In the 1994 Race Day flood, a significant amount of rainfall resulted in widespread flooding as several streams burst their banks, and the lake levels rose. This led to flooding of some areas along the lakeside. Over 400 individuals had to be evacuated by boat back to Queenstown for their safety (NIWA, 2018b).

Based on discussion with research participants, the flooding was quite sudden and caused a lot of damage due to the amount of debris. The Glenorchy-Queenstown Road was also washed out in several places and closed for a month. Research participants recalled how the community shared supplies and supported one another during this time. According to research participant, DoC initiated the emergency management

response, however DoC's time was quickly absorbed responding to bridges that had washed out on the DoC tracks.

6.1.4 1999 Flood

In November 1999, a period of prolonged heavy rainfall resulted in extensive flooding across Otago, Southland, Canterbury, and the West Coast. This event led to record high lake levels in Lake Whakatipu, causing significant inundation in the Glenorchy township. The floodwaters also resulted in road damage that isolated Kinloch from Glenorchy (NIWA, 2018a). Based on discussions with research participants, this resulted in the flooding of some homes in the township. The community helped affected households with sand bagging and moving furniture.

6.1.5 2020 Rees/Dart River Flood

A Land River Sea Consulting Ltd report outlines the most recent flood event in the Rees/Dart river area, which occurred on the 3rd and 4th of February 2020 (Gardner, 2022). During this event, the wetland area filled and overtopped the Glenorchy floodbank near the eastern end, leading to floodwaters flowing into the recreation grounds.

Residential areas at the northern ends of Oban and Argyle Streets, as well as parts of Butement Street, were affected by flooding. This inundation led to damage and required precautionary evacuations in several houses. Significant rainfall forced road closures due to landslides and roads washing out across the Head of the Lake including the Queenstown-Glenorchy Road. Based on discussions with research participants, the 2020 Rees/Dart River flood was a good test of the emergency management system. The community largely self-organised, as demonstrated by the following quotations.

> *"Emergency services were half an hour ahead of everyone because they had already received information and acted"* – *Research participant*
>
> *"A natural hierarchy kicks in"* – *Research participant*

6.2 Existing natural hazard mitigation and preparedness

There are several emergency management response personnel, plans and processes in place to increase community preparedness and resilience to natural hazard events at the Head of the Lake.

6.2.1 Personnel

Key emergency management personnel for the Head of the Lake include:

- the Otago Emergency Management Advisor for the Queenstown Lakes District - this person is responsible for CDEM in the Queenstown Lakes area, including the Head of the Lake. The EMA's primary objective is to increase social and economic resilience in the community.
- The Glenorchy Community Response Group (refer to 'Services and amenities' section for further detail)
- Emergency Services personnel (e.g., Fire Brigade, St John's, Police).

6.2.2 Plans

There are two key emergency management documents for the Head of the Lake in place:

- The Emergency Management Otago Glenorchy Community Resilience Guide (currently in draft)

- The Community Response Plan (not public facing[18]).

6.2.2.1 Emergency Management Otago Glenorchy Community Resilience Guide for Glenorchy

The draft Glenorchy Resilience Guide (the Resilience Guide) supersedes the Glenorchy Community Response Plan (CDEM, n.d.). The draft Resilience Guide outlines the specific natural hazards in the Head of the Lake area and provides resources and information to help the community prepare for, respond to, and recover from natural hazard events. It also considers the specific needs and vulnerabilities of the community at the Head of the Lake. This includes a template to help households plan for natural hazard events.

The goal of the Resilience Guide is to strengthen community resilience by managing risks, being ready to respond to and recover from emergencies, and by enabling, empowering, and supporting individuals, organisations, and communities at the Head of the Lake to act for themselves and others, for the safety and wellbeing of all.

6.2.2.2 Community Response Plan

The Community Response Plan (CRP) was developed in September 2022 by the Glenorchy Community Response Group (CRG) in conjunction with Emergency Management Otago. This builds upon the Glenorchy Resilience Guide, to specify the pre-determined Action Plans around which the immediate community response will be based. Action Plans for five different hazards (flooding, earthquake, wildfire, extreme weather event, landslip) have been developed and rehearsed by the CRG in conjunction with Emergency Management Otago and other agencies, including local emergency services. Each Action Plan describes actions for Emergency Management Otago, the CRG, emergency services, and affected community members (if necessary). The CRP has been developed primarily for the use of the Glenorchy Community Response Group and Emergency Management Otago. As it contains personal contact information, it is not public facing.

6.2.2.3 Civil Defence Emergency Management Centres / Community Emergency Hubs

As outlined in the Community Resilience Guide, a Civil Defence Centre / Community Emergency Hub may be set up by the community to support those who have been affected by an event. It is a place for the community to come for information, reassurance, to have a hot drink, and to meet with each other and talk. A Community Emergency Hub is:

- Entirely owned and led by the local community within guidelines set by Emergency Management Otago.
- Community resourced
- Local community focused
- In communication with the local Emergency Operations Centre or Incident Control Point
- Not for overnight stays
- Run by members of the community.

There are two locations at the Head of the Lake where a Community Emergency Hub has previously been set up: Camp Glenorchy and Glenorchy Primary School. In discussions with the community, it was learned that Camp Glenorchy is a certified 'Living Building', which means it meets very high sustainability standards. Notably, it utilises solar panels, and has a sophisticated onsite energy and water management system which assists the building in using 50% less water and energy than other similar facilities. The facility is also built to withstand a magnitude 8 Alpine Fault earthquake and has enough food and resources to accommodate 100 people for a couple of weeks. For these reasons, Camp Glenorchy is considered an incredibly valuable

[18] The Community Response Plan has been developed primarily for the use of the Glenorchy Community Response Group and Emergency Management Otago. It is therefore not public facing as it contains personal contact information.

community resource. It is currently held in the Glenorchy Community Trust, which is directed by local community members.

6.2.3 Processes

Based on discussions with research participants, there are several processes in place to manage natural hazard risks in addition to the personnel and plans outlined above:

- 'Otago Gets Ready' emergency alerts – community members can sign up to emergency alerts
- lake and river level monitoring
- road and river maintenance, and
- reactive repair.

The DoC also has processes in place to manage natural hazard risks for tourists / visitors. From discussions with research participants, the DoC closely monitors weather and has closure plans for a range of natural hazards (e.g., rain, wind). If a closure plan is triggered, websites and signage are updated, and people are flown out of DoC tracks by helicopter if there is damage to bridges. In a significant event, the DoC's focus is to get tourists and visitors out of the community as quickly as possible, so not to deplete local resources.

6.3 Community perceptions of natural hazard risk

A range of data was gathered as part of this assessment to help understand the vulnerabilities and resilience of the community at the Head of the Lake.

6.3.1 Understanding of risk

From discussions with research participants, residents generally have a good understanding of natural hazards in the area. Several research participants noted that people "choose to live in the community" and that the risks "come with the territory". This was a common theme raised by research participants; whilst residents are aware of the risks, it was something that they accepted about living in the area.

The top risks to individuals/households identified by resident survey participants were financial risks, loss of access (i.e., to resources, medication, health care), loss of shelter and utilities, loss of life, damage to property, halting of farming and business operations and loss of employment.

The top risks to businesses identified by business survey participants were financial risks (e.g., loss of potential customers and revenue), loss of access to people and/or resources outside the Head of the Lake, loss of access to/from Kinloch, damage to property and equipment, loss of fuel, loss of telecommunication (i.e., to communicate with clients), and reduction in property values.

A number of research participants expressed an understanding that if there was a large event that affected the region (e.g., an Alpine Fault earthquake), the community could be without any external support for an extended period of time (i.e., a week or longer). If the community was to be 'cut off' for an extended period, 27% of resident survey participants thought this would have impacts on their lifestyle / enjoyment life, 20% thought it would have financial impacts, and 13% thought it would impact their health and wellbeing. 40% thought this would have little impact on them/their household.

Of the business survey participants that indicated they are dependent on transporting people and/or resources into and/or out of the Head of Lake, 75% said that their business could not operate and/or would cease to function. One business survey participant said that they could possibly operate out of Queenstown, as they have access to a helicopter.

6.3.2 Preparedness

When asked what they do to prepare, or what plans they have in place for natural hazard events, discussions with research participants were mixed. Some research participants were highly prepared and self-sufficient with back-up generators, radios, solar power supply, and 2-3 weeks of food supplies. Others expressed a desire to be prepared but lacked the motivation or financial resources to set themselves up (i.e., invest in an emergency kit and back-up food supplies). This spectrum was reflected in the resident survey response. When asked what they do to prepare if they are aware a potential storm is coming, one resident survey participant shared that they have enough emergency supplies to last them 3-4 weeks, while another resident survey participant talked about shopping for food in case the Glenorchy-Queenstown Road was closed. The range in levels of preparedness was also evident in discussions with Glenorchy School students.

Comparatively, business survey participants said they prepare for a storm by monitoring the weather, rainfall, and lake and river levels closely and make a call on the day whether or not it is safe to operate. They also ensure batteries are fully charged, move livestock, send staff home (if it is safe to do so), warn their customers and drivers, cancel/postpone/refund customers, and stock up on supplies. One business survey participant said that they have an inhouse procedure in place to prepare for such events.

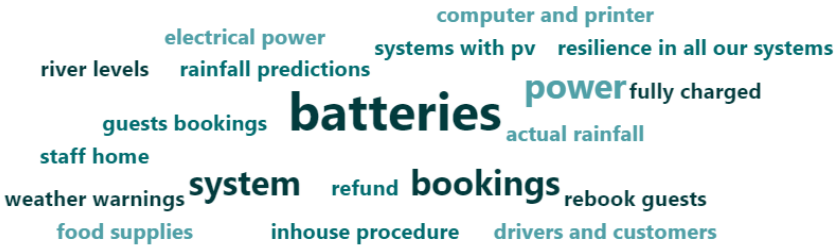

Figure 6-3: Response to business survey question "If you are aware there is a potential storm coming, what does your business do to prepare?"

6.4 Community perceptions of resilience

6.4.1 Community resilience

Our discussions with research participants suggest that the Head of the Lake is a very resilient community.

> *"The community is very resilient; it has gone through some tragedies, and pulled together"* – *Research participant*

This is reflected in the most recent QLDC Quality of Life Survey results, whereby Glenorchy participants were more likely than any other sub-community in the QLDC area to state that their neighbourhood is prepared for an emergency. Notably, a large proportion of Glenorchy participants indicated that they had joined a community response group (55%), had an emergency plan (73%), and had an emergency kit (67%), compared to 3%, 35%, and 55% of Queenstown participants respectively (Versus, 2024).

Practically, the Head of the Lake has a wide range of assets that they could draw upon in a natural hazard event. These include but are not limited to the assets listed in Table 6-1 below.

Table 6-1: Community assets described by research participants

Asset	Examples
Transport	The lake / water transport – provides an alternative travel route to transport people and resources in/out of Glenorchy. As well, a large number of households also own boats. Helicopters – provide access to remote locations and an alternative means of transporting people and resources in/out of Glenorchy Horses
Flood mitigation	The Golf Course The Glenorchy-Rees floodbank
Alternative energy sources and supplies	Camp Glenorchy Smithy's fuel tanks Food sources (e.g., vegetable gardens, orchards, home kill, fish) Diverse heat sources (e.g., solar) Starlink
Storage space (e.g., for furniture)	Community Hall
Emergency services and skills	Community Response Group Fire Brigade St John's First Responder
Equipment	Machinery Tools (e.g., chainsaws) Rifles Walkie talkies / radios
Social cohesion	Community clubs/organisations/networks
Diverse knowledge and skills	Understanding of the local environment Diverse set of practical skills (e.g., earthworks, hunting)

The community also has a diverse array of skills, and this was highlighted by several research participants as a strength of the community.

> *"Some are good at leading and mobilising others, and other are good at getting stuff done..."* – *Research participant*

> *"It's amazing how many resource and talent thats in it [the community]"* – *Research participant*

The community also has regular power outages, and it appears from our discussions with research participants that residents have adapted to this reality. Many households have back-up generators and wood burners. However, it was noted by some research participants that some of the newly built homes only have heat pumps, therefore would be less resilient depending on the time of the year.

Socially, research participants recalled many times where the community "rose to the occasion" during periods of difficulty and/or isolation.

> *"Glenorchy has a strong and deep community network that is easily called upon in emergencies."* – *Research participant*

As discussed in the 'Community' section of this report, the Head of the Lake has a strong community, whereby everyone comes together and "chips in" in difficult times. In most discussions with research participants, people expressed confidence that the community would pull together and help each other in a natural hazard event. Based on discussions with research participants, locals also have a good understanding of who is most vulnerable or who would need checking on in an emergency. Some locals also have unwritten agreements with neighbours to pool together their resources and live together if they were to become isolated, or if one of their homes were unliveable and they had nowhere else to go.

One research participant talked about the inherent resilience of the community because of where it is located. This was echoed by several other research participants that believe part of the reason why many people move to the area/live in the area is because of its isolation and the particular lifestyle this requires. Others commented that this was likely more a sentiment of older generations, or people who had lived in the area for a long time and had an understanding of what it meant to live in a small, isolated community.

> *"The older generation are very pragmatic about resilience. They understand they are a rural community at "the end of the line", therefore they have to have a certain level of resilience".* – *Research participant*

From discussions with research participants, people that have lived in the community for a long time tend to monitor the weather (e.g., forecasts, lake and river levels) and know when or at what stage they need to take action. In comparison, some research participants expressed concern that newcomers to the community (including visitors and people that stay in the area temporarily) do not understand the risks or are apathetic about the natural hazardscape.

> *"Longer-term residents have demonstrated worry and a sense of responsibility to "school up" newcomers on resilience".* – *Research participant*

Whilst some research participants were confident in people's ability to look after themselves, others thought some parts of the community would require support (refer to 'Vulnerabilities' section of this report). For this reason, some research participants were hesitant to label the community as "resilient" because they believed the community would require support, particularly in the medium-long-term following an event (i.e., when resources were exhausted). Others acknowledged that the community was growing and changing, therefore, things that worked in the past may not work in the future.

> *"Sometimes if you present as resilient and self-sufficient, authority presume you will be fine but that is not necessarily the case"* – *Research participant*

6.4.2 Tolerance

Research participants were asked questions to understand their tolerance of natural hazard events, in terms of what they would need to remain functioning or in place to remain living in the community.

The level of tolerance varied among research participants, however most expressed that they would remain in the community for as long as they feasibly could.

> *"I'd stick around – I'm entrenched in this place"* – *Research participant*

> *"As long as there are still people here, and two thirds of the dwellings are still habitable, I would say we would probably stay put."* – *Research participant*

For some, tolerance would depend on the availability and access to key infrastructure and facilities, such as the Glenorchy School and gas/fuel. For example, children staying connected with other children and being able to play sport oustide the community and connect with other schools in the district (e.g., cross-country, camping) was viewed as important by one research participant.

"It would be important to us later that the school is operating" – *Research participant*

Access to medication and health care was also highlighted by some research participants as important. In a similar vein, several research participants highlighted the importance of moving around the community to access or share resources.

If people lost their homes, one research participant commented that the cost of housing would mean that many people in the community would have to leave the Head of the Lake to source affordable housing (i.e., many long-term residents bought their homes 20 years ago). On this topic, several research participants said they would be open to relocating somewhere else in the community if they had to (i.e., if their home was no longer liveable) and it was made possible. However, from discussions with research participants, there not a lot of viable land to build on. In this sense, one research participant commented that people's tolerance would depend on the certainty and timing of options in relation to housing. Others expressed concerns about the impact that "splitting up" the communtiy would have on social cohesion and community-spirit.

Business owners and operators that participaed in the research expressed little tolerance for medium-long term impacts. As summarised in the 'Utilities' section, many businesses are dependent on transporting people and/or resources into and/or out of the Head of Lake, therefore an extended road closure would impact their ability to operate in the area.

"After a month, I would have to find resources to get into town so that the business could continue operating" – *Research participant*

Simialrly, some research participants seemed to think people could 'get by' financially in the short-term following a natural hazard event, however in the medium-long term, people would need an income stream to afford to remain living in the community.

6.4.3 Vulnerabilities

Based on discussions with research participants, there are several vulnerable sectors of the community:

- **The high-needs community**. Those with mental health challenges, or without adequate resources or plans in place to prepare for and recover from a natural hazard event. This part of the community is mostly likely to rely on other members of the community.
- **Tourists / visitors to the area**. This part of the community would require shelter, resources, and transport out of the area *"…getting tourists and visitors [out of the area] will be the first priority"* – *Research participant*
- **People with multiple low-level, low-income jobs and unemployed**. This part of the community may need support to afford to remain living in the community.
- **Temporary workers**. Those who have short-term jobs in the Head of Lake and are newer/temporary members of the community.
- **The older population**. This part of the community may need support to evacuate their homes safely and are more likely to require health or medical care.
- **Young children and families that do not have wider family in the area**. This part of the community may require support (e.g., physical, economic, mental/emotional).

Several research participants also expressed concerns about the breadth and depth of emergency services personnel in the area. Specifically, research participants were concerned that the people with specialist skills would be spread thin in an emergency. Similarly, one research participant commented on the risk of volunteers "burning out". It was also highlighted that key emergency infrastructure such as the Fire Station and St John's ambulance are located in an area highly susceptible to liquefaction and flooding, which places this service, and communities' access to this service, at risk in these events. From discussions with research

participants, Camp Glenorchy gives many locals confidence in the resilience of the community (assuming this resource is not depleted by tourists / visitors).

7 Wider region dependencies

7.1 Economic

Both domestic and international visitors to the Queenstown Lakes District are arriving with the expectation of an outstanding natural environment and scenery. Visitors seek opportunities to experience the region through recreational and tourism activities.

Carlaw et al. (2018) undertook an analysis to quantify the economic benefits generated by international visitors to the Queenstown Lakes District. This found that tourism to Queenstown Lakes District generated $632 million in GDP. Employment sustained in the district as a direct impact of tourism, was estimated to be 8,600 FTE. This is a significant proportion of international tourism GDP nationally. Carlaw et al. estimated tourism in the Queenstown Lakes District to generate 75% of the national tourism total GDP ($845 million) (Carlaw et al., 2018). Tourism in Queenstown is therefore not only important to the region, but the national economy.

Glenorchy has long been a popular attraction for visitors wanting to explore the natural landscape. Approximately 28% of domestic visitors and 32% of international visitors arriving in Queenstown also visit Glenorchy (QLDC, 2023a). Without access to the landscapes and activities available in areas such as Glenorchy, Queenstown would likely be less attractive to tourists. The prosperity of the region both economically and environmentally, and the sub-areas within it, are therefore highly dependent on one another.

There are several tourism businesses located in Queenstown, which operate in the Head of the Lake. From discussions with local businesses, these include large tour and transport operators, and some wedding vendors. From discussions with a small sample of businesses operating within Glenorchy and Queenstown, most rely on the Glenorchy-Queenstown Road to access the Head of the Lake. However, few businesses have access through water transport. Most operate in all seasons and weather, but do not take risks if it threatens the safety of their staff and customers.

7.2 Social

Some Queenstown residents and tourist operators are dependent on the Head of the Lake as the location of their job, or the location or their business operations. Other industries that work in the Head of the Lake but are based elsewhere include the film industry, wedding industry, construction, logistics and local and central government departments.

Some residents of Queenstown and the wider Otago region have family members located at the Head of the Lake and are therefore dependent on access to and from the Head of the Lake for social connection. Particularly, many older members of the Head of Lake community move to Queenstown, or other locations in Otago, when they require easier access to amenities such as health services. These people often have family members and friends located back in the Head of the Lake community.

Around 27% of dwellings in the Head of the Lake community are unoccupied (StatsNZ, 2018). These are likely to be either holiday homes or part-time residences, which are likely owned by families in the Otago region or further afield, including overseas.

8 Exploring current resilience under natural hazard scenarios

8.1 Indicative natural hazard scenarios (specified by Otago Regional Council)

In this section of the report, the social and economic impacts of three indicative natural hazards scenarios are assessed to better understand the resilience of the Head of the Lake community to potential natural hazard events under 'status quo' conditions. 'Status quo' conditions refer to both the current community, and the natural hazard management measures currently in place (such as emergency management and the existing floodbank).

To enable this assessment to explore the potential social and economic consequences of natural hazard events at the Head of the Lake, ORC provided three indicative scenarios based on available science and information at the time the SEIA was commissioned. The three scenarios pertain to:

1. A major Alpine Fault earthquake
2. A major flood event
3. Repeated, moderate flooding events.

The three scenarios provide context to assess the potential social and economic impacts of a major earthquake[19] and flooding events, and moderate but repeated flooding events. Details of the scenarios which have informed this assessment are provided in Appendix E. The scenarios are descriptive (not predictive or associated with a specific likelihood).

Appendix E details the technical studies that the indicative scenarios have been based on.

As specified in Chapter 3, more detailed qualitative and quantitative natural hazard risk analysis is being undertaken by Beca Ltd in parallel to this SEIA. The risk analysis broadly considers the above hazards.

8.2 Status Quo – Vulnerability and adaptive capacity of community

This section assesses the current status of the community with regards to social and economic vulnerability and adaptive capacity. To achieve this, the current **exposure** of social and economic dependencies (e.g., homes, livelihoods and essential infrastructure) to natural hazards is considered. We then consider the existing social and economic **sensitivities,** and the Head of the Lake community's capacity to **adapt**/withstand an event (refer to the 'Socio-economic impact methodology' section).

8.2.1 Exposure

8.2.1.1 Direct exposure

Based on technical studies on the susceptibility of the Head of the Lake to natural hazards, it appears that the Glenorchy township is the most vulnerable in terms of the number of natural hazards it is exposed to (Tonkin & Taylor, 2023; Gardner, 2022; Gardner & Beagley, 2023). Depending on the severity of the flood, a proportion of houses in the Glenorchy township are likely be impacted by flooding (based on visual interpretation of modelled flood depths in studies by Gardner (2022) and Gardner & Beagley (2023)) (Gardner, 2022). Some houses on rural properties are on areas of higher ground, where possible. However, based on visual interpretation of the modelled flood depths in the Gardener (2022) and Gardner & Beagley

[19] The possible effects of an Alpine Fault earthquake include seismic shaking, liquefaction and lateral spreading.

(2023) studies, sections of these properties nearest the rivers may be inoperable until water resides, and debris is cleared. Properties where there are steep embankments may experience landslips as well.

Figure's 8.1 and 8.2 below show the modelled Rees/Dart Rivers and Buckler Burn 100-year ARI[20] flood depths, in relation to key community services and amenities in the Glenorchy township.

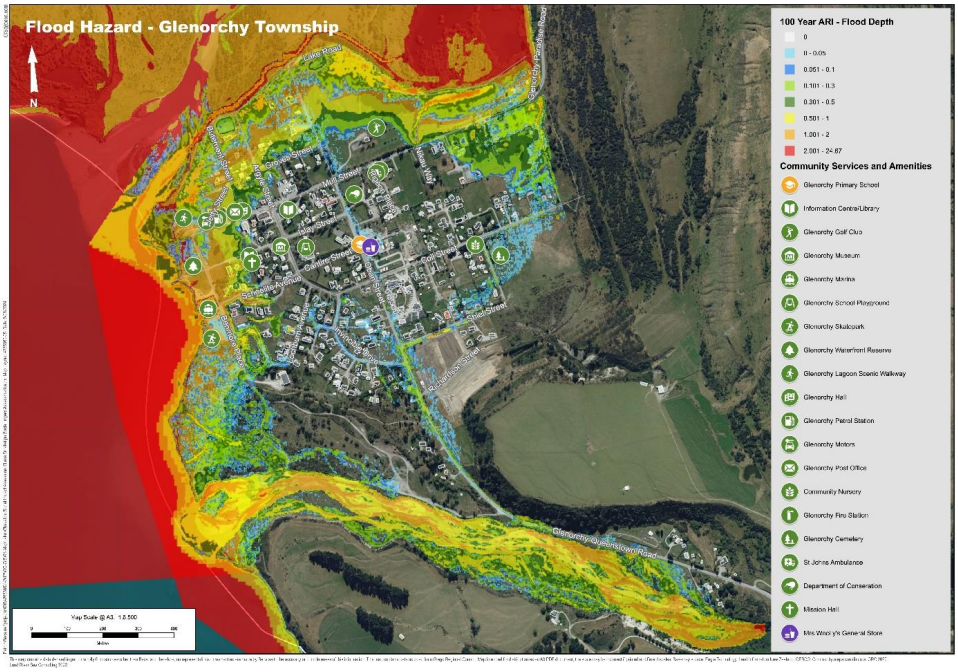

Figure 8-1: Rees/Dart Rivers 100-year ARI – Glenorchy Township (base map created by Beca Ltd, using flood hazard mapping from Land River & Sea (Gardner, 2022; Gardner & Beagley, 2023). Key community services and amenities have been added to the map for the purposes of this report.

[20] ARI is the acronym for 'Average Recurrence Interval'. ARI describes the probability of a flow of a certain size occurring once every 100 years on average.

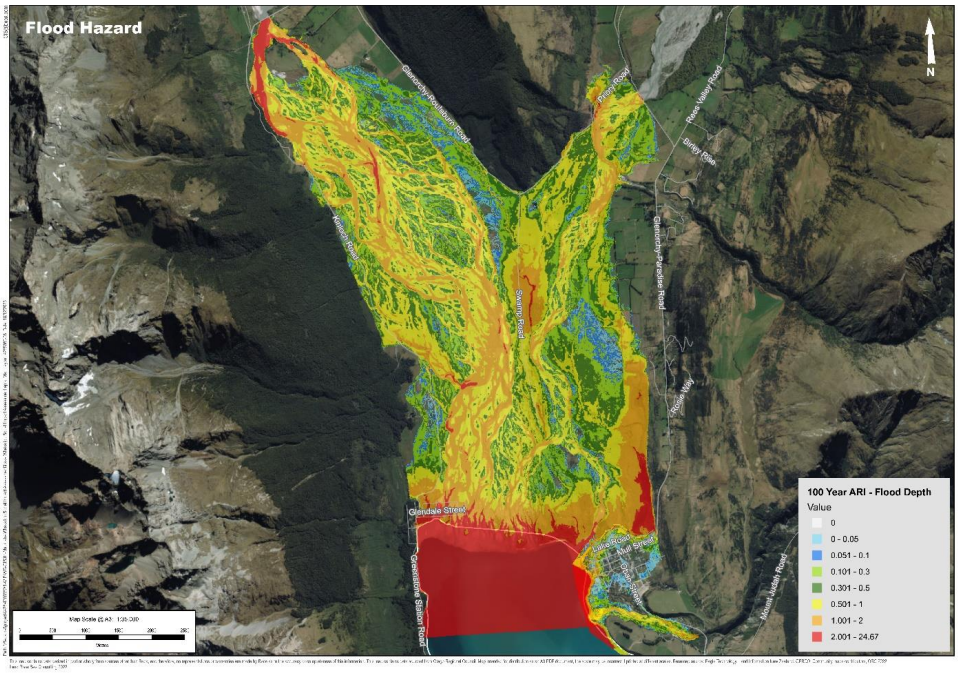

Figure 8-2: Rees/Dart Rivers 100-year ARI – Head of the Lake (base map created by Beca Ltd, using flood hazard mapping from Land River & Sea (Gardner, 2022; Gardner, 2023). Key community services and amenities have been added to the map for the purposes of this report.

Based on the study by Tonkin & Taylor (2023), it appears that a large proportion of the Glenorchy township would be vulnerable to liquefaction and lateral spreading following an Alpine Fault earthquake. The liquefaction and lateral spreading vulnerability of areas outside of the Glenorchy township is less known. Liquefaction and lateral spreading in these areas would likely depend on the shaking intensity experienced, ground conditions, and designs of buildings and infrastructure.

Figure 8.3 below shows varying zones of liquefaction vulnerability and lateral spreading ground damage, in relation to key community services and amenities in the Glenorchy township, It should be noted that the boundaries between the various zones are not precise and that areas of more or less damage could occur on either side of the boundaries.

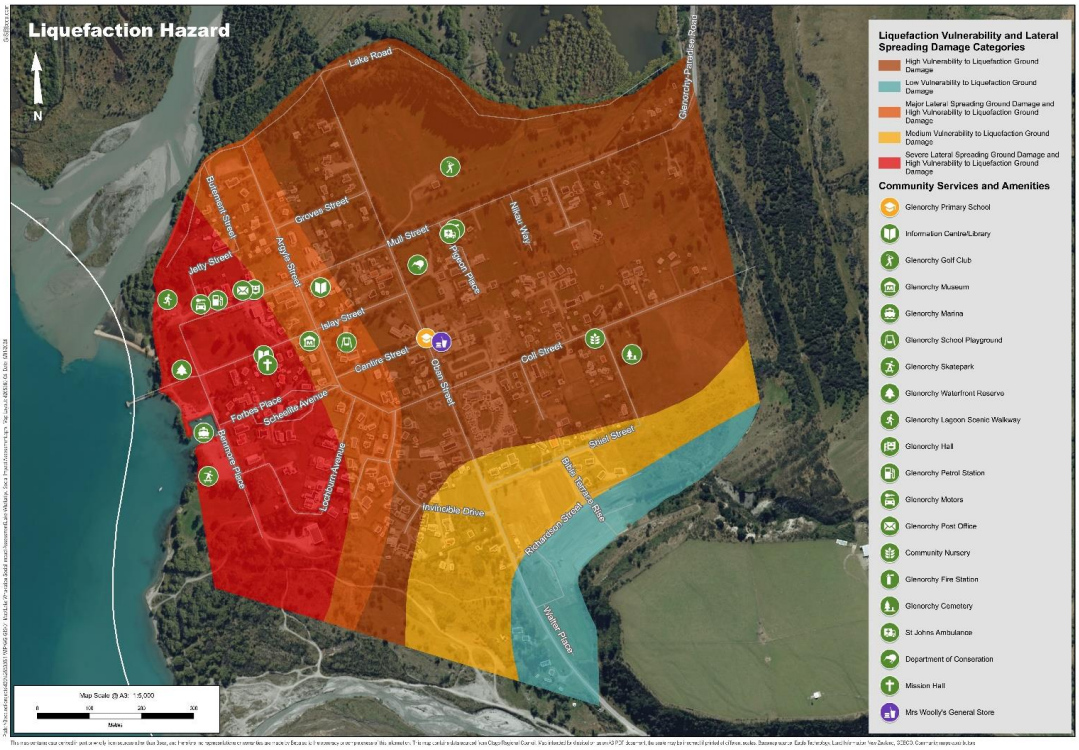

Figure 8-3: Liquefaction vulnerability and lateral spreading ground damage areas, in relation to key community services and amenities in the Glenorchy township (base map created by Beca Ltd, using liquefaction hazard mapping from Tonkin & Taylor (2023)). Key community services and amenities have been added to the map for the purposes of this report.

8.2.1.2 Indirect exposure

As described in the 'Utilities' section of this report, the Glenorchy-Queenstown Road is essential to the functioning and wellbeing of the Head of the Lake community. The community is dependent on the road to access goods and services (i.e., health, education), as well as employment, employees, and consumers of goods and services (i.e., to support local business). The Queenstown-Glenorchy Road is susceptible to damage from both flooding and a seismic event. The level of damage and therefore duration of road closure is likely to increase with the severity of the event both in terms of flooding and earthquakes.

Other roads and bridges are important to connect more isolated areas to the Glenorchy township and beyond (e.g., Mull Street / Glenorchy-Paradise Road, Glenorchy-Routeburn Road, Kinloch Road, Rees River Bridge, Dart River bridge). These are also susceptible to damage and inundation.

As described in the 'Utilities' section of this report, power supply has become more resilient in recent times and works are under way to improve the services. However, it is likely that power services would be compromised during a natural hazard event.

The water supply network in the Glenorchy township and the two reservoirs on Bible Terrace are susceptible to damage from an earthquake. Rural properties in the Head of the Lake provide their own water supply, and most are confident of water being available, based on discussions with research participants.

Currently households across the Head of the Lake manage and treat their own wastewater at their properties, and these wastewater supplies may be damaged during an earthquake.

8.2.2 Sensitivity

8.2.2.1 Social

As described in the 'Community perceptions of resilience' section of this report, there are several sectors of the community that are particularly vulnerable to natural hazards. Namely, the high-needs population, elderly, young people and families, tourists/visitors, people with multiple, low-level, low-income jobs, and temporary workers.

a. Age

From discussions with research participants, the youngest and oldest members of the Head of the Lake community are most vulnerable when facing natural hazards. In this area there are relatively small populations of younger and elderly people. With regards to elderly people, the demands of living in the Head of the Lake requires a level of health and mobility. This is due to limited health care, no formalised support services, no retirement facilities in the area, and the physical demands of the lifestyle. This is reflected in the statistics of the area with no one in the Head of the Lake aged over 65 reporting activity limitations (StatsNZ, 2018).

b. The high needs community

Members of the community without adequate resources or plans in place to prepare for and recover from a natural hazard event are also highly vulnerable to natural hazard events. Depending on the extent of damage / duration of road closures, this sector of the community is likely to rely heavily on local resources for support. Based on discussions with research participants, there are a large number of people in the community that hold down various, low-level, low-income jobs. Based on the latest Census data (StatsNZ, 2018), 1.5% of the population at the Head of the Lake are also unemployed. This sector of the community may also need support in the form of employment or financial support to afford to remain living in the community.

c. Tourists/visitors

Similar to the high-needs community, tourists/visitors are likely to rely heavily on local resources for support in a natural hazard event (e.g., food, shelter, transport). Depending on the extent of damage / duration of road closures, this sector of the community may need to be accommodated within the community for an extended period, until they can be transported out of the area.

d. Health and disability

Again, the demands of living in the Head of the Lake requires a level of health and mobility. These demands are likely to increase in a natural hazard event, therefore those with a high level of physical health needs and disability are likely to be vulnerable. There are currently relatively low levels of physical limitations and disability reported in the community (2.6%) (StatsNZ, 2018). Children aged 5-15 years of age reported the highest levels of physical limitations and disability. The reason for why this group has a higher level of physical limitations and disability is unknown, but a possible explanation could be that one might not choose to move to the area if they have mobility limitations. However, if born into the area with family connections and support this may be more sustainable. It would be more difficult for those who wish to live independently.

As outlined in the 'People' section of this report, there are few statistics reported for health. However, research participants noted that mental health was as concerns for members of the community. One reason given was that the Head of the Lake attracts people hoping to escape the 'rat race' and recover from the mental demands of a busy urban lifestyle, as well as those seeking a more solitary lifestyle. Another reason

given was that living in the area can be socially isolating, which can take a mental toll on people, and the Head of the Lake does not currently have programmes in place to identify these issues early and provide primary care.

Of note is that the Head of the Lake community is a small community and often people "wear many hats". In a natural hazard event, these people would be susceptible to high levels of fatigue from trying to address both their household and community's challenges.

Economic

e. Income

Based on the 2018 Census results, there is a large range of incomes in the Head of the Lake (StatsNZ, 2018). Based on discussions with research participants, many residents have a more subsistence or transient lifestyle, taking casual employment where required and living in mobile or rented accommodation. On the other hand, some residents are extremely wealthy. These people often identify the Head of the Lake as their second home or part-time residence, with many being based overseas.

f. Reliance on single industry

As referenced in the 'Economic overview' section of this report, the Head of the Lake's economy is driven largely by tourism (Infometrics, 2023). The next largest industries, being hospitality and film production, are also highly dependent on one another. Based on discussions with research participants, film production generates more tourism in the area (e.g., Lord of the Rings) and depends on hospitality to house and service workers. Similarly, hospitality and tourism operators depend on each other to attract visitors. A business operator interviewed as part of this research commented that, *"People expect things to do when they get here".* While this dependency is economically beneficial, it leaves the community vulnerable to external fluctuations, such as visitor numbers, infrastructure, and natural resources.

g. Reliance on visitors

Changes in visitor numbers has considerable influence over the community's economic stability. Figure 8-4 shows the reduction of visitor spending in the region (Queenstown NZ, 2023a) as a direct consequence of reduced visitor numbers during this period[21]. This figure shows how post the Covid-19 pandemic in 2020, a reduction in visitor numbers causes reduced visitor spending in the area. The impact of reduced visitor numbers causes large financial pressure on both the local economy and people's livelihoods. Section 5.6 shows how the number of employees (Figure 5-19) and GDP (Figure 5-21) in the Head of the Lake declines in response to the reduction of tourism post Covid-19.

[21] Visitor numbers for the Head of the Lake was not directly provided. Instead, visitor numbers were estimated based on the percentage of domestic and internationals visitors in Queenstown that also visit Glenorchy (QLDC, 2023a). This percentage was then applied to the available visitor estimates for Queenstown (Queenstown NZ, 2023a).

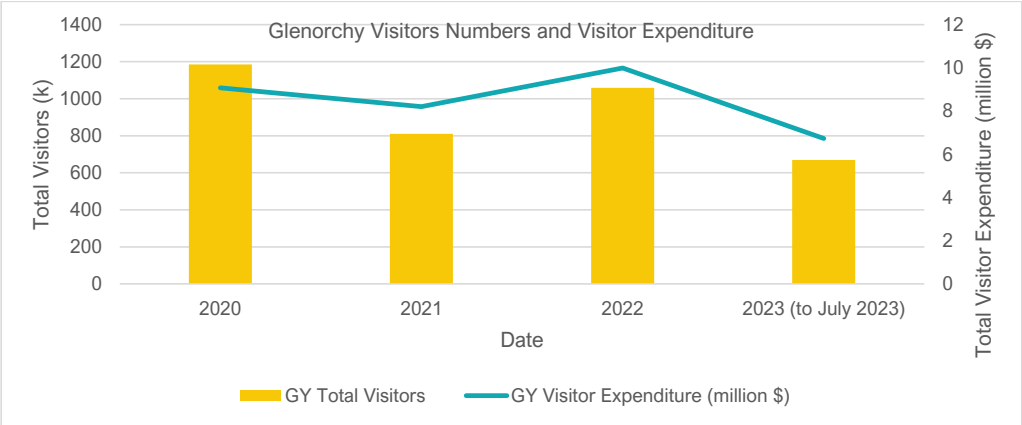

Figure 8-4: Glenorchy total estimated visitors (QLDC, 2023a) and visitor expenditure (Queenstown NZ, 2023a)

h. Reliance on built infrastructure

One of the largest challenges for the area is accessibility. As described in the 'Roads' section of this report, most businesses noted a dependency on roading and telecommunications for operations. For businesses in the tourism and hospitality industries, road closures would cause immediate loss of income. In addition, disruptions in telecommunications limits contact with tourists for bookings.

The Head of the Lake is particularly sensitive to closures along the Queenstown-Glenorchy Road, as this restricts vehicle access to the entire Head of the Lake community. Access may be possible during a natural hazard event by helicopter or boat if it is safe to do so, however based on discussions with research participants, the initial focus is likely to be on transporting tourists/visitors out of the area.

For other industries, operations can operate under disruptions for a short period as usual, unless damage to infrastructure is directly on their land/business.

i. Reliance on natural resources

Many businesses directly or indirectly depend on Head of the Lakes natural resources (e.g., mountains, lake, rivers, landscapes) for the operation of their businesses. Minor changes to the landscape and natural features, such as smaller slips caused by heavy rainfall, are unlikely to cause significant economic impact. For example, a 4WD tourist operator that was interviewed as part of this research noted that they frequently adjusted their operations to accommodate for minor changes to their route such as slips, treefall, and river widening.

On other hand, large-scale changes to natural features (e.g., large slips, widespread liquefaction) caused by natural hazard scenarios have the potential to be critical to all industries. Many tourism operators are dependent on the landscape directly, such as hiking services, land-based activities, and water-based activities. Wedding and film industries are also dependent on the natural features that the Head of the Lake is known for. Large changes to the natural landscape are therefore likely disrupt the operations of such businesses. In addition, tourists are attracted to the area for the beautiful scenery. Large-scale damage to the natural landscape could cause a decline in the area's attractiveness if sustained.

The agriculture industry directly depends on the land. Any damages to agricultural land, would put people's business and livelihoods at risk. As discussed in section 5.6.7, these are predominately high-country station farms. Given the size of these properties, there is more capacity for stock to be moved to undamaged pastures.

8.2.3 Adaptive capacity

This section considers the adaptive capacity of the Head of the Lake community from a social and economic perspective. Adaptive capacity can be understood as the capacity of a community to anticipate, cope with, and recover from the effects of a natural hazard event.

Social

a. Decision making and leadership

The Head of the Lake community has several governance structures in place for decision making and leadership (refer to 'Governance' section of this report). In regard to emergency management, leadership and decision making largely relies upon local volunteers. Namely, the Community Response Group (CRG), the volunteer fire brigade, and volunteer St John's first responders.

As outlined in the Community Response Plan, the CRG's role is to provide information and support to the community whilst supporting Emergency Management Otago's official CDEM response. In a rapid-onset event, the CRG will provide quality local information to the Emergency Management Adviser for the Queenstown Lakes District. During a slow-onset event, key information is likely to come from the EMA in the form of official assessments from regional and national sources. The Community Response Plan also provides guidance with regards to the responsibilities and actions of local emergency services.

In relation to preparedness and recovery, much of the community infrastructure in the Head of the Lake has been created as part of community initiatives and therefore may not have formal or legislative frameworks in place for the recovery and reinstatement of these services. These community-led initiatives give agency to community organisations, such as the Glenorchy Community Association, to be responsible for, and make decisions regarding the community in ways that they know best. Whilst this is a strength of the community, it possibly highlights the need for more formal arrangements for critical community infrastructure. Other community infrastructure and services such as education and emergency services will have organisational decision making and leadership processes in place in regard to the resilience of infrastructure.

b. Financial security

The capacity of the community to cope with economic crises and losses would be dependent on each household's/business's individual circumstances, which would be reliant on the level of damage to property, local and central government decision making, insurance, financial commitments, savings, and the household's/business's ability to continue to earn an income.

Research participants also expressed concerns around the impact of natural hazard information (such as Tonkin & Taylor's report (2022)) on property value, insurances, and investment in the area, and the potential for this to affect their financial security.

> *"While I agree that we should prepare ourselves for possible emergencies from natural hazards I am disappointed and angry that the ORC has publicised Glenorchy as a dangerous place to live. The impact of natural hazards fails in comparison to the damage done to property values and increase in building and insurance costs" – Research participant*

The average national personal income as of 2018 (when Census data was collected) was $49,000 (StatsNZ, 2018). As of 2018, approximately 69% of the Head of the Lake population earned below the national average personal income (StatsNZ, 2018). From discussions with research participants, most people seemed to think that people could 'get by' financially in the short-term (depending on the severity of the event and individual circumstances), however in the medium-long term, people relying on an active income (i.e., not retired) would need a secure income stream to afford to remain living in the community.

For local roles in the hospitality and tourism sectors, these are known to be (excluding managerial roles) lower paying jobs, and there is an element of seasonality and temporality to these jobs which would be most susceptible to economic impacts. When describing the various sectors of the community, research participants indicated that there is a sector of the community was described by a research participant as having a "mosaic of income sources", or multiple, low-level, low-income jobs. Those earning lower wages are likely to have less financial security both in terms of savings and insurances such as income protection.

> *"People cobble together what they can because they have to [in order to live in the area]"* – *Research participant*

As a community, a lot of local clubs and organisations are dependent on volunteerism and fundraising for resources. Whilst there are some funds held by the community from annual events for community projects this is a limited resource.

c. Food and water security

As outlined in the 'Preparedness' section of this report, the levels of preparedness in the community appear to be mixed. Most research participants spoke about having a backup of food supplies that were imperishable due to previous experience of power outages and road closures or weather conditions. Some thought they would have enough backup of food supplies to last 2-3 weeks and access to alternative power and water supply. However, others appeared to be less prepared. These research participants expressed a desire to be prepared but not the imminent urgency or financial resources to set themselves up.

The local water reservoirs and individual water supplies were considered by research participants to be resilient (this may require further assessment). With regards to water and food security some research participants expressed concerns around provisions for visitors who would not have additional food supply, and therefore be reliant on local supplies. Large venues such as Camp Glenorchy has enough food supplies and resources to cater to 100 people for a couple of weeks.

d. Housing security

At present, the majority of residents have access to basic amenities[22] (4% of the Head of the Lake population reported no access, or access to only one basic) (StatsNZ, 2018). This may be those members of the community living in vans and or unconnected tiny homes. In 2018, all homes had access to a source of heating (StatsNZ, 2018). From discussions with research participants, there are some people choosing to live in vans but no reports of homelessness.

An assessment of the resilience of the housing stock has not been undertaken in detail. From discussion with research participants, some residents are aware of homes in areas known to flood. Also, it was noted by research participants that Camp Glenorchy was built to withstand an earthquake and flooding and housed the community generator.

Many research participants spoke of having alternate power sources (such as generators or batteries), manual ways to heat their homes (fires) and ways to cook (gas barbeques). However, some research participants thought that some of the newly built homes in the area only had heat pumps (noting that some were designed to be heated passively).

[22] Data on 'access to basic amenities' was collected as part of the 2018 Census. 'Access to amenities' indicates what basic amenities (e.g., cooking facilities, shower or bath, and electricity) are available inside an occupied private dwelling. The amenities need to be in working order to be counted in the Census.

It is noted that a large portion of the houses within Glenorchy township are within a liquefaction risk area. Research participants spoke of the need to temporarily house visitors during a natural hazard event, but then to also make temporary accommodation available to local residents without shelter.

e. Social connectedness

It was acknowledged by research participants that as the community grows there are likely to be more people that lack local social connections or networks or are less known to the rest of the community. However, in general, our assessment is that this is a very connected community with many different clubs and organisations that bring the community together and can be mobilised to provide functions in a state of emergency. Due to the community's relative isolation and level of self-reliance on meeting community needs, local residents have formed community structures to fill the gaps and are used to coming together to address issues or achieve goals.

f. Knowledge, awareness and skills to face natural hazards

As described in the 'Community resilience' section of this report, the Head of the Lake has a comprehensive set of skills, knowledge, awareness, and assets that they could draw upon in a natural hazard event. From the young to the elderly, there is a high level of awareness of the environment and in particular the rivers in terms of how they morph and change over time, water levels, and subsequent flooding risks.

> *"You can see climate change if you are connected to nature….you can't live here and not be aware of it…you need to be attuned to it" – Research participant*

Whilst there also seems to be a reasonable level of understanding with regards to earthquakes and the fault systems, and the more recent information of lateral spread and liquefaction, there was a sense among research participants that seismic events are more difficult to anticipate and prepare for.

Most research participants appeared to be very knowledgeable in terms of the potential risks of the different river systems and patterns of flooding. In terms of skills to face natural hazard events, research participants spoke of different phases of hazard response including preparedness, the emergency, and the recovery. In regard to preparedness, people spoke of different preparedness activities such as having designated community members who check river levels and plans to move household goods/stock from specific houses/properties if certain risks are evident. This was recounted by both school children and adults. People also spoke of having food and water supplies, alternate power and heating sources, and being aware of their property vulnerabilities.

In terms of an emergency, research participants spoke of being evacuated where necessary, having access to alternate forms of transport (i.e., boat and helicopter), and checking on neighbours. People also identified who would coordinate the emergency management response, who was more vulnerable and living alone, and the ways they would communicate with others. They spoke to the skills and resources of the community in self-managing and having access to heavy machinery to move debris and clear essential pathways.

g. Economic

From discussions with research participants, local business owners and operators are aware of the vulnerability that their geographical location, and reliance on tourism, puts them in. Our assessment is that the business community is highly resilient and do their best to balance the economic benefits of tourism and the landscape, with their way of life and need for economic stability. The businesses community also actively seeks sustainable operations to mitigate risks and ensure resilience in the face of challenges.

As outlined in the 'Sensitivity' section of this report, economic activities in the community are highly reliant on natural resources, critical infrastructure, and access points to wider region, leaving it highly vulnerable to natural hazard events. The immediate aftermath of a natural hazard event is likely to result in disrupted operations, limited mobility, and economic setbacks, therefore the community's ability to adapt in response to

a natural hazard event in the short-term is limited. In the long-term, there lies the potential for adaptation through the development of resilient infrastructure and operations.

9 Assessment of potential social impacts

Refer to Appendix E for the details of the indicative natural hazard scenarios referred to in this chapter of the report.

9.1 Indicative Scenario 1 – Major Alpine Fault earthquake

9.1.1 Way of life

9.1.1.1 Way people live

Figure 8-3 from the Tonkin & Taylor (2023) report shows the vulnerability of the Glenorchy township to liquefaction and lateral spreading damage. Approximately 50% of Glenorchy township falls within 'high' liquefaction hazard vulnerability zones, and an additional 30% within 'major or severe lateral spreading damage' zones.

In this scenario, 50% of buildings within the 'high' liquefaction hazard vulnerability zone suffer severe damage, and 75-90% to buildings within the 'major or severe lateral spreading damage' zone suffer severe damage to the point of being impractical or uneconomic to repair (Tonkin & Taylor, 2023). Depending on the shaking intensity, some buildings will also be damaged by seismic shaking in this scenario. At Modified Mercalli (MM) VIII level, Type 1[23] buildings will be heavily damaged, and some will collapse. Type 2[24] buildings will be damaged, and some will partially collapse, while some Type 3[25] buildings will also be damaged.

Consequently, a number of residents within the Glenorchy township would need to make a decision about whether to repair their properties or relocate. Whilst this would be dependent on decision-making processes, many people would at least require temporary relocation. Whilst the Canterbury Earthquakes and the consequential approach to property damage (Te Ara, 2023) is an example in New Zealand, it is not determined whether this scenario would be applied to the Head of the Lake and would be dependent on the significance of the event and government decision making.

Under this scenario, properties outside the Glenorchy township may also be damaged.

Many residents' lives would be disrupted temporarily, as minor repairs are undertaken, and as decisions are made about the reinstatement of infrastructure. This would have flow-on effects on people's livelihoods, social networks, education and the feasibility of remaining in the community. The level of disruption would

[23] Buildings with low standard of workmanship, poor mortar, or constructed of weak materials like mud brick or rammed earth. Soft storey structures (e.g. shops) made of masonry, weak reinforced concrete or composite materials (e.g. some walls timber, some brick) not well tied together. Masonry buildings otherwise conforming to buildings Types 1 to 3, but also having heavy unreinforced masonry towers. (Buildings constructed entirely of timber must be of extremely low quality to be Type 3) (Geonet, n.d.).

[24] Buildings of ordinary workmanship, with mortar of average quality. No extreme weakness, such as inadequate bonding of the corners, but neither designed nor reinforced to resist lateral forces. Such buildings not having heavy unreinforced masonry towers (Geonet, n.d.).

[25] Reinforced masonry or concrete buildings of good workmanship and with sound mortar, but not formally designed to resist earthquake forces (Geonet, n.d.).

also depend on the availability of temporary accommodation in the community (whilst there are many accommodation and holiday homes in the area, availability would be dependent on how much damage they suffered) and in the longer term, the availability of alternate land to build on and houses to purchase.

Decisions around whether to remain in the community would likely depend on attachment to place, social networks remaining, ability to earn incomes, ability to be housed, roading connections and community infrastructure. Based on discussions with research participants, it is difficult for residents to anticipate these impacts and the consequential decisions they would make, as they are dependent on a plethora of things, including how many people are in their household and the needs of each member of the household.

9.1.1.2 Way people work

Disruptions to the way people work are also likely in this scenario, either as a result of damages to the environments (including buildings) where people conduct business, or to the roads which people rely on to access employment, employees, goods, services, and as consumers of goods and services (i.e., to support local business).

Following the Canterbury earthquakes, many people either lost their jobs or were forced to change their working circumstances (e.g., travel to different premises to work, etc.) due to damage to extensive damage to buildings (Potter et al., 2015).

The duration of disruptions to the way people work in this scenario would be dependent on the extent of damage to environments where people conduct business, such as tourist destinations. Duration could range from the day of the event, to a month, to a permanent disruption if business closure results in job loss. Following the Canterbury earthquakes, there was a sharp decline in the employment rate, with the employment rate falling from 67% in September 2010 to 63% in September 2011 (Potter et al., 2015). This compared with employment growth for New Zealand as a whole of 1.1% during the same period (StatsNZ, 2011). The workforce in the Head of the Lake may reduce significantly in this scenario, depending on how many residents remained in the area.

Other jobs may arise due to the recovery effort that a resident may be able to transfer to and businesses may be able to pivot to cater for the recovery effort. Following the Canterbury earthquakes, the number of people employed in the construction sector increased greatly, with demand particularly high for carpenters, joiners, painters, concreters, plasterers, and general labourers (Potter et al., 2015).

9.1.1.3 Way people recreate

Following the Canterbury earthquakes, some community facilities where people used to meet (e.g., cafes, libraries, marae, cultural centres, schools) were damaged and closed down or relocated. This included the closure of a number of sport and recreational facilities. Furthermore, earth movements caused the closure of a number of tracks and paths that had been used by residents for recreation in the Port Hills, and alongside rivers, parks, and beaches. The threat of earth movements such as slips and falling rocks remained high for an extended period due to on-going aftershocks, restricting the use of these recreational sites (Potter et al., 2015).

In this scenario, disruption to recreation in the Head of the Lake is likely to occur due to local road closure, closures of walking trails, suspension of tourist recreation activities, and damage to the natural environment including cracks on land. This would impact both the local and wider community who use the natural environment for recreation purposes. The duration of disruption to recreation could range from a few weeks to a few months, depending on the activity requirements and the extent of damage to infrastructure that the recreation activity is reliant on.

9.1.1.4 Way people educate

In this scenario, initial disruptions may occur for school students in the Head of the Lake due to local road closures and potential damage to school buildings. For example, some students may not be able to access school (primary or secondary) due to road closures and may temporarily require online alternatives. The viability of Glenorchy Primary School reopening quickly would depend on the level of damage to school buildings and essential infrastructure (e.g., roads, water, power). Fluctuations on the school roll as students move in and out of the area could further affect the school's viability for opening and remaining open.

Within three weeks of the February 2011 aftershock in Christchurch, 84% of school students in the greater Christchurch area were able to attend school. However, more than half of secondary schools were 'site sharing', to enable two schools to use one school facility every day. Over 12,000 school students left their school and enrolled elsewhere, including at schools outside the region (Potter et al., 2015).

If the population in the Head of the Lake declined significantly post-earthquake, the structure of Glenorchy Primary School may need to be re-evaluated to accommodate a smaller roll. Based on discussions with research participants, this may result in some families choosing to relocate for schooling purposes if the size of the school no longer meets their requirements (i.e., a larger social environment for their children). Some families may also consider temporarily locating in Queenstown for secondary education if social resources allow.

9.1.2 Community

9.1.2.1 Community character

In this scenario, there may be disruptions to community character in the Head of the Lake as a result of damage to historic buildings. Heritage buildings were particularly affected by the Canterbury earthquake aftershocks due to the large number of unreinforced masonry structures. The impacts of the damage to these buildings on the community and sense of local identity is evident in the highly debated discussions about whether or not (and if so, how) to restore the Christchurch Cathedral (Potter et al., 2015). It is likely that some of the historic character in the Head of the Lake would be compromised in this scenario, and it would be dependent on the extent of damage as to whether it can be restored.

As evident in many communities such as Christchurch, where major damage occurs as a result of an earthquake, the character of the area often evolves to reflect this point in time when major rebuild occurs. For example, Christchurch's Earthquake National Memorial was a key component of the Central Christchurch Recovery Plan.

The 'feel' of the community may also change in the Head of the Lake in this scenario, as people move out of the area, and the community experience's a large influx of outside input and increased building activity. In the immediate aftermath of the February 2011 Canterbury earthquake there were reports of tens of thousands of people leaving the city. For most people, this was a short-term response to an emergency, as families wanted time out from the aftershocks and from the damage to their homes and workplaces (CERA, 2015). Population loss is likely to unsettle the close-knit community character in the Head of the Lake, and quiet, independent, and isolated sense of place, particularly in the short-term.

9.1.2.2 Community services

Much of the community infrastructure in the Head of the Lake is located in the 'high' liquefaction hazard zones mapped in the Tonkin & Taylor (2022) report. Assessments of the resilience of key community assets (e.g., the school, emergency facilities) is required as these would be essential to the response and recovery of the community.

In this scenario, road closures may impact internal and external access to community services. Whilst many of the community services the community are reliant on are located outside of the community (e.g., the hospital), the services provided within the community are also important for community wellbeing (i.e., emergency services, health clinic), cohesion (i.e., community hall, primary school and library) and convenience (i.e., local gas station and groceries).

The Head of the Lake community is largely reliant on access to the wider region (e.g., Queenstown) to access employment, employees, goods, services, and consumers of goods and services (i.e., to support local business). Most research participants highlighted access both within the community and to Queenstown as was essential to remaining in the community following a natural hazard event.

Road closures within and to/from the community may also impact the ability for the community to assemble to respond to the emergency and/or delay emergency services coming in to assist. Communities in the districts most affected by the Kaikōura earthquakes experienced temporary isolation due to loss of road access (e.g., Kaikoura, Hanmer Springs). Access was only possible by air and sea due to damage to/from road and rail networks. (MCDEM, 2016). It is understood that there is both boat and helicopter resources that could be utilised in the Head of the Lake if required.

Many of the community services in the Head of the Lake are dependent on volunteers who may be personally impacted in this scenario. This could impact the ability of the community to respond to the earthquake. Based on discussions with research participants, it is likely that people would volunteer during an emergency if they are able to, however key members of the community may be forced to relocate (either temporarily or permanently due to damage to residences). As a result, voluntary emergency services (i.e., fire and ambulance) may become short staffed. The ability of the community to self-sustain in short-term would also depend on the number of visitors that need to be taken care of and the number of resources (both human resource and food and accommodation) that would be taken up. Based on DoC track numbers for walks in the Head of the Lake, there could be more than 250 day visitors on any given day, as well as a large number of overnight trampers.

9.1.2.3 Community cohesion

In the short-term, it is very likely that the community would come together to respond, and community cohesion would be very high. Longer term, the community would likely experience large disruptions to the way it operates and comes together. Cohesion would depend on the viability of community members to remain in the community, who is left, and their role in the community. Equally, if some local businesses close down permanently, this is likely to impact the way that the community functions, depending on the community's reliance on the business/service.

Canterbury residents reported that the earthquakes helped increase sense of community, and also contributed to improving social connectedness immediately following the earthquakes, however some community connectedness was also lost as a result of people being forced to leave their homes and relocate to other areas within or outside the region (Potter et al., 2015).

The Head of the Lake community has historically been smaller and 'more remote and rural', however the makeup of the community it is likely to undergo significant changes, as other communities suffering earthquakes have. Following the Canterbury earthquakes, the proportion of children and young people leaving Christchurch city was estimated to be higher than it was for other age groups. This was a result of families with young children leaving the city and the outflow of students choosing not to return to Christchurch to study (Potter et al., 2015).

It is likely some key roles in the Head of the Lake community may need to be reallocated, and how the community performs certain roles may need to be re-evaluated. This may be difficult if population numbers decline, and key people leave the area.

Based on discussions with research participants, leaving the Head of the Lake is not an option for some community members due to attachment to people and place, and these people would adapt as required. For other community members, the decision would depend on the futures they can envision for themselves and/or their families, and the availability of the required resources and incomes sources.

9.1.3 Political systems

Much of the appeal for many people living in the community is the ability to make decisions for themselves and actions these. To demonstrate this, one research participant said, "If we want something to happen in the community, we do it ourselves as we cannot rely on it being provided for us" .The initial emergency response would likely be a combination of local decision making by the Community Response Group and wider CDEM support. In the longer term, a lot of the decision-making would be dependent on local and central government, and insurance companies. For a community that prides itself on independence and managing things for themselves, there is likely to be a high level of unrest at this stage, as residents would have limited ability to influence decision-making processes. Processes to facilitate both local decision-making, and expedience of local and central government decision-making would help facilitate the community's recovery. One research participant commented that people's tolerance of the living environment following a signficiant natural hazard event would depend on the certainty and timing of options in relation to housing.

9.1.4 Environment

In this scenario, the amenity and quality of the surrounding environment would depend largely on the extent of debris, cracks, liquefaction ejecta and landslips in rural areas and water ways. The amenity of the Glenorchy township would depend on the state of built infrastructure and essential infrastructure such as water supply and wastewater. In addition, sewage could cause an environmental issue if septic systems are damaged.

Damage to critical tourism infrastructure following the 2016 Kaikoura earthquake hampered the recovery of tourism businesses in Kaikōura (Stevenson et al., 2017). Uplift of the coastline resulted in shallowing of the marina and channel area, which stopped whale-watching and dolphin encounter business activity. The inability to provide these experiences had negative flow-on consequences for other tourism and hospitality operators in the township (Stevenson et al., 2017). The ability of locals and tourists to regain access to the Head of the Lake in this scenario would depend on the quality (i.e., required clean up), safety to access, and ability to access tourist and recreation destinations.

9.1.5 Health and wellbeing

In this scenario, the extent of physical injuries in the Head of the Lake would depend on what hazards people are exposed to during the earthquake (e.g., falling objects, landslips). Health may also be temporarily compromised due to damage to sewage systems and contamination of drinking water.

The ability to provide aid to people would depend on the availability of local ambulance officers and access roads around the community being open. Access around the community to check on vulnerable members of the community would be very important. Under this scenario, the community would require medical supplies and services to be flown in while the Glenorchy-Queenstown Road is closed.

Beyond the potential injuries from the event, fatigue would likely be a significant issue. Key members of the community that are part of emergency response services, or response efforts (e.g., operating machinery to clear debris) are most likely to experience fatigue, as there would likely be a high level of reliance on these members of the community. However, this impact would depend on the level of response required, and the

rest afforded to these community members. Outside services would need to relieve community members and provide substitution for key activities.

Essential health services are located in Queenstown or beyond and would need to be provided for. Stress (including financial stress) is likely to exacerbate physical and mental health needs and access issues, and fatigue may make accessing required services more difficult in the short-term.

Following the Canterbury earthquakes, health and welfare services were highly sought after for assistance with general stress symptoms (particularly immediately following the earthquakes), hyper-vigilance and anxiety. In 2012 (following the September 2010 and February 2012 earthquakes), Cantabrians reported suffering moderate or major distress related to aspects such as loss of facilities (34%), on-going aftershocks (42%), dealing with insurance issues (37%) and making decisions about damage, repairs and relocation (29%) (Potter et al., 2015).

Unlike the communities impacted by the Canterbury earthquakes, Kaikoura residents could not move in and out of the region freely, if at all following the 2016 Kaikoura earthquake. This meant that one of the major coping and mitigating factors reported for those involved in the Canterbury earthquakes; the ability to leave the area for respite, was not available for residents in the Kaikōura District (Johall et al., 2015).

9.1.6 Personal property rights

In this scenario, a large proportion of properties, particularly in the Glenorchy township, are likely to be damaged. An initial response would likely be an assessment of the habitability of these buildings and classification ‘stickering’ which indicates the safety of the building for occupation. This approach was taken to buildings damaged in the Hawkes Bay floods and Canterbury earthquakes. During the Canterbury earthquakes, owners could accept either a buyout of their properties from government agencies or negotiate with their insurer (Te Ara, 2023). However, under the current legislation, any buyout process following an earthquake event in the Head of the Lake would be reactive and ad hoc. A similar buyout process to that observed in Christchurch would remove homeowners’ personal property rights, including their ability to make decisions regarding their property. As observed during the Canterbury earthquakes, the process was slow and tedious, and displaced residents for an extended period. However, this process has since been streamlined to improve customer service (EQC, 2021). The potential impacts in this scenario would likely depend on the decision-making processes adopted for the Head of the Lake, and none have been predetermined at this stage. The expedience and communication of a process would be key to providing homeowners with certainty. Pre-determined alternative options for relocation may also assist in provided a wider range of options for landowners.

9.1.7 Fears and aspirations

Due to the uncertainty and predictability of an Alpine Fault earthquake, research participants expressed fears mainly in relation to houses prices, insurances, and perceptions of the community as being an unsafe place to live. However, some research participants expressed fears about how the community would manage in an earthquake event, and the viability, health, sustainability and vibrancy of their community following an earthquake event. Adaptation has the opportunity to address some of these fears and increase community resilience.

The documented vision for the Head of the Lake community is:

> *“A unique, inclusive community that fosters and embraces individuality, diversity and innovation, encourages resilience and promotes community vitality and collaboration. The Glenorchy community has a collective strong voice that advocates for positive change.*

Glenorchy has the infrastructure to support a thriving boutique local economy in keeping with the rural landscape, actively respects and enhances the natural environment, collectively works towards providing their own resources (self-sufficiency)."

Whilst research participants did not express aspirations for major growth or development in the community, people expressed a desire for progression and prosperity, which could be affected by an earthquake event.

The impact of this scenario on this community aspiration is largely unknown, however there is likely to be impacts on community cohesion, infrastructure, and the natural environment. The extent of these impacts would likely depend on the scale of damage, community transitions (members moving to and from the community) and the recovery process.

9.2 Indicative Scenario 2 – Major Flood

Some of the potential social impacts of a major flooding event would be similar to a Magnitude 8 Alpine Fault Earthquake event (Scenario 1). To avoid repetition, this section references the Scenario 1 assessment (refer to section 9.1) where similarities are anticipated, and highlights any differences including the likely extent, severity and duration of impacts.

9.2.1 Way of life

9.2.1.1 Way people live

In this scenario, disruptions to the way people live are likely. Specifically, impacted households may need to temporarily evacuate and access to essential infrastructure (e.g., water, power, telecommunications) is likely to be compromised. As well, road closures would impact daily routines due to loss of access within and to/from the community. These impacts are likely to be short-term (i.e., one to two weeks), and most houses would be able to be repaired depending on the extent of the damage, and the timing of governmental decision making and insurance processes. During this time, some locals may need to be temporarily housed in the township or local accommodation providers.

Depending on advanced warning, the time of year, and the time of day, visitors/tourists to the area may be able to be evacuated prior to the flooding event. Some visitors/tourists may need to be temporarily housed in the township or local accommodation providers (as evidenced in the 1994 Race Day floods). If local accommodation providers are at capacity, this may place strain on local resources and households (i.e., if residents need to accommodate a number of people for an extended period).

9.2.1.2 Way people work

Similar to Scenario 1, disruptions to the way people work are also likely in this scenario, either as a result of damage to the environments (including buildings) where people conduct business, or to the roads which people rely on to access employment, employees, goods, services, and consumers of goods and services (i.e., to support local business).

The duration of disruptions to the way people work in this scenario would be dependent on the extent of damage to environments where people conduct business, such as tourist destinations. In this scenario, roads would likely be closed for up to one month, however visitors/tourists to the area may be suspended for longer depending on the safety of the roads, and tourist destinations such as DoC tracks.

Alternate transport options such as transport by boat may need to be considered in the interim, depending on the timing in the year and duration of road closures.

9.2.1.3 Way people recreate

Similar to Scenario 1, disruption to recreation is likely to occur in this scenario due to siltation in the lake, local road closure, closures of walking trails, suspension of tourist recreation activities, and damage to the

natural environment including from debris and landslips. This would impact both the local and wider community who use the natural environment for recreation purposes. The duration of disruption to recreation could range from a few weeks to a few months, depending on the activity requirements and the extent of damage to infrastructure that the recreation activity is reliant on.

Disruption to recreation would likely occur due to sedimentation in the lake, local road closure, closures of walking trails, suspension tourist recreation activities, damage to the environment from debris and landslides. This would impact both the local and wider community who use this area for recreation. The duration could range from a few weeks depending on the activity requirements to months or more if particular infrastructure that the recreation activity is reliant on is damaged. Walking tracks could be particularly impacted and may be closed for an extended period depending on the required repairs. For example, in 2020, the Routeburn Track was closed for ten months following torrential rain and slips which severely damaged the Track including some of its facilities (DoC, 2020). The duration of track closures in this scenario would be largely dependent on the extent of slips and landslides, and how quickly debris is cleared.

9.2.1.4 Way people educate

Similar to Scenario 1, initial disruptions may occur for school students in this scenario due to local road closures and potential damage to school buildings. The viability of the Glenorchy Primary School reopening quickly would depend on how quickly roads reopen and access to essential infrastructure (e.g., water, power). Fluctuations on the school roll as students move in and out of the area could further affect the School's viability for opening and remaining open.

9.2.2 Community

9.2.2.1 Community character

Similar to Scenario 1, there may be disruptions to community character as a result of damage to historic buildings. It is likely that some of the historic character in the Head of the Lake would be compromised in this scenario, and it would be dependent on the extent of damage as to whether it can be restored.

The 'feel' of the community may also change in this scenario, if people move out of the area (e.g., while their house is being repaired) and the community experiences an influx of outside input. This has the potential to temporarily unsettle the close-knit community character.

9.2.2.2 Community services

In this scenario, much of the community infrastructure is likely to be resilient, or only suffer nuisance flooding and therefore would be able to be restored in reasonable timeframes.

Whilst many of the community services the community are reliant on are located outside of the community (e.g., the hospital), the services provided within the community are also important for community wellbeing (i.e., emergency services, health clinic), cohesion (i.e., community hall, primary school and library) and convenience (i.e., local gas station and groceries).

The largest challenge is likely to be external and internal access to these community services due to road closures. Temporary access is likely to be established through alternate access routes or alternate transport services. Refer to Scenario 1 for more information on reliance on external and internal access.

9.2.2.3 Community cohesion

In the short-term, it is very likely that the community would come together to respond, and community cohesion would be very high. The required effort to recover may impact some community members more than others, depending on their individual circumstances and the level of need to accommodate others.

During, and in the weeks immediately following the devastation of Cyclone Gabrielle, people demonstrated a high-level of care for their community, with many people volunteering their time to help others (Crimp, 2023; RNZ, 2023).

Similar to Scenario 1, in the longer-term, community cohesion in the Head of the Lake would depend on the viability of community members to remain in the community, who is left, and their role in the community. Equally, if some local businesses close down permanently, this is likely to impact the way that the community functions depending on the community's reliance on the business/service. These potential impacts are anticipated to be at a lower level than Scenario 1, as less people are likely to leave the community.

9.2.3 Political systems

As detailed in Scenario 1, much of the appeal for many people living in the community is the ability to make decisions for themselves and actions these. Similar to Scenario 1, the initial emergency response would likely be a combination of local decision making by the Community Response Group and wider CDEM support. In the longer term, a lot of the decision-making would be dependent on local and central government decisions regarding local infrastructure repair, and insurance companies' decisions regarding house repairs. Processes to facilitate both local decision-making, and expedience of local and central government decision-making would help facilitate the community's recovery.

9.2.4 Environment

Refer to Scenario 1 for potential impacts on the environment.

9.2.5 Health and wellbeing

In this scenario, the extent of physical injuries would depend on what hazards people are exposed to during the event (e.g., landslips). With sufficient warning, residents and visitors/tourists should be able to make themselves safe and evacuate if required. However, road closures may cause issues with evacuations, and accessing outside help/services (e.g., medical care). Health may also be temporarily compromised due to damage to sewage systems and contamination of drinking water.

Preliminary findings into the impacts of Cyclone Gabrielle indicate that mental and emotional strain caused by the cyclone is of upmost concern to the community (All Sorts, n.d.). Even among those who did not directly experience the brunt of the extreme weather, two-thirds of survey respondents reported experiencing secondary stress for the hardships of others. Other significant stressors identified included concerns over red or orange weather warnings, anxiety during rainfall, financial burdens, and increased work pressures (All Sorts, n.d.).

Refer to Scenario 1 for potential health and wellbeing impacts. Health and wellbeing impacts are still likely to be high under this Scenario (2) but are likely to impact a smaller proportion of the population, and over a shorter duration, compared to Scenario 1.

9.2.6 Personal property rights

In this scenario, impacts on personal property rights would depend on the extent of damage to properties, and the decision-making process for repairs. This would likely be dependent on both local and central government, and insurance companies. Refer to Scenario 1 for potential impacts. As per Scenario 1, the expedience and communication of a process would therefore be key to providing homeowners with certainty. Pre-determined alternative options for relocation may assist in provided a wider range of options for landowners.

9.2.7 Fears and aspirations

Based on discussions with research participants, most people have a high level of awareness of the environment and in particular the rivers in terms of how they morph and change over time, water levels, and subsequent flooding risks. However, the changing alluvial landscape does come with a level of fear and uncertainty as to the nature of potential flooding events. From discussions with research participants, climate change is also a concern, due to the likely increase in the frequency of flooding events, and the potential impact of this on local infrastructure such as bridges and local roads.

The documented vision for the Head of the Lake community is:

> *"A unique, inclusive community that fosters and embraces individuality, diversity and innovation, encourages resilience* and promotes community vitality and collaboration. The Glenorchy community has a collective strong voice that advocates for positive change.*
>
> *Glenorchy has the infrastructure to support a thriving boutique local economy in keeping with the rural landscape, actively respects and enhances the natural environment, collectively works towards providing their own resources (self-sufficiency)."*

The ability to withstand a major flood would impact the ability of the community to achieve these aspirations.

9.3 Indicative Scenario 3 – Repeated Moderate Floods

It is possible that the community would experience similar social impacts from a moderate, repeated flood (this scenario) to a major flood (Scenario 2), however the extent, severity and duration of the potential social impacts is likely to be less. To avoid repetition, this section references the Scenario 2 assessment (refer to section 9.2) where similarities are anticipated, and highlights any differences including the likely extent, severity and duration of impacts. Different social impacts associated with the cumulative effects of repeated flood events are also highlighted.

9.3.1 Way of life

9.3.1.1 Way people live

In this scenario, disruptions to the way people live are likely to be similar to Scenario 2, however less people are likely to be impacted, and for a shorter duration. Like Scenario 2, some visitors/tourists may need to be temporarily housed in the township or local accommodation providers.

9.3.1.2 Way people work

In this scenario, disruptions to the way people work are likely to be similar to Scenario 2, however less people are likely to be impacted, and for a shorter duration.

9.3.1.3 Way people recreate

In this scenario, disruptions to recreation are likely to be similar to Scenario 2, however the geographic extent of impacts, and the time required to clean up (e.g., clear debris) is likely to be less.

9.3.1.4 Way people educate

Similar to Scenario 2, initial disruptions may occur for school students in this scenario due to local road closures, however less students are likely to be impacted, and for a shorter duration, as it anticipated that roads would be reinstated quickly.

9.3.2 Community

9.3.2.1 Community character

Minimal impacts on community character are anticipated in this scenario. Most of the historic community character should be able to be preserved, and the feel and sense of place within the community is likely to be retained, as outside input would be limited to small areas of damage.

A small number of community members may choose to leave the community temporarily following repeated flooding events, as they may want time away from the damage to their home and/or business. This may temporarily unsettle the close-knit community character; however, this potential impact is anticipated to be minimal given the small number of buildings that are likely to be impacted in this scenario.

9.3.2.2 Community services

Refer to Scenario 2 for potential impacts on community services.

9.3.2.3 Community cohesion

In this scenario, it is very likely that the community would come together to respond, and community cohesion would be very high. Whilst the required effort to recover is likely to be small, repeated flooding may impact some community members more than others, depending on their individual circumstances and the level of need to accommodate others. Community cohesion may be impacted if these people choose to leave the community temporarily or permanently, however this impact is anticipated to be minimal given the small number of buildings that are likely to be impacted in this scenario.

9.3.3 Environment

In this scenario, environmental impacts are likely to be similar to Scenario 2, however the geographic extent of impacts, and the time required to clean up (e.g., clear debris) is likely to be less.

9.3.4 Health and wellbeing

In this scenario, the risk of physical injuries is expected to be low. There is likely to be similar health and wellbeing impacts as Scenario 2, however less people are likely to be impacted.

Community members whose homes and/or businesses are affected by repeated flooding are at higher risk of cumulative mental health and wellbeing impacts. In particular, these people are more likely to experience financial stress and anxiety during rainfall. As evidenced following Cyclone Gabrielle, other members of the community may experience secondary stress for the hardships of others (refer to Scenario 2).

9.3.5 Personal property rights

Refer to Scenario 2 for potential personal property rights.

9.3.6 Fears and aspirations

Refer to Scenario 2 for potential impacts on the community's fears and aspirations. Repeated floods have the potential to exacerbate fears relating to the uncertainty of flooding events.

10 Assessment of potential economic impacts

Refer to Appendix E for the details of the indicative natural hazard scenarios referred to in this chapter of the report.

10.1 Indicative Scenario 1 – Major Alpine Fault Earthquake

10.1.1 Damage to households

Figure 8-3 from the Tonkin & Taylor (2022) report shows the vulnerability of the Glenorchy township to liquefaction. Approximately 50% of Glenorchy township falls within 'high' liquefaction hazard zones, and an additional 30% within 'major or severe lateral spreading damage' zones.

In this scenario, an estimated 50% of buildings within the 'high' liquefaction hazard zone suffer severe damage, and 75-90% of buildings within the 'major or severe lateral spreading damage' zone are likely to suffer severe damage to the point of being impractical or uneconomic to repair (Tonkin & Taylor, 2023).

Depending on the shaking intensity, some buildings will also be damaged by seismic shaking in this scenario. At Modified Mercalli (MM) VIII level, Type 1[26] buildings will be heavily damaged, and some will collapse. Type 2[27] buildings will be damaged, and some will partially collapse, while some Type 3[28] buildings will also be damaged.

Based on the high proportion of buildings impacted by liquefaction and lateral spreading under this scenario and the median house price in the Head of the Lake ($900,000), the total damage to households in Glenorchy would be at least $100 million (OneRoof, 2023). This cost estimate assumes additional costs associated with the damage to buildings from seismic shaking in this scenario.

10.1.2 Repair of capital infrastructure

Large infrastructure repairs and replacements would likely be required in this scenario due to extensive liquefaction and lateral spreading damages. Replacement of roading infrastructure is estimated to cost $700,000 per km for local roads (Te Manatū Waka, 2023). This considers land, formation, pavements, bridges, drainages, culverts, traffic facilities, and other horizontal structures. Based on the length of the road network in Glenorchy that falls within the 'high' liquefaction or 'major or severe lateral spreading damage' zone (approximately 1-3km), repair and replacement of roading infrastructure would cost between $0.7 to $2.1 million in this scenario. This figure may be higher given the challenging terrain and if access via Glenorchy-Queenstown Road is also impacted.

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[26] Buildings with low standard of workmanship, poor mortar, or constructed of weak materials like mud brick or rammed earth. Soft storey structures (e.g. shops) made of masonry, weak reinforced concrete or composite materials (e.g. some walls timber, some brick) not well tied together. Masonry buildings otherwise conforming to buildings Types 1 to 3, but also having heavy unreinforced masonry towers. (Buildings constructed entirely of timber must be of extremely low quality to be Type 3) (Geonet, n.d.).

[27] Buildings of ordinary workmanship, with mortar of average quality. No extreme weakness, such as inadequate bonding of the corners, but neither designed nor reinforced to resist lateral forces. Such buildings not having heavy unreinforced masonry towers (Geonet, n.d.).

[28] Reinforced masonry or concrete buildings of good workmanship and with sound mortar, but not formally designed to resist earthquake forces (Geonet, n.d.).

10.1.3 Cost of response and relief

During the Canterbury earthquakes, clean-up costs were estimated to be $25 million for 500,000 tonnes of liquefaction ejected ejecta (Villemure et al., 2012). Based on observed liquefaction maps in Villemure et al.'s report (2012) these costs were spread over 125 km².

The Tonkin & Taylor (2022) report notes that liquefaction and lateral spreading in the 'high' liquefaction and 'major or severe lateral spreading damage' zones in Glenorchy township is expected to be comparable to or worse than Christchurch's red zones. Based on the clean-up costs for liquefaction ejecta in Christchurch's red zones (Villemure et al., 2012) and the spatial extent of the 'high' liquefaction and 'major or severe lateral spreading damage' mapped in the Tonkin & Taylor (2022) report (estimated 1 km²), this scenario would result in approximately 4,000 tonnes of liquefaction ejecta. This would cost approximately $200,000 to clean up.

10.1.4 Short-term economic losses

In the months following the 2016 Kaikoura earthquake, tourism operators in Kaikōura faced significant ongoing challenges apart from the positive inflow of response personnel. Kaikōura experienced an unprecedented drop in visitor numbers due to road closures and the negative perceptions of travel during a period of high seismicity (Stevenson et al., 2017).

Due to the likely closure of the Queenstown-Glenorchy and local roads for one to two weeks under this scenario, as well as the time required to respond and recover, the local economy would likely halt until usual travel can commence. For the tourism and hospitality industries, this would likely result in a direct loss of income. Based on average daily visitor spending (Queenstown NZ, 2023a), the direct impact of no tourism for one to two weeks could be between $250,000 and $500,000.

For other key industries, including film, agriculture, and trade, usual operations would likely be restricted. However, this would not necessarily result in direct loss of income. From discussion with research participants, these industries are capable of adapting operations in response to large disruptions (such as natural hazard events).

10.1.5 Long-term economic losses

Businesses interviewed as part of this research reported a sustained loss in revenue for three months following the 2020 Dart/Rees River flooding event. Assuming average daily tourism spending in the area (Queenstown NZ, 2023a) reduces by 50% for three months following a major Alpine Fault earthquake, this would be equivalent to a $1.5 million to $3 million loss in income. Due to the extent of damage and economic hardship experienced under this scenario, some businesses may be forced to close or struggle to return to usual operations.

10.1.6 Employment

As a result of the likely impact to the local economy under this scenario, employment would likely decline in the Head of the Lake. Depending on an employees' contract, immediate income may not be guaranteed, causing uncertainty and financial hardship for individuals and households. In the long-term, the impact to businesses may cause reduction in hours or job loss for the employees of affected businesses.

Beyond the direct impact, the impact on the local economy is likely to contribute to a broader reduction in employment across the community, as other dependent businesses may also experience setbacks.

10.2 Indicative Scenario 2 - Major Flood

10.2.1 Damage to households

40 dwellings in the Glenorchy township are anticipated to experience some level of flooding under this scenario, of which 20 are in locations where floodwaters are expected to be greater than 0.5 metres depth. According to Australian Disaster Resilience (AIDR) flooding greater than 0.5 metres has potential to cause moderate/high hazard to structures at moderate flow speeds (Smith & McLuckie, 2015). It is assumed that 50% of the homes at >0.5 metres are severely damage to be impractical or uneconomic to repair. Based on this assumption, 10 homes are unliveable.

Based on 10 houses being impacted to the extent of requiring a retreat and the median house price in Glenorchy being $900,000 (OneRoof, 2023), the cost would exceed $4.5 million. The occupants of the remaining 30 houses would likely experience temporary access restrictions, minor repairs, and debris, however they are likely to be able to return to their homes.

10.2.2 Repair of capital infrastructure

In this scenario, river erosion is likely to impact roading infrastructure and prevent access to some destinations within the community. This may require road repairs, and temporary access routes to be formed. The expected extent of damage is likely less than 1km of local roads, primarily observed around river crossings north of Glenorchy. The cost of replacement for this extent would be approximately $700,000, based on the replacement cost being $700,000 per km for the local roading network (Te Manatū Waka, 2023) which includes land, formation, pavements, bridges, drainages, culverts, traffic facilities and other horizontal structures.

10.2.3 Short-term economic losses

Based on discussions with research participants, the Kinloch Lodge has demonstrated high resilience, with research participants noting potential viability of access by ferry, and the ability to sustain itself independently for an extended period. Roads may also open sooner for temporary 4WD access to allow for the supply of goods and services. However, this would likely be insufficient to enable usual tourism activity. Based on the average daily visitor spending (Queenstown NZ, 2023a), the direct loss of no tourism due to the closure of Kinloch access roads for one month would be approximately $80,000. This is an estimation based on self-reported annual revenue range for businesses operating north of Glenorchy township.

In addition, an average of 55 overnight hikers and 100 day-hikers visits the Routeburn daily. The closure of Routeburn access roads for one month is therefore likely to cause direct loss of income for hiking tourism services, such as transport operators, accommodation, and guided tours. The decline of visitors also has the potential to reduce spending in other industries such as hospitality. Based on the average daily visitor spending (Queenstown NZ, 2023a) and that Routeburn hikers make up 35-40% of visitors to Glenorchy[29], this would result in a $375,000 to $425,000 reduction in tourism spending in the Head of the Lake.

Based on the average daily visitor spending (Queenstown NZ, 2023a), the direct loss of no tourism for one to two weeks due to the closure of the Queenstown-Glenorchy Road would be between $250,000 and $500,000.

[29] This has been estimated based on average daily hiker counts, and average daily visitors to the Head of the Lake

10.2.4 Cost of response and relief

Access roads on the Rees and Dart River plain are likely to be temporarily closed due to flooding in this scenario. In addition, potential debris impacts along the Routeburn and Kinloch access roads is likely to isolate these parts of the community for up to one month. The Queenstown-Glenorchy Road is also expected to experience debris impacts in this scenario, isolating the entire Head of the Lake community from the wider region for up to two weeks. Ferry and helicopter access may be possible to supply residents with essential resources. The estimated long-term economic losses associated with this reduction in access are detailed below.

10.2.5 Long-term economic losses

Under this scenario, business operations are unlikely to return to usual for one to three months. This is estimated based on businesses reporting as part of this research a sustained loss in revenue for 3 months following the 2020 Rees/Dart River floods. Assuming spending in the Head of the Lake reduces by 50% during this time, this would be equivalent to a $0.5 million to $1.5 million loss in income.

Beyond this, most businesses would recover in the long-term, assuming landscape or building damages have not directly impacted operations. Long-term economic losses would likely be less direct, such as increases in insurance premiums and less investment in the Head of the Lake. For more details refer to the ‘Potential economic impact across all scenarios’ section below.

10.2.6 Employment

Depending on an employees’ contract, immediate income may not be guaranteed under this scenario, causing uncertainty and financial hardship. In the long-term, business impacts may cause reductions in hours, but is unlikely to cause large job instability.

10.3 Indicative Scenario 3 – Repeated Moderate Flood

10.3.1 Damage to households

Approximately 10 dwellings are expected to experience flooding above floor level under this scenario. This would likely cause damage to both buildings and personal property, however, would likely not require complete relocation in the short-term. Owners of these affected properties would bear the financial burden of repairing the damage and replacing any contents that may have been lost or damaged, and face uncertainty and concern in the longer-term.

10.3.2 Repair of capital infrastructure

There is unlikely to be severe damage to capital infrastructure in this scenario. However, repeated flooding events have the potential to result in cumulative damage that requires ongoing repairs and maintenance. Continual investment in restoration is likely to become costly and is unlikely to mitigate risk, assuming infrastructure remains exposed to future inundations.

10.3.3 Cost of response and relief

In this scenario, some parts of the community are likely to be isolated for up to one week due to Rees and Dart River flooding and erosion, and debris impacts on Routeburn and Kinloch access roads. The Queenstown-Glenorchy Road is also expected to experience debris impacts in this scenario, isolating the entire Head of the Lake community from the wider region for up to two days. Ferry and helicopter access may be possible to supply residents with essential resources. The estimated short-term and long-term economic losses associated with this reduction in access are detailed below.

10.3.4 Short-term economic losses

Based on the average daily visitor spending (Queenstown NZ, 2023a), the direct loss of no tourism due to the closure of Kinloch access roads for one month would be approximately $20,000. This is an estimation based on self-reported annual revenue range for businesses operating in Kinloch. Furthermore, the closure of Routeburn access roads for two days would cause direct loss of income for hiking tourism services, as well as other businesses servicing hikers. Considering Routeburn hikers make up 35-40% of visitors to the Head of the Lake, this would result in a $85,000 to $95,000 reduction in income in the Head of the Lake based on daily visitor spending (Queenstown NZ, 2023a).

Based on the average daily visitor spending (Queenstown NZ, 2023a), the direct loss of no due to the closure of the Queenstown-Glenorchy Road for two days would be between $250,000 and $500,000.

10.3.5 Long-term economic losses

Whilst there is likely to be a short-term loss of income in this scenario, most businesses are likely to recover in the long-term. Long-term economic losses would likely be less direct, such as increases in insurance premiums and less investment in the area. In addition, repeated flooding events in this scenario may lessen public confidence in the environment, discouraging visitors and tourists. This could have flow on impacts on tourism and GDP. For more details refer to the ‘Potential economic impact across all scenarios’ section below.

10.3.6 Employment

Depending on an employees’ contract, immediate income may not be guaranteed under this scenario, causing uncertainty and financial hardship. In the long-term, the impact to businesses may cause reductions in hours, but is unlikely to cause large job instability.

10.4 Potential economic impact across all scenarios

10.4.1 Insurance losses

Following previous natural hazard events in Aotearoa, the insurance market has weakened due to the surge in claims and widespread property damage (e.g. Cyclone Gabrielle (Tibshraeny, 2024)). Insurance premiums are likely to increase as risk of natural hazard increases.

10.4.2 Less investments

Similarly, there is often a decline in both the value and number of investments following natural hazard events in Aotearoa, due to increased uncertainty and perceived risks of owning property in the area (Ministry for the Environment, 2020; Morton, 2022; Bell, 2023). The aftermath of natural hazard events can create an atmosphere of economic instability, causing potential investors to adopt a more cautious approach.

11 Conclusion

This report provides an overview of the Head of the Lake community in terms of its economic and social profile. It is noted that this is a well-functioning and motivated community that self-organises to meet community aspirations. The environment is the main reason why people live and visit the area. Part of living at the Head of the Lake is being aware of the environment and its changes. This community is largely aware of the unpredictability of nature and that living in the area does mean being susceptible to the dynamic environment, and in particular the fluvial environment. Climate change adds another level of complexity and is likely to increase the frequency and severity of flood events.

Over time, the community has become more reliant on the hospitality and tourism trade, and these industries are very susceptible to natural hazard events as the environment and access are often impacted and take time to recover. A major natural hazard event also has an impact in terms of visitor confidence to return to the area. A key issue for the community both socially and economically is the resilience of access t/from, and within the Head of the Lake area, as this is key to the community's social and economic wellbeing.

It is noted that the community is changing as it grows, and as new people settle in the area. Whilst much of the sense of place and values of the community appear to have been retained, the awareness of the environmental risks and corresponding preparedness may not be as front of mind for newcomers to the community as those who have experienced issues in the past. Therefore, newcomers to the community may not be as resilient in terms of preparedness and tolerance. This would need to be factored into planning for the future.

This information can be used to consider both the adaptation needs of the Head of the Lake community and the consequences of potential adaptation responses under consideration as part of ORC's Head of Lake Whakatipu Natural Hazard Adaptation Programme.

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A

Appendix A – Interviews and focus groups guides

Interviews

Participant(s)	Themes	Questions
Key stakeholders - QLDC	- Role - Functions - Description of the community from their perspective - Community values - Arts, culture and heritage - Tourism economic contribution - Film economic contribution - Key employment industries - Community objectives - Community concerns - Growth and development - Future investment in the community - 'Status quo' emergency management response - Role in emergencies - Community resilience - Risks - Challenges - Opportunities	- What is your role? - How would you describe the community at the Head of the Lake? - What is the tourism industry's contribution to the economy? - What is the film industry's contribution to the economy? - What does the community value in relation to arts and heritage? - What are the objectives or plans, if any, for arts and heritage at the Head of the Lake? - What are the challenges or biggest threats to arts and heritage, in relation to natural hazards? - If/what planning for growth or development has occurred in the area? - Is there any future investment and/or development planned for the community? E.g., community social infrastructure - What are the strengths of the community? - What are the vulnerabilities?
Key stakeholders - DoC	- Significance of the area to DoC - Operations in the area - Track / hut / visitor numbers - Potential impacts of natural hazard scenarios - Needs for operation - Access requirements	- What is your role in the community? - What are the average track/hut/visitor numbers? - How do natural hazards impact your operations? - If/what role do you have in emergencies / how do you respond in natural hazard emergencies? - Do you have a natural hazard plan? - What do you rely on accessing? - How do natural hazards impact the population you are responsible for? - What are the strengths of the community? - What are the vulnerabilities?
Key stakeholders – emergency service providers	- 'Status quo' emergency management response - Community resilience - Tolerance - Risks - Challenges	- What is your role in the community? - How would you describe the community at the Head of the Lake?

	- Opportunities	- If/what role do you have in emergencies / how do you respond in natural hazard emergencies? - Do you have a natural hazard plan? - What do you rely on accessing? - How long could you manage with the road in and out of Glenorchy closed? - How do natural hazards impact the population you are responsible for? - What are the strengths of the community? - What are the vulnerabilities?
Key stakeholders – community service providers (e.g., Community Association, Community Nurse, School Principal)	- Role in the community - Functions - Description of the community from their perspective - Access requirements - How road closures impact them (i.e., their tolerance for closure) - Role in natural hazard events - Impact of past and future events on role - Tolerance - Resilience - Concerns regarding the community (in relation to their role i.e., education, health etc)	- What is your role in the community? - How would you describe the community at the Head of the Lake? - What do you rely on accessing? - If/what role do you have in emergencies? - Do you have a natural hazard plan? - How do natural hazards impact your operations? - How do natural hazards impact the population you are responsible for? - How long could you manage with the road in and out of Glenorchy closed? - What are the strengths of the community? - What are the vulnerabilities?
Community organisation/club/group representatives	- Role in the community - Functions - Description of the community from their perspective - Access requirements - How road closures impact them (i.e., their tolerance for closure) - Role in natural hazard events - Impact of past and future events on role - Tolerance - Resilience - Concerns regarding the community (in relation to their role i.e., education, health etc)	- What is your organisation's role in the community? - How would you describe the community at the Head of the Lake? - What does your community organisation rely on access to? - If/what role does your community organisation have in emergencies? - What are the strengths of the community? - What are the vulnerabilities?
Business owners/operators	- Business activity - Reliance on connections into and outside of Glenorchy - Experience of natural hazards - Tolerance - Resilience	- Can you please provide an overview of your business activities in Glenorchy? - Are your operations for 2023, reflective of a 'usual' state? - Can you please describe any external connections that are crucial for the success of

	- Role in emergency management planning/response	your business, such as suppliers or customers outside of Glenorchy? - To what extent does the community at the Head of the Lake rely on your business? - To what extent do you rely on other local businesses to operate? - Has there been any significant natural hazard events in the past that have directly impacted your business? - How did your business cope with and recover from any previous natural hazard events? - In what ways (if any) has your business adapted (this could be operational or infrastructure) to mitigate vulnerability impact of natural hazards? - Are there specific natural hazards that pose a higher risk to your business, what is the risk and how do you address these concerns? - What strategies or measures does your business have in place to build resilience against natural hazards? - Are there specific resources or expertise that your business can contribute to the broader emergency management efforts in Glenorchy? - What are some of the challenges and opportunities do you see in conducting business within the Glenorchy area?
Semi-structured 'drop-in' interviews with residents	- Description of the community from their perspective - Values - Challenges of living in the area - Experience and impacts of natural hazard events - Resilience - Tolerance - Access requirements - How road closures impact them (i.e., their tolerance for closure) - Community vulnerabilities and resilience to natural hazards	- What is your occupation? - How long have you lived here? - Do you have any roles in the community? - What do you value about living in the area? - What are the challenges of living in the community? - If there was to be a flood or earthquake event in Glenorchy, what are the key things that you need to sustain yourself here? - What would make it unliveable/unsustainable? - What are the strengths of the community? - What are the vulnerabilities?

Focus groups

Queenstown-based businesses operating at the Head of the Lake	- Business activity - Reliance on connections into and outside of Glenorchy - Experience of natural hazards - Tolerance - Resilience	- What is your business? - What makes Glenorchy a unique and sought after destination? - If/how are you reliant on the Queenstown-Glenorchy Road? - How do you operate when you know there's big rains coming?

	- Role in emergency management planning/response	- How resilient is your business to natural hazard events?
Community representatives (e.g., residents and representatives of community organisations/clubs/ groups)	- Values - Sectors of the community - Assets in the community - Natural hazard vulnerabilities and resilience	- What's most important to the community? - What are the different sectors or clusters of the community? - What are the community's assets? - What are the community's vulnerabilities? - What are the community's strengths?
Glenorchy Primary School students	- Values - Movement (in, out and around the community) - Experience and impacts of natural hazards	- What do you like about living at the Head of the Lake? (brainstorm) - Where do you like to go in Glenorchy and why? (mapping activity) - What do you leave Glenorchy for and how often? (brainstorm) - What is your experience of when the roads have been closed or power has been cut?

B

Appendix B – Survey questions

Residents and businesses survey

1. Are you responding to this survey as a resident or a local business. *If you would like to respond as a resident AND a business owner, please fill out this survey twice, once as a resident, and once as a business.*
    - Resident
    - Business.

Business questions

1. Where is your business based?
    - Glenorchy
    - Kinloch
    - Paradise
    - Campbelltown
    - Rees Valley
    - Dart Valley
    - Greenstone Valley
    - Queenstown
    - Other
2. Where is your business based? (tick all that apply)
    - Glenorchy
    - Kinloch
    - Paradise
    - Campbelltown
    - Rees Valley
    - Dart Valley
    - Greenstone Valley
    - Queenstown
    - Other (free text box)
3. Where do you carry out your business?
    - Glenorchy
    - Kinloch
    - Paradise
    - Campbelltown
    - Rees Valley
    - Dart Valley
    - Greenstone Valley
    - Queenstown
    - Other (free text box)
4. Is your business dependent on its location (i.e., it relies on the land or specific local attractions)? Or you could operate your business from anywhere / you work remotely?
5. What sector does your business operate in?
    - Tourism
    - Hospitality
    - Retail
    - Horticultural
    - Agricultural
    - Construction
    - Home business (workshop/services)
    - Home business (office-based work)
    - Other (please state)

6. What are the primary products or services offered by your business? E.g., a construction company may offer construction materials, construction equipment, construction services, and/or project management services.
7. Is your business dependent on its location or could it operate anywhere (e.g., your business is location specific if it relies on the land or specific local attractions or you could operate your business form anywhere / you work remotely)
    a. Your business is dependent on its location.
    b. Your business could operate anywhere.
    c. Other
8. How long has your business been operating?
    - Less than a year
    - 1-5 years
    - 5-10 years
    - More than 10 years
9. How many staff does your business employ?
    - None
    - Less than 5
    - 5-10
    - 10-20
    - 20 +
10. Do your employees live in the Head of the Lake Whakatipu area?
    - Yes
    - Some
    - None
11. What is the Full-Time Equivalent of your staff (calculated by combining full time and part time staff)?
    - Less than 5
    - 5-10
    - 10-20
    - 20 +
12. Is your business seasonal? If yes, select all that apply.
    - Summer
    - Autumn
    - Winter
    - Spring
    - No, my business is not seasonal.
13. Which of the following revenue range options best represents your business's annual sales?
    - Less than $50,000
    - - $50,000 to $100,000
    - - $100,000 to $500,000
    - - $500,000 to $1 million
    - - More than $1 million
    - - Prefer not to state.
14. Is your business dependent on the ability to transport people and/or resources into and/or out of Head of Lake Whakatipu area?
    - Yes
    - No
    - Unsure
15. If yes to Q9, what are you reliant on accessing outside of Head of Lake Whakatipu area? Select all that apply.

- Staff
- Customers
- Goods in
- Goods out
- Other (please specify)

16. If yes to Q9, how often does your business rely on the ability to transport people and/or resources into and/or out of Head of Lake Whakatipu area?
    - Daily
    - Several times a week
    - Weekly
    - Fortnightly
    - Monthly
    - Less than monthly
17. If your business was unable to transport people and/or resources into and/or out of Head of Lake Whakatipu area, please describe how this would impact your business and/or the community?
18. If you are able to, please describe the top three risks to your business if there were to be a significant flooding event? E.g., financial costs, damage to property, road isolation
19. If you are able to, please describe the top three risks to your business if there were to be a significant earthquake event?
20. Has your business been impacted by natural hazards previously?
21. *If yes to Q15,* please tell us about the impacts you experienced.
22. If you are aware there is a potential storm coming, what does your business do to prepare?
23. Is there anything else you would like to let us know about the possible impacts of a natural hazard event on your business and / or community?
24. Would you be happy for a member of our team to phone you to discuss some of your responses in more detail? Note that we will only be carrying out follow-up interviews (approx. 10 minute long) with a sample of the community.
25. *If yes to Q19* please provide your name and phone number so that we can get in touch.

Resident questions

1. How old are you?
    - Under 15 years
    - 15-29 years
    - 30-64 years
    - 65 years or older
2. What is your gender?
    - Male
    - Female
    - Non-binary
    - Other
    - Rather not say.
3. What is your ethnicity?
    - European
    - Māori
    - Pasifika
    - Asian
    - Middle Eastern/Latin American/African
    - Other
4. What area do you live in?
    - Glenorchy

- Kinloch
- Paradise
- Campbelltown
- Rees Valley
- Dart Valley
- Greenstone Valley
- Other

5. How long have you lived at your current property?
   - Less than a year
   - 1-5 years
   - 5-10 years
   - More than 10 years
   - My whole life
6. How long have you and your family/whānau lived in the area?
   - Less than a year
   - 1-5 years
   - 5-10 years
   - 10+ years
   - My whole life
   - Multiple generations
7. Which of the following best describes your household situation?
   - Living alone
   - Couple, no children.
   - Group flatting
   - Couple with children living at home.
   - Couple with no children at home (i.e., children have left home)
   - Living with extended family
   - I'd rather not say.
   - Other (please state)
8. Do you work from home?
   - Yes – I work exclusively from home/my business is based at my home.
   - Yes – I work from home most of the time.
   - Yes – I work from home several days a week.
   - Yes – I work from home occasionally (less than once a week)
   - No – I am employed, but I never work from home.
   - No – I am not employed so I never work from home.
   - No – I am retired so I never work from home.
9. Do you generate any income from your property (e.g., accommodation, farming, horticulture etc.)
   - Yes – this is my main source of income.
   - Yes – this makes up part of my income.
   - No
10. Of the following, what do you and/or your household travel outside of Head of Lake Whakatipu area for? Please select all that apply.
    - Employment
    - Education
    - Recreation
    - Social activities
    - Shopping / errands
    - Health

- Other (please specify?)

11. How often do you travel outside of Head of Lake Whakatipu area to access the places and/or people you have identified above?
    - Daily
    - Several times a week
    - Weekly
    - Fortnightly
    - Monthly
    - Less than monthly
12. If you and/or your household were unable to travel outside of Head of Lake Whakatipu area for an extended period of time (i.e., a week or longer), please indicate what impacts (if any) this would have on you and/or your household.
    - Impact on health and wellbeing
    - Impact on lifestyle / enjoyment of life
    - Financial impacts
    - Other (please specify)
13. If you are able to, please describe the top three risks to you and/or your household if there were to be a flooding event? E.g., financial costs, damage to property, road isolation
14. If you are able to, please describe the top three risks to you and/or your household if there were to be an earthquake event?
15. Have you and/or your household been impacted by natural hazards previously?
16. *If yes* to Q12, please tell us about those impacts you experienced.
17. If you are aware there is a potential storm coming, what do you and/or your household do to prepare?
18. Is there anything else you would like to let us know about the possible impacts of natural hazards on yourself, your household, or your community?
19. Would you be happy for a member of our team to phone you to discuss some of your responses in more detail? Note that we will only be carrying out interviews (approx. 10 minute long) with a sample of the community.
20. *If yes to Q16* please provide your name and phone number so that we can get in touch.

C

Appendix C – Demographics

Theme	Metric / %	Glenorchy / Head of Lake Whakatipu	Queenstown-lake District	Otago Region
Population	Number of People	450	39,153	225,186
Sex	Males	222	19,971	110,970
	Females	225	19,182	114,219
Age	Median Age	40.2	34.4	38.2
	Under 15 – usually resident population (%)	11.3	16.6	16.5
	15 - 29 years - usually resident population (%)	18.6	23.5	22.95
	30 - 64 years - usually resident population(%)	58	49.3	44
	65+ years - usually resident population (%)	10.6	10.5	16.5
Birthplace	Birthplace – NZ (%)	64.2	40.7	78.1
	Birthplace – overseas (%)	35.8	59.3	21.9
Ethnicity	Ethnicity – European (%)	92	83.6	86.9
	Ethnicity - Māori (%)	5.3	5.3	8.7
	Ethnicity - Pacific Peoples (%)	2.0	1.0	2.7
	Ethnicity - Asian (%)	3.3	9.9	7.1
	Ethnicity - Middle Eastern / Latin/ American / African (%)	2	4.7	1.8
	Ethnicity - Other Ethnicity (%)	1.3	1.3	1.4
	Māori Descent - Don't Know (%)	1.9	2.3	2.5
Religious Affiliation	No Religion (%)	66.7	61.2	55.8
	Religious affiliation – Buddhism (%)	1.2	1	0.7

	Religious affiliation – Christian (%)	45.3	29.1	33.4
	Religious affiliation – Hinduism (%)	0	1.6	0.8
	Religious affiliation – Islam (%)	0	0.4	0.7
	Religious affiliation - Judaism (%)	0	0.2	0.1
	Religious affiliation - Māori religions, beliefs, philosophies (%)	0	0.1	0.2
	Religious affiliation - spiritualism, new age (%)	0.7	0.4	0.5
	Religious affiliation – Other (%)	1.3	1.8	1.5
	Religious affiliation - refuse to answer (%)	5.3	4.6	6.4
Disability Data	One or more activity limitations (%)	2.6	2.8	6.6
Home Ownership	Home ownership - Own or partly own (%)	57.6	39.1	52.2
	Home ownership - In family trust (%)	13.6	23.6	15.8
	Home ownership - Do not own and do not hold in a family trust (%)	30.5	37.3	32
Types of heating	No heating use (%)	0	0.6	0.6
	Heat Pump (%)	30.4	57.2	60.7
	Electric Heater (%)	33.9	43.4	43.8
	Fixed Gas Heater (%)	5.4	17.4	7.2
	Portable gas heater (%)	3.6	2.4	3
	Wood burner(%)	78.6	54.2	51.6
	Pellet Fire (%)	1.8	0.7	2.4
	Coal Burner (%)	3.6	1.3	4.9
	Other types of heating (%)	7.1	10.9	5.9

Years since arrival in New Zealand for the usually resident population	Less than 1 year (%)	17.3	12.9	9.6
	1 year (%)	9.6	13.6	8.5
	2 years (%)	7.7	10.2	6.6
	3 years (%)	7.7	7.4	5.4
	4 years (%)	3.8	5.7	4.1
	5 – 9 years (%)	15.4	18.2	16.5
	10 – 19 years (%)	15.4	19.5	23.4
	20 years or more (%)	19.2	12.5	25.8
Income	Median Income	38,0000	40,600	30,0000
	Income over $70,000 (%)	17.4%	19.9%	14.4%
	Loss (%)	0.8	0.3	0.5
	Zero (%)	3	2.7	4.9
	$1,000-$5,000 (%)	5.3	4.4	6.8
	$5,001-$10,000 (%)	5.3	3.7	5.8
	$10,001-$15,000 (%)	5.3	4.4	7.1
	15,001-$20,000 (%)	7.6	6	10.1
	$20,001-$25,000 (%)	6.8	6	8.7
	$25,001-$30,000 (%)	6.1	6.3	6.2
	30,001-$35,000 (%)	6.8	7	5.4
	$35,001-$40,000 (%)	8.3	8.4	6
	$40,001-$50,000 (%)	13.6	13.2	9.9

	$50,001-$60,000 (%)	10.6	10.3	8.2
	$60,001-$70,000 (%)	6.1	7.4	6.1
	$70,001-$100,000 (%)	10.6	10.7	8.6
	$100,001-$150,000 (%)	5.3	5.1	3.5
	$150,001 or more (%)	1.5	4.1	2.2
Source of Income	Sources of income - no source (%)	8.0	8.3	8.6
	Sources of income - NZ super or veteran's pension, other super/pensions (%)	14.9	11.0	10.5
	Sources of income - Jobseeker support (%)	5.5	9.9	10.4
	Sources of income - Sole parent support (%)	1.5	2.4	2.6
	Sources of income - Supported Living Payment (%)	1.5	2.1	2.0
	Sources of income - student allowance (%)	2.5	2.6	2.4
	Other government benefits, govt income support payments (%)	3.6	4.6	4.6
Occupation	Unemployed (%)	1.5	1.1	3.2
	Not in the Labour Force (%)	12.9	18.3	31.4
	Employed Full Time (%)	69.7	66.4	49.2
	Occupation – Managers (%)	25	21.5	17.7
	Occupation - Professionals (%)	15.2	16.5	20.2
	Occupation - Technicians and trade Workers (%)	17.9	16.4	13.2
	Occupation - Community and administrative workers (%)	11.6	11.8	10.7
	Occupation - Clerical and administrative workers (%)	8	8.8	9.8
	Occupation - Sales workers (%)	6.2	10.6	9.6
	Occupation - machinery operators and drivers (%)	4.5	4.5	5.5

	Occupation – labourers (%)	12.5	9.9	13.2
Means of Travel to Work	Means of travel to work – bus (%)	0	3.2	
	Work at home (%)	21.4	15.7	14.3
	Means of travel to work – train (%)	0	0.1	0
	Means of travel to work - Passenger in a car, truck, van or company bus (%)	0.9	3.5	4.3
	Means of travel to work – bicycle (%)	3.6	3	2.2
	Means of travel to work - drive a private car, van or truck (%)	44.6	48.9	54.6
	Means of travel to work - Walk or jog (%)	19.6	11.1	9.1
	Means of travel to work - Drive a company truck, car or van (%)	9.8	13.6	11.8
Means of Travel to Education	Means of travel to education - school bus (%)	28.6	19.1	9.1
	Stay at home (%)	14.3	9	5.4
	Means of travel to education - public bus (%)	0	3.2	0
	Means of travel to education – train (%)	0	0	0
	Means of travel to education - passenger in car, truck or van (%)	14.3	37	33.3
	Means of travel to education – bicycle (%)	19	8.2	3.9
	Means of travel to education - drive a private car, truck or van (%)	9.5	8.5	10.3
	Means of travel to education - walk or jog (%)	9.5	13.9	33.4
Marital status	Married (not separated) (%)	37.1	47.8	45.8
	Separated (%)	3.8	1.9	2.8
	Divorced or dissolved (%)	10.5	6	7.4
	Widowed or surviving civil union partner (%)	2.9	2.9	5.4

	Never married and never in a civil union (%)	46.7	41.4	38.6
Qualification	No qualification (%)	9.9	8.6	17.6
	Bachelor's degree and level 7 qualification (%)	18.2%	19.2	13.6

D

Appendix D – Population Projections

					2023 to 2033			2023 to 2033		
Variable	2023	2033	2043	2053	Change	Annual change	% change	Change	Annual change	% change
Glenorchy Other										
Residents	150	170	180	190	20	2	1.3	40	1	0.8
Total Houses	80	80	90	100	0	0	0.0	20	1	0.7
Total Visitors (Average Day)	90	120	120	120	30	3	2.9	30	1	1
Total Visitors (Peak Day)	240	310	320	330	70	7	2.6	90	3	1.1
Total Population (Average Day)	240	280	300	320	40	4	1.6	80	3	1
Total Rating Units	170	180	190	200	10	1	0.6	30	1	0.5
Glenorchy Township										
Residents	410	490	570	650	80	8	1.8	240	8	1.5
Total Houses	220	270	310	350	50	5	2.1	130	4	1.6
Total Visitors (Average Day)	300	440	490	530	140	14	3.9	230	8	1.9
Total Visitors (Peak Day)	800	1130	1250	1360	330	33	3.5	560	19	1.8
Total Population (Average Day)	710	940	1060	1180	230	23	2.8	470	16	1.7
Total Rating Units	330	390	440	500	60	6	1.7	170	6	1.4

(QLDC, 2023a)

E

Appendix E - Indicative natural hazard scenarios

11.1 Major[30] Alpine Fault Earthquake

This indicative scenario was formed using the available science and natural hazards information at the time this SEIA was commissioned, including the following technical reports:

- DJA Barrell (2019)
- Murashev et al. (2004)
- ORC (2015)
- Robinson & Davies (2013)
- Tonkin & Taylor (2021)
- Tonkin & Taylor (2022)
- Tonkin & Taylor (2023).

The following information is descriptive (not predictive or associated with a specific likelihood) and has been provided for the purposes of exploring the potential social and economic consequences of natural hazard events at the Head of the Lake.

- **Seismic shaking –** with reference to the Modified Mercalli Intensity Scale, MMVII – MMVIII shaking intensities are anticipated. Within this range, shaking will be felt by all, and people are likely to experience difficulty standing. Steering of motor vehicles may also be difficult.
    - At level MMVII, there will be substantial damage to fragile contents of buildings, and furniture will move. Unreinforced stone and brick walls will crack, and Type 1[31] buildings will crack with some masonry falls. There will be some damage to type 2[32] buildings; unbraced parapets and brick gables and architectural ornaments will fall, and roofing tiles will become dislodged. Many unreinforced domestics chimneys will be damaged and there will be a few instances of damage to brick veneers and plaster or cement-based lining. At this level, water will be made turbid by stirred up mud, there will be small rock falls from steep slopes, and instances of unconsolidated, wet or weak soils. Some fine cracks will appear in sloping ground and there will be a few instances of liquefaction.
    - At MMVIII level, Type 1 buildings will be heavily damaged, and some will collapse. Type 2 buildings will be damaged, and some will partially collapse, while some Type 3[33] buildings will

[30] 'Major' is used to describe a magnitude 8 Alpine Fault earthquake which has a 40-60% chance of occurring over the next 50 years (Tonkin & Taylor, 2022; Tonkin & Taylor, 2023)

[31] Buildings with low standard of workmanship, poor mortar, or constructed of weak materials like mud brick or rammed earth. Soft storey structures (e.g. shops) made of masonry, weak reinforced concrete or composite materials (e.g. some walls timber, some brick) not well tied together. Masonry buildings otherwise conforming to buildings. Types 1 to 3, but also having heavy unreinforced masonry towers. (Buildings constructed entirely of timber must be of extremely low quality to be Type 1) (Geonet, n.d.)

[32] Buildings of ordinary workmanship, with mortar of average quality. No extreme weakness, such as inadequate bonding of the corners, but neither designed nor reinforced to resist lateral forces. Such buildings not having heavy unreinforced masonry towers (Geonet, n.d.)

[33] Reinforced masonry or concrete buildings of good workmanship and with sound mortar, but not formally designed to resist earthquake forces (Geonet, n.d.)

also be damaged. There will damage to some pre-1965 infill masonry panels, post-1980 brick veneers, decayed timber piles of houses and unreinforced domestic chimneys. There will also be a few instances of damage to structures Type 4[34]. Houses not secured to foundations may move, and monuments and many unreinforced domestic chimneys will be brought down. In the natural environment, there will be cracks on steep slopes and in wet ground and small-moderate slides. There will also be small water and sand ejections and localised lateral spreading adjacent to streams, canals, lakes, etc.

- **Liquefaction and lateral spreading (Glenorchy township) –** areas in the Glenorchy township mapped as 'high liquefaction vulnerability' (Tonkin & Taylor, 2022; 2023) could experience widespread liquefaction. This would cause damage to buildings and infrastructure (e.g., water supply, roading) (Tonkin & Taylor, 2022). Approximately 50% of buildings in this 'high' liquefaction hazard area suffer severe damages (Tonkin & Taylor, 2023). Areas in the Glenorchy township mapped as 'major or severe lateral spreading damage' could experience widespread lateral spreading. This is likely to cause severe damage (impractical or uneconomic to repair) to 75-90% to buildings within the lateral spreading hazard areas.
- **Liquefaction and lateral spreading (rural areas) –** rural areas outside the Glenorchy township have been mapped as having 'low to moderate liquefaction potential' (GNS, 2019). However, actual susceptibility could be higher. Liquefaction and lateral spreading could cause damage to dwellings and infrastructure (e.g., roads, bridges) in liquefaction-prone areas.
- **Slope stability (landslide, rockfall) -** landslides and/or rockfalls are expected at locations on the Queenstown-Glenorchy Road. This could result in the closure of the Queenstown-Glenorchy Road for 1-2 weeks.

11.2 Major Flood Event (Greater than 100-year ARI)

This indicative scenario was formed using the available science and natural hazards information at the time this SEIA was commissioned reports:

- Gardner (2022) - Rees/Dart river
- Gardner & Beagley(2023) – Buckler Burn
- Mohssen, M (2021).

The following information is descriptive (not predictive or associated with a specific likelihood) and has been provided for the purposes of exploring the potential social and economic consequences of natural hazard events at the Head of the Lake.

- **Rainfall** - Local nuisance flooding due to exceeded drainage capacity.
- **Rees River Flooding** - About 40 dwellings in Glenorchy township are within the flooded area, of which about 20 are in locations where floodwaters are >0.5 metres depth. Access roads on the Rees floodplain are closed due to flooding - the approaches to the Rees River bridge are inundated, the Paradise Road and Priory road are also closed.

[34] Buildings and bridges designed and built to resist earthquakes to normal use standards, i.e., no special collapse or damage limiting measures taken (mid-1930s to c. 1970 for concrete and to c. 1980 for other materials) (Geonet, n.d.)

- **Dart River flooding and erosion** - Kinloch Road may close due to high river flows and lake levels (for up to 1 week). River erosion directly impacts the road and prevents access at localised sites and requires temporary access routes to be formed.
- **Buckler Burn** - Floodwaters flow into the residential areas around Oban Street, Shiel Street and Invincible Drive, but are generally relatively shallow (<0.5 metres depth)
- **Debris flows and slope stability** - Debris impacts on Routeburn and Kinloch access roads (road closed up to 1 month). Debris impacts on Queenstown - Glenorchy road (closed up to 2 weeks).

11.3 Repeated, moderate flood events (about 20-year ARI)

This indicative scenario was formed using the available science and natural hazards information at the time this SEIA was commissioned:

- Gardner (2022) – Rees/Dart
- Gardner & Beagley (2023) – Buckler Burn
- Mohssen, M (2021)
- ORC (2020)
- Shaw et al. (2022).

The following information is descriptive (not predictive or associated with a specific likelihood) and has been provided for the purposes of exploring the potential social and economic consequences of natural hazard events at the Head of the Lake.

- **Lake Wakatipu and Rees River flooding -**O Overtopping of the Glenorchy floodbank and flooding into the township with similar extents to Feb 2020 event. About 10 dwellings are within the flooded area, and some are flooded to above floor level. A similar magnitude flood is repeated within a relatively short period (5 s years).
- **Dart River flooding and erosion -** Road closure due to flooding of up to 3 days. Localised river erosion threatening the roadway, which would result in loss of access if not immediately addressed through emergency works actions.
- **Buckler Burn -** No impact on township area
- **Debris flows -** Debris impacts on Routeburn and Kinloch access roads (road closed up to 1 week/10 days). Debris impacts on Queenstown - Glenorchy Road (closed up to 2 days)

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HEAD OF LAKE WHAKATIPU

COMMUNITY UPDATE 35 | APRIL 2024

Kia ora koutou,

We are excited to announce that we are ready to share the findings of the first phase of the socio-economic impact assessment with you via an online presentation on **Wednesday, 22 May from 7pm**. You can find more details, including the Zoom meeting link, in the section below.

We also have details about a Head of the Lake youth art competition, adaptation education sessions at Glenorchy Primary School, and updates on four assessments.

Sharing the findings of the socio-economic impact assessment

We plan to share findings of the first phase of the socio-economic impact assessment with you at **7pm on Wednesday, 22 May**.

When and how?
ORC and the Beca team will show how they developed a community profile and assessed the social and economic impacts of different hazard scenarios proposed by the ORC under “status quo” hazard management actions in an online presentation.

This presentation will be recorded and uploaded to our project web page for those who could not attend the live session or would like to view it again.

Zoom meeting details
The meeting link is here.
Meeting ID: 833 4470 6577
Passcode: 081914

Release of information at the next public ORC Safety and Resilience Committee meeting
The socio-economic impact assessment report will be published on the ORC website at the same time that the ORC Safety and Resilience Committee agenda is published on **6 May**. All council agendas, including reports, are available two days before a meeting. This report will then be presented to the committee on **8 May**. You can also watch this meeting on the ORC YouTube page.

Future community engagement
We are coming back to the community later in the year to tell you about the findings of the next two assessments, and to understand which adaptation pathways you prefer. These assessments are:

- Flood and erosion mitigation and nature-based solutions feasibility assessment.
- Glenorchy and Kinloch natural hazard risk assessment.

You can find more details about these assessments in the last section of this newsletter.

Your feedback is appreciated as we work to come up with a strategy of how to adapt to and manage some of these hazards.

Image: The Glenorchy boat shed

Head of the Lake Youth Art Competition

Enter our competition to create a picture using the theme 'What does the Head of the Lake mean to you?'
We are looking entries from children and young people aged 17 and under to show us what they love about the Head of the Lake!

Be creative — your art could be a painting, drawing, collage or anything else you choose.

Entries close 12 noon Thursday, 9 May 2024.

The top entries will receive a voucher for books or art supplies, and have their artwork featured in the ORC's Head of Lake Whakatipu natural hazards adaptation strategy.

Who can enter?

Children and young people aged 17 and under.

How do you enter?

1. Download the entry form here.
2. Create your picture.
3. Drop your completed form and your artwork into collection boxes at **Glenorchy Primary School** or **Glenorchy Motors** by **12 noon Thursday, 9 May 2024**.
4. Or, send it via email to headofthelake@orc.govt.nz. Please ensure scanned images of the artwork are high resolution (minimum 300dpi) if sending via email.

Image: View towards the Glenorchy wharf

Adaptation education at Glenorchy Primary School

We are really excited to be working with Enviroschools at Glenorchy Primary School in April and May.

Our focus will be on how the landscape changes over time, how people have adapted to these changes in the past and present, and what adaptation could look like in the future.

We also have a fun, new educational game introducing some key concepts around adaptation that we are excited to try out with the students.

Image: View over Glenorchy township

Assessment progress update

Flood and erosion mitigation and nature-based solutions feasibility assessment
An assessment of potential engineered flood and erosion management and a 'nature-based solutions' approach for the Rees and Dart floodplain areas, and the Glenorchy township, is in progress with the team from Damwatch Ltd. This project, which is partially funded by the Ministry for the Environment through the 'Nature-based Solutions for Resilience Planning' programme, is due to be completed by the middle of the year.

Glenorchy and Kinloch natural hazard risk assessment
Led by consultants at Beca, the natural hazard risk assessment project is progressing well. The first phase of assessment is near completion, and a second phase of more detailed assessments has recently started. These detailed risk assessments are expected to focus on; flooding from the Rees and Dart rivers, Lake Whakatipu and the Buckler Burn, and liquefaction and lateral spreading at Glenorchy.

Socio-economic impact assessment — phase two
The second phase of the socio-economic impact assessment will focus on screening a long list of possible adaptation responses for socio-economic risks and opportunities. At this stage, this is a high-level screening to inform the next steps of the programme. We'd like to thank everyone for their time and contribution to the socio-economic impact assessment.

Cultural impact screening

The team at Aukaha (mana whenua-owned environmental consultants) is currently screening a long list of possible adaptation responses for cultural risks and opportunities through a te ao Māori lens. At this stage, this is a high-level screening to inform the next steps of the programme, similar to phase two of the socio-economic impact assessment. This work is an important aspect of incorporating mana whenua values and views into our work at the Head of Lake Whakatipu.

Image: Glenorchy wetlands by Matthew Gardner

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

9.2. Clutha Delta Natural Hazards Adaptation

Prepared for:	Safety and Resilience Committee
Report No.	OPS2410
Activity:	Governance Report
Author:	Ann Conroy, Team Leader Natural Hazards Adaptation Jamie MacKenzie, Natural Hazards Adaptation Specialist Tim van Woerden, Senior Natural Hazards Analyst Jean-Luc Payan, Manager Natural Hazards
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	8 May 2024

PURPOSE

[1] To update Council on progress with the Clutha Delta natural hazards adaptation programme including engagement planning and natural hazards assessments.

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 Adaptive 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 papers on this work programme, presented in November 2023[1] and February 2024.[2]

[5] The development of an engagement plan is underway. This programme is piloting aspects of the in-development ORC engagement framework. This paper presents the 'Develop' phase of the engagement planning process, which focuses on determining key stages, objectives and risks of engagement.

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

[7] Other related activities are being undertaken to improve coastal monitoring and forecasting; and gather additional data to inform assessments and modelling.

RECOMMENDATION

[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.
[2] Conroy A, MacKenzie J, van Woerden T, Robinson S and Payan J, 2024. Clutha Delta Natural Hazards Adaptation. Report HAZ2307 to the Otago Regional Council Safety and Resilience Committee, 8 February 2024.

That the Committee:

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

2) ***Notes*** *the Clutha Delta natural hazards adaptation work programme and community engagement planning.*

BACKGROUND

[8] Otago Regional Council (ORC) is leading a programme of work to develop a natural hazard adaptation strategy for the Clutha Delta area (Figure 1).

[9] The hazards context and the proposed natural hazards adaptation work programme for the Clutha Delta were summarised in the November 2023 update paper to the Safety and Resilience Committee.

[10] The February 2024 update to the Safety and Resilience Committee summarised this programme's approach to engagement. This programme is piloting aspects of the in-development ORC engagement framework, including practical kete/toolkits and templates, and is informed by best practice research and policy.

[11] The work programme is currently in the first phase of the 10-step DAPP cycle ("*what is happening?*") outlined in Figure 2, 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.

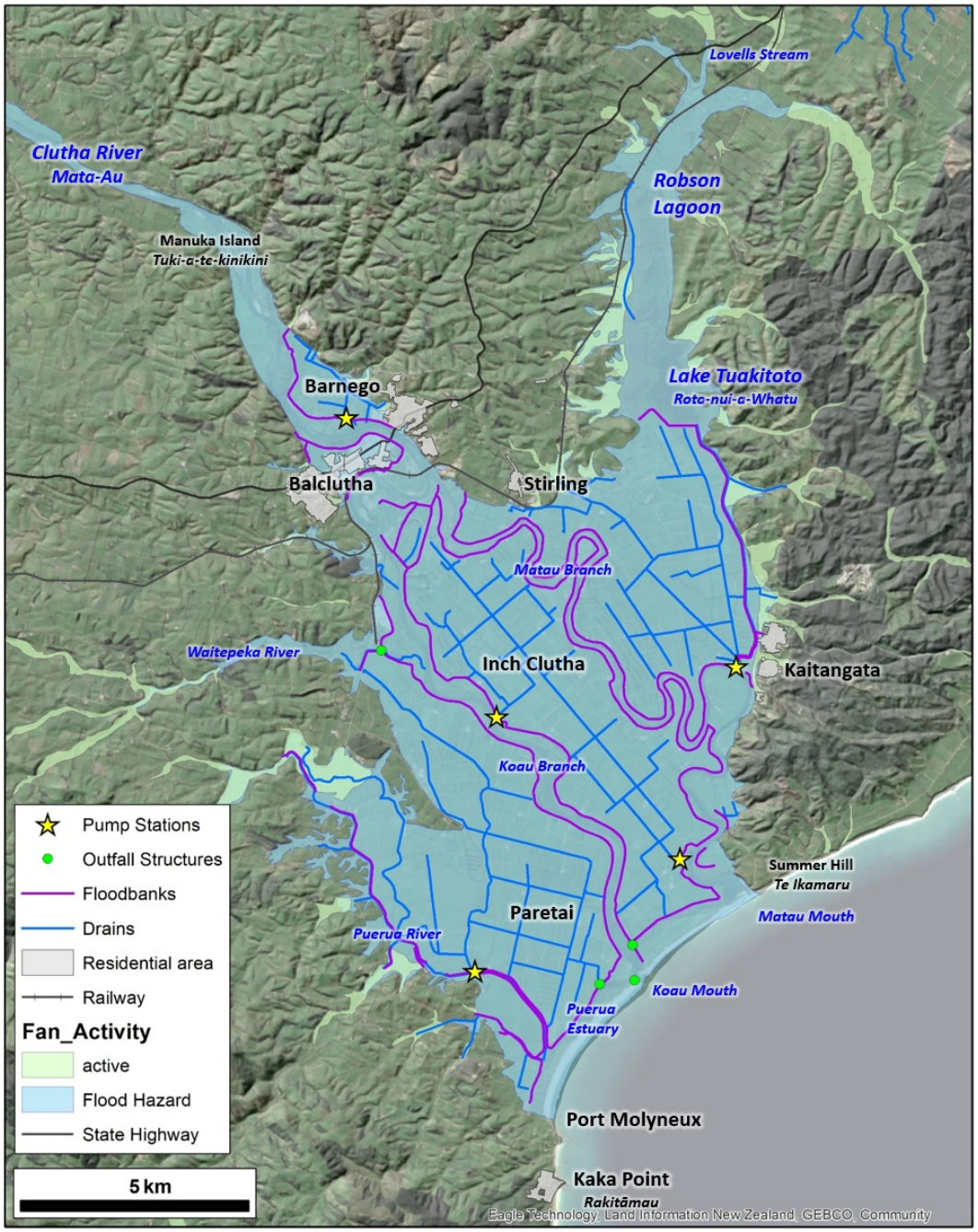

Figure 1: Overview map of the Clutha Delta, showing the main locations and ORC scheme infrastructure (e.g. floodbanks, drains). The blue shaded area is the mapped flood hazard area, and the green shaded areas are mapped as active floodwater-dominated alluvial fans. Maori place names are from the Ngāi Tahu atlas Kā Huru Manu.

Figure 2: Overview of the 10-step decision cycle from Ministry for Environment (2024) guidance for Adaptation Pathways planning.

[12] 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 ORC Long-Term Plan cycle (2027-2037) and review of the 2024-54 Infrastructure Strategy.

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

DISCUSSION

[14] ORC and Clutha District Council (CDC) staff met on April 11 to discuss the programme of work, and governance and partnership arrangements. CDC confirmed their preferred level of involvement in the strategy programme is as a partner. CDC would like to further explore the following possible arrangements and their utility for programme governance:

- documenting the relationship between councils in a joint agreement or memorandum of understanding.
- oversight and direction by a joint steering group
- how councillors would be updated
- integrated approach to partnership with iwi

[15] Regarding involvement in key workstreams, CDC wishes to collaborate closely on community engagement.

NATURAL HAZARDS INVESTIGATIONS

[16] The November 2023 and February 2024 papers 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. The investigations noted here are targeted for completion by December 2024.

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

[18] 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

[19] 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.

[20] The project is being carried out in response to the coastal erosion event of July 2023, which was described in the August 2023[3] paper to the Safety and Resilience Committee.

[21] The management response to coastal erosion impacts on ORC's coastal infrastructure at the Koau Mouth and Puerua River was described in the February 2024[4] paper to the Safety and Resilience Committee and this tactical maintenance is ongoing.

[22] Technical 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.

[23] The consultant team carried out a site visit to the Koau Mouth training line and Paretai area in March 2024. This site visit was an opportunity for the consultants to gather first-hand observations of coastal processes and their geomorphic/infrastructure impacts.

[24] Analysis for the first focus area (understanding the July 2023 erosion event) is largely completed. Hydraulic model development is underway, and the model will be used to assess impacts of geomorphic changes to flooding hazard and drainage processes.

[25] The finalised technical report for this investigation is expected to be completed mid-September 2024.

[26] Other related activities (outlined in paragraphs 27-30) are being undertaken to improve coastal monitoring and forecasting; and gather additional data to inform assessments and modelling.

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[3] Report OPS2324, 10 August 2023. Paragraphs 82-91.
[4] Report HAZ2307, 8 February 2024. Paragraphs 60-66.

[27] Periodic aerial imagery and survey data are being captured at approximately monthly intervals to allow observation and interpretation of geomorphic coastal changes in the Clutha's Koau mouth area. The most recent aerial imagery, captured in February and March 2024, is shown in Figure 4. For comparison, Figure 3 shows the same river mouth location prior to (January 2020), and shortly after the July 2023 coastal erosion event.

[28] A temporary water level monitoring station was installed in the lower Puerua River channel in October 2023 to measure water levels in the Puerua estuary about 700 metres upstream from the outlet culverts. The station will allow for analysis and comparison of relative water levels to those at the monitoring station located at the Paretai Pump Station (>5 km upstream from the outlet).

[29] Procurement is underway for additional survey data of culverts, bridges and drains within the modelled area. This data will support improvements in the representation of structures in the hydraulic model.

[30] Procurement is underway with MetOcean, the oceanographic branch of MetService, to provide forecasting of key parameters influencing coastal hazards (inundation and coastal erosion) in the Otago region. Coastal forecast information will also be provided for ten locations spaced along the Otago coastline.

- Forecast parameters will include wave characteristics (height, period, direction), sea height (storm tide), and wind characteristics (speed, direction).
- For Clutha Delta, forecasts will be provided for an offshore location in Molyneux Bay to provide early awareness of sea conditions which may cause potential impacts, and enable proactive monitoring of the coastal morphology and ORC's coastal infrastructure at the Clutha Delta.
- Forecasts will also benefit ORC's flood response activities and allow early warning for territorial authorities and Emergency Management Otago.

Figure 3: Aerial imagery showing the Koau Mouth of the Clutha River / Mata-Au in January 2020 (left), and July 2023 following the coastal erosion event (right).

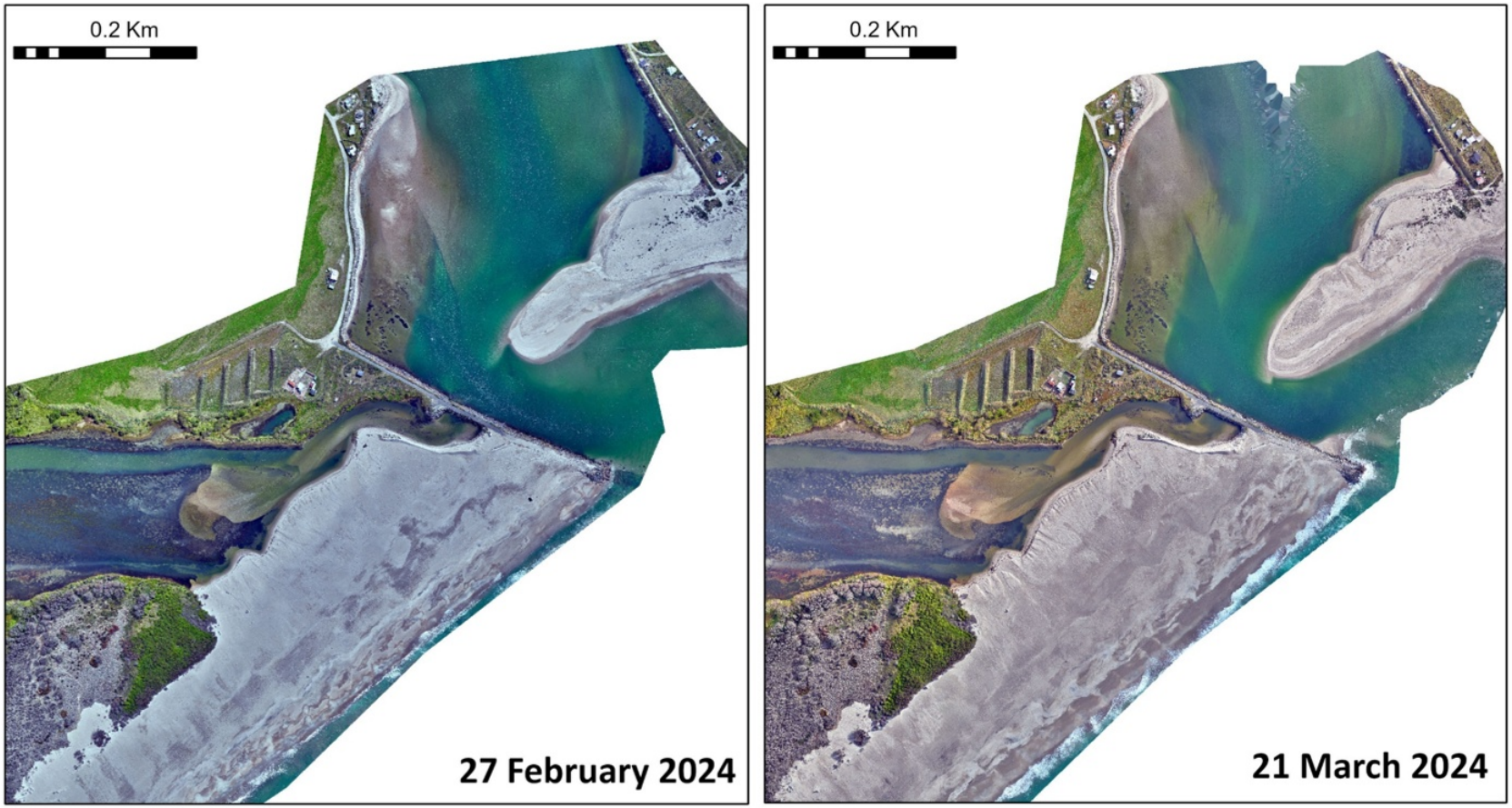

Figure 4: Aerial imagery showing the Koau Mouth of the Clutha River / Mata-Au in February (left) and March (right) 2024.

Flood Hazard Assessment

[31] A comprehensive flood hazard assessment for the Clutha Delta has been scoped and the first preparatory studies are being procured. 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 Otago planning for flooding events.

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

[33] Procurement is underway for external technical advice to assist with selecting the most suitable approaches to considering climate change effects on river flows, geomorphic changes in the Clutha River channels, and storm surge and sea level influences on flood hazard.

Liquefaction hazard assessment

[34] A high-level liquefaction hazard assessment for the Clutha Delta is in procurement. 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.

[35] This new study will add increased understanding of this hazard type, beyond the regional-scale liquefaction hazards information previously published and publicly available. For example the hazard mapping by GNS Science (2019) which can be viewed online through ORC's Natural Hazards Portal,[5] and the CDC's mapping portal.[6]

[36] The proposed investigation scope includes;

a. Collection of additional geotechnical data within the Clutha Delta area,
b. Geotechnical analysis including liquefaction vulnerability categorisation mapping and estimation of key liquefaction hazard descriptors,[7] and
c. Qualitative risk assessment for seismic hazards in the Clutha Delta area, including fault rupture, seismic shaking and liquefaction/lateral spreading.

[37] In preparation for the assessment, ORC has collaborated with geotechnical consultants to compile existing geotechnical data so it can be available for use in analysis. This data has been made available online through the New Zealand Geotechnical Database (NZGD),[8] an online database that provides a searchable repository for new and existing geotechnical information across the country.

[38] A total of 77 existing geotechnical records for the Clutha Delta have been located and recently uploaded to the NZGD. This has included 15 geotechnical boreholes and 62 cone penetrometer tests (CPTs). The spatial distribution of all geotechnical records now available is shown in Figure 5.

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

[6] https://gis.cluthadc.govt.nz/CluthaMaps/Viewer/?map=7f0906d94c2b4c8989359590591de879

[7] e.g. Estimation of Liquefaction Severity Number (LSN), liquefaction triggering thresholds, cumulative thickness of liquifiable material, magnitude of shaking-induced reconsolidation settlement, and the expected lateral displacement at the ground surface due to lateral spreading and/or lateral stretch.

[8] https://www.nzgd.org.nz/

[39] Utilizing existing geotechnical data may reduce the number of new geotechnical tests required for the assessment, with corresponding cost and efficiency benefits.

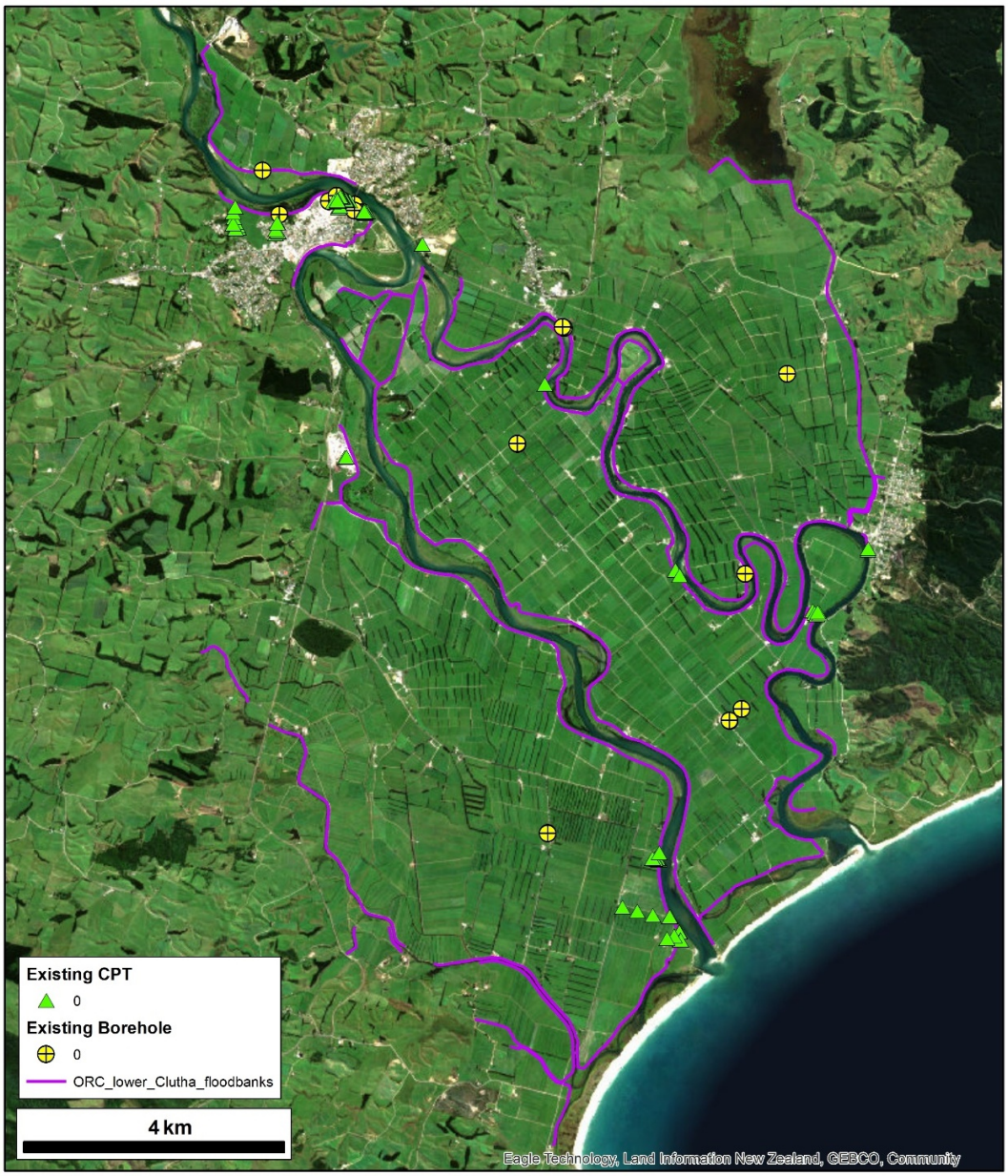

Figure 5: Locations of publicly available geotechnical information in the Clutha Delta area, from the New Zealand Geotechnical database (NZGD), including those recently compiled and added to the database.

ENGAGEMENT PLANNING

[40] The development of an engagement plan is currently underway. Engagement planning is piloting resources from Council's in-development community engagement framework.

[41] An update to the Safety and Resilience Committee in February 2024 noted the 'Discover' phase is now complete and the current phase of engagement planning is 'Develop', as shown in Figure 6. In the discovery phase, work was completed to understand the context, scope of engagement, audience, purpose, and leadership.

[42] As an outcome of the discovery phase, 'collaborate' was recommended as the level of engagement for the work programme (see spectrum of participation in Figure 7). This is because adapting to natural hazards and a changing climate at the Clutha Delta 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.

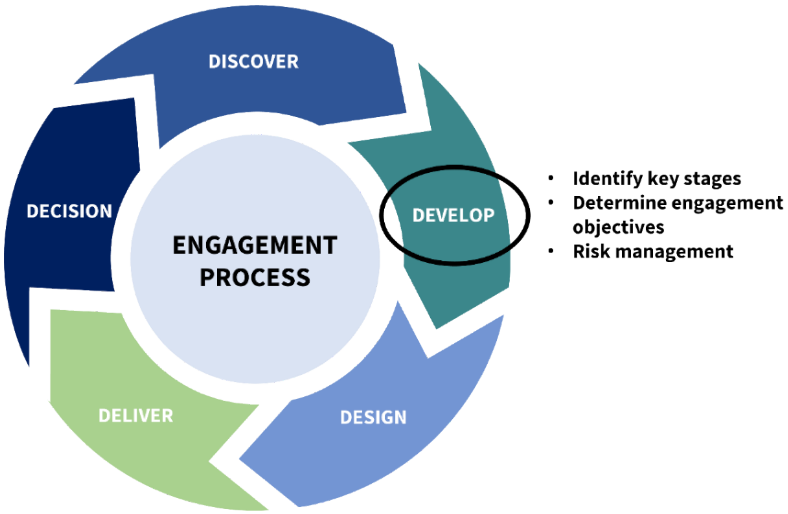

Figure 6: Phases identified in the engagement planning process and key steps for the current 'develop' phase.

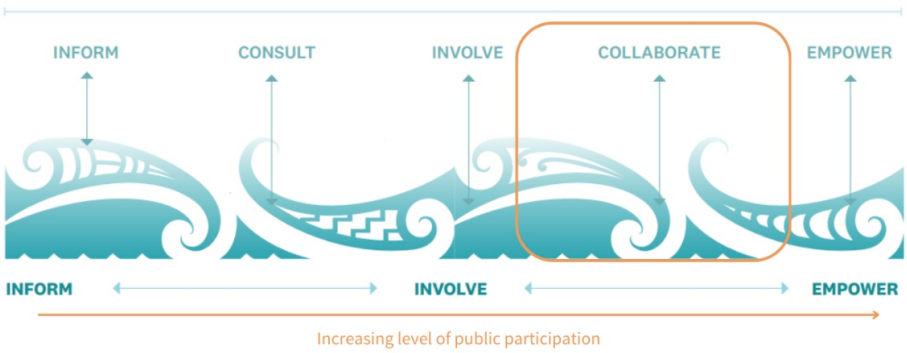

Figure 7: Public Participation Spectrum, adapted from He Mahi Rau Rika: Significance, Engagement and Māori Participation Policy.

[43] The aim for the current 'Develop' phase is to identify the different stages of engagement needed across the programme, determine engagement objectives and begin risk management planning (Figure 6).

[44] A high-level overview of key stages and purpose of engagement are identified in Table 1. More detail around the key stages for 2024 is provided below.

Table 1: High-level timeline for engagement activities and development of an adaptation strategy, for the Clutha Delta programme.

	Programme Milestone	Stage of community engagement	Purpose of engagement
2023	**December** - Scoping completed for all new natural hazards investigations	Early engagement planning and discovery stage	➢ *Gain a baseline understanding of previous engagement, local context, existing relationships*
2024	**December** - All new natural hazards investigations completed	Engagement planning Focus areas for community engagement activities in 2024: • Whakawhanaukataka / relationship building (Q2, Q3) • Co-develop engagement plan (Q2, Q3) • "what is happening?" (Q3, Q4) • "what matters most?" (Q3, Q4) • Updates about technical studies and programme progress (ongoing)	➢ *Build trust and relationships* ➢ *Understand level of engagement* ➢ *Share knowledge* ➢ *Social learning* ➢ *Build community capacity, capability and resilience*
2025	**June** • Natural hazard risk assessment completed • Adaptation option assessments completed **December** - Natural hazard adaptation strategy (first iteration) completed	Engagement planning Focus areas for community engagement activities in 2025: • "what can we do about it?" • Pathways, triggers and thresholds • Updates about technical studies and programme progress (ongoing) • "Make it happen" -feedback on draft strategy	➢ *Share knowledge* ➢ *Generate new ideas and innovative solutions* ➢ *Contribute to decision-making* ➢ *Build community capacity, capability and resilience*

Key Community Engagement Stages for 2024

[45] Key community engagement stages for 2024:

- Whakawhanaukataka/Relationship building
- Co-develop engagement plan
- What is happening?
- What matters most?
- Updates about technical studies and programme progress (ongoing)

[46] Whakawhanaukataka is the process of getting to know one another, or to build relationships. Building genuine and meaningful relationships is a key principle for effective engagement in natural hazard and climate change adaptation contexts[9].

[47] The aim of the whakawhanaukataka stage is to establish relationships with partners, stakeholders and affected communities early in the engagement process. This will help to understand the community and their expectations, as well as the level of interest or capacity of different agencies and organisations to engage with the work programme.

[48] It is important to firstly establish a relationship between the programme team and Clutha District Council (CDC) staff to ensure a coordinated and aligned approach to engagement with iwi and community. Relationship building will then extent to mana whenua and additional kaitiaki, key stakeholders and affected communities as identified in a stakeholder analysis exercise (see February 2024 update).

[49] Whakawhanaukataka will help support the next stage of engagement to co-develop an engagement plan. An objective of this stage is for CDC, iwi, communities and stakeholders to contribute (should they be interested and have capacity) into the 'Design' stage of engagement, particularly around their preferred ways of engaging with Council and planning evaluation. This approach demonstrates how we seek to collaborate with partners, stakeholders and community so engagement activities reflect what works best for this community and place.

[50] The next stages of engagement 'what is happening?' and 'what matters most?' reflect the stages of the DAPP cycle for adaptation planning.

[51] Engagement as part of the 'what is happening?' stage will centre on two-way knowledge sharing, to build an understanding of the local area and hazardscape. Findings from ORC's technical studies, combined with mātuaraka Māori and local knowledge, will form a shared understanding of the risks and potential impacts of natural hazards and climate change, and the changing landscape of the Clutha Delta.

[52] 'What matters most?' stage aims to better understand the diverse views, values and aspirations for the future of affected, communities, stakeholders, iwi and partners. Key objectives of this stage of engagement will be to understand what is most important about their place and community, their view of the adaptation programme and what

[9] Barth, J., Bond, S., & Stephenson, J. (2023). Community engagement for climate change adaptation. Centre for Sustainability, University of Otago. Retrieved from http://hdl.handle.net/10523/15157 and; 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/

they envision it needs to deliver. This will inform the overarching vision and strategic direction of the Strategy.

[53] ORC Councillors play an important role throughout these stages of engagement to actively participate in the knowledge sharing process, act as a touch point in their communities, advocate for the programme and attend community engagement activities.

[54] Consideration has been given to different communication channels to inform audiences about programme updates, including technical updates and engagement opportunities. This programme intends to broaden its reach as wide as possible amongst affected communities and stakeholders to ensure an inclusive approach to engagement.

[55] Communication channels may include a programme webpage on the ORC website and programme updates via existing publications (e.g. Clutha Leader). Appropriate communication channels will be identified with local community organisations as part of theco-development stage.

[56] A key risk identified in engagement planning, is potential community concern that the adaptation programme is something being done 'to them', rather than 'with them'. To mitigate this risk, ORC will foster true collaboration, and be open and transparent throughout all steps of the programme.

[57] Another consideration is of other community engagement activities across the Clutha District, or that local communities may be interested in over the same time period. Clear messaging will help to provide clarity of the purpose, aims and scope of engagement as part of the adaptation programme. ORC will also consider how best to avoid engagement fatigue and better support alignment across ORC engagement activities.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[58] 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".*

[59] The proposed Otago Regional Policy Statement June 2021[15], notified in late March 2024, 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 those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."*[10]

[60] The ORC Infrastructure Strategy 2024-2054 was released in late-March 2024 for Long-Term Plan consultation.[11] Diagram 3 of the Infrastructure Strategy outlines the timeline of proposed management activities for the Lower Clutha Flood Protection and Drainage Scheme over the coming three decades. The natural hazards adaptation work programme will complement and help guide these activities.

[10] ORC Natural Hazards Portal: http://hazards.orc.govt.nz
[11] From page 194 at: https://www.orc.govt.nz/media/16381/council-agenda-2024-03-20.pdf

Financial Considerations

[61] 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).

[62] 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 Considerations

[63] Engagement planning considers and is designed to be consistent with organisational commitments made through He Mahi Rau Rika: ORC Significance, Engagement and Māori Participation Policy.

[64] Engagement involves a two-way interaction where the organisation actively seeks input, feedback, and participation from the community and stakeholders. It aims to foster knowledge sharing, collaboration, and relationships by involving stakeholders in decision-making processes and activities.

Legislative and Risk Considerations

[65] 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.

[66] Engagement planning will include a risk management plan for engagement related activities throughout the delivery of the programme.

Climate Change Considerations

[67] 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.

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

[69] A revised version of the national coastal hazards and climate change guidance was published in February 2024,[12] updating the earlier 2017 guidance document. This guidance is a key reference for ORC in climate change and adaptation planning.

Communications Considerations

[70] Communications typically involves the one-way exchange of information from an organisation to the community and stakeholders. It focusses on delivering messages through various channels. The programme team are working with the Communications team to ensure communications and engagement planning are integrated, complementary and build off each other.

[12] Ministry for the Environment. 2024. Coastal hazards and climate change guidance (https://environment.govt.nz/assets/publications/Coastal-hazards-and-climate-change-guidance-2024-ME-1805.pdf)

NEXT STEPS

[71] A high-level timeline for natural hazards and risk investigations, engagement activities and development of an adaptation strategy, is given in Table 1.

[72] 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.

[73] ORC is taking a Te Tiriti partnership approach with iwi. Next steps include contacting appropriate representatives from mana whenua and additional kiatiaki to begin the whakawhanaukataka process. Early discussions with mana whenua and kiatiaki will be an important step for the work programme to develop relationships and identify opportunities for Te Tiriti partnership and participation in programme governance, management, and delivery.

[74] Next steps for engagement focus on building relationships with partners, stakeholders and communities as discussed in paragraphs 46-49. This will help guide the co-development of the engagement planning, working through the 'Design' stage (see Figure 6) to identify preferred methods, evaluation, resourcing and risk management for the engagement process.

[75] The development of an engagement plan is underway, and is anticipated to be completed and brought to the Safety and Resilience Committee for its next quarterly update for endorsement.

[76] Engagement planning is an iterative process and planning will be regularly revisited as the programme moves forward into a new stage, or if there are any notable changes.

[77] 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, iwi, communities and stakeholders.

ATTACHMENTS

Nil

9.3. Asset Management Plan 2024

Prepared for:	Safety and Resilience Committee
Report No.	OPS2404
Activity:	Asset Management – Flood Protection, Land Drainage and River Management
Author:	Arsalan Ali, Asset Management Engineer Brett Patterson, Project Delivery Lead
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	23 April 2024

PURPOSE

[1] To seek Council endorsement of the *Otago Regional Council Asset Management Plan 2024 – Flood Protection, Land Drainage, and River Management Infrastructure* (AMP).

EXECUTIVE SUMMARY

[2] Otago Regional Council (ORC) provides flood protection and land drainage to approximately 21,000ha of rural and urban land in Otago. This is achieved through infrastructural assets that include 218km of floodbanks, 12 pumping stations, 42 bridges, 369 culverts and various river assets (e.g. Shotover delta training line, Albert Town riverbank rock work, Lindsay Creek floodwalls and channel lining).

[3] The community is dependent on the effective performance of this infrastructure for their safety and economic wellbeing. This includes part of the Dunedin Central Business District, University of Otago city campus, Dunedin International Airport and the townships of Balclutha, Alexandra, Milton, Outram and Mosgiel. It includes key transport routes such as state highways and the railway network. Approximately 7,462ha of land that relies on ORC's flood protection and land drainage infrastructure is less than one metre above current mean sea level.

[4] An AMP has been prepared for these infrastructural assets, consolidating existing plans and documents. The purpose of the AMP is to serve as ORC's tactical plan for the delivery of ORC's strategic vision, and community outcomes relevant to ORC's flood protection, land drainage, and river management infrastructure.

RECOMMENDATION

That the Committee:

1) ***Notes*** *this report.*
2) ***Recommends that the Council endorses*** *the Otago Regional Council Asset Management Plan 2024 – Flood Protection, Land Drainage and River Management Infrastructure and any amendments arising from adoption of the 2024-34 Long Term Plan and Infrastructure Strategy 2024-2054.*

BACKGROUND

[5] Otago Regional Council (ORC) provides flood protection and land drainage to approximately 21,000ha of rural and urban land in Otago. This is achieved through infrastructural assets that include 218km of floodbanks, 12 pumping stations, 42

bridges, 369 culverts and various river assets (e.g. Shotover delta training line, Albert Town riverbank rock work, Lindsay Creek floodwalls and channel lining).

[6] The community is dependent on the effective performance of this infrastructure for their safety and economic wellbeing. This includes part of the Dunedin Central Business District, University of Otago city campus, Dunedin International Airport and the townships of Balclutha, Alexandra, Milton, Outram and Mosgiel. It includes key transport routes such as state highways and the railway network. Approximately 7,462ha of land that relies on ORC's flood protection and land drainage infrastructure is less than one metre above current mean sea level.

[7] Audit New Zealand released a publication in 2010 titled "*Asset management for public entities: Learning from local government examples".* The report notes that "*Asset Management has never had this much focus, or been this important",* and provides examples of asset management, with commentary, as adopted by public entities in New Zealand. The purpose of the report is to use the abovementioned examples to provide points of reflection and learning for enhancing an organisations asset management principles.

[8] A subsequent publication was released by Audit New Zealand in 2018 titled "*Asset Management and long-term planning: Learning from audit findings 2015 to 2017".* In addition to endorsing asset management implementation in the public sector, report builds on and further reinforces the benefits of adopting asset management within an organisation.

[9] The Local Government Act 2002 Amendment Act 2014 became law on 8 August 2014 and made changes to the Act pertaining to infrastructure delivery and asset management. Specifically; "*reinforcing the importance of asset management planning as part of a Council's prudent stewardship of resources; requiring Councils to prepare an infrastructure strategy for at least 30-year period, and to incorporate this into their long-term plans from 2015*" (Department of Internal Affairs New Zealand, 2014).

[10] In 2018 Tonkin and Taylor in association with Covec Ltd prepared a report for the Rivers' Managers Special Interest Group, "*Hiding in plain sight – An overview of current practices, national benefits and future challenges of our flood protection, river control and land drainage schemes".* The purpose of the report was to undertake a national assessment of current practices, quantify benefits at a national level and identify future challenges associated with flood protection, river control and land drainage schemes managed by regional Councils.

[11] The recommendations of the report underscore the benefits of adoption of asset management principles for the management of flood protection, land drainage and river management infrastructure. The report also notes central government organisations that have done a considerable amount of work to improve the delivery of infrastructure services in New Zealand. Specifically, the Department of Internal Affairs, Office of the Auditor General an`d Local Government New Zealand have all emphasised the importance of asset management being at the core of effective management of infrastructure assets.

[12] Asset management is a focus area for Te Uru Kahika's River Managers' Special Interest Group. The Group fosters collaboration between council staff on best practice.

DISCUSSION

[13] The AMP has been developed using material and guidance from the following nationally and internationally recognised authorities:

a. International Standards Organisation ISO 55000:2014
b. Institute of Public Works Engineering Australasia (IPWEA)
c. Association of Local Government New Zealand
d. Audit New Zealand and Office of the Auditor General
e. International Infrastructure Management Manual (IIMM). The IIMM manual was developed with public and private sector input from New Zealand, Australia, United States, United Kingdom, and South Africa.
f. Department of Internal Affairs New Zealand
g. New Zealand Infrastructure Commission *Te Waihanga*
h. Te Uru Kahika's River Managers' Special Interest Group.

[14] The relationship between the AMP, the Infrastructure Strategy and ORC's strategic directions and plans is shown below in Figure 1.

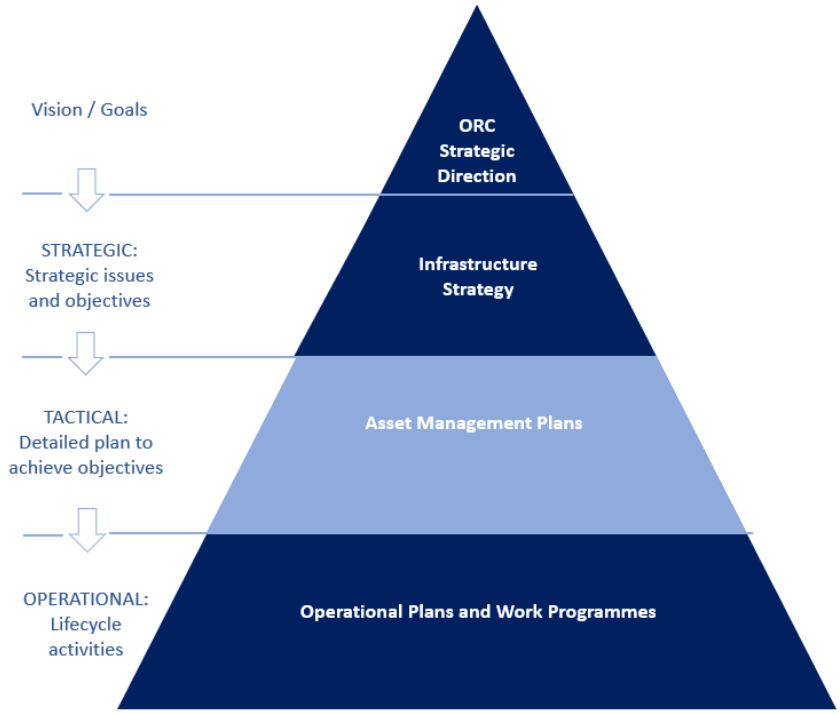

Figure 1. Relationship between the AMP, Infrastructure Strategy, and ORC's strategic directions and plans.

[15] The AMP describes ORC's assets and asset management processes including lifecycle management and improvement items. These improvement items provide a targeted approach to enhancement and standardisation of existing systems (e.g. data collection and storage, risk management, operations and maintenance activities). The improvement items have been identified with a focus on achieving reliable and accurate information on ORC assets to support decision-making.

[16] The AMP is a tactical plan however it may need amendments arising from the adoption of the Infrastructure Strategy 2024-2054 and 2024-34 Long Term Plan. These are likely to be minor because of the tactical nature of the AMP.

[17] The AMP will be formally reviewed in conjunction with, or prior to, the review of the Infrastructure Strategy 2024-2054.

OPTIONS

[18] There are no alternate options being presented.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[19] The AMP serves as a tactical plan for achieving ORC's strategic directions.

Financial Considerations

[20] Delivery of the work that is guided by the AMP has been provided for in the Draft Infrastructure Strategy 2024-2054 and the Draft 2024-34 Long Term Plan.

Significance and Engagement

[21] The endorsement of the AMP does not trigger any engagement requirements under Councils Significance and Engagement Policy.

Legislative and Risk Considerations

[22] The are no statutory obligations to be considered in the endorsement of the AMP by Council.

[23] Infrastructure resilience has been identified as a Strategic Risk for ORC. The AMP supports the management of this risk.

Climate Change Considerations

[24] Climate change considerations have been discussed in the Draft Infrastructure Strategy 2024-2054. The AMP provides oversight to the management of the effects of future climate change on the ORC's assets in respect of flood risk, land drainage, and river management infrastructure.

Communications Considerations

[25] The AMP will be made publicly available on ORC's website.

NEXT STEPS

[26] Make any amendments that are necessary arising from the adoption of the Infrastructure Strategy 2024-2054 and 2024-34 Long Term Plan.

ATTACHMENTS

1. Asset Management Plan [**9.3.1** - 75 pages]

Otago Regional Council

Asset Management Plan 2024

Flood Protection, Land Drainage and River Management Infrastructure

Prepared by Engineering, Operations Directorate

Contributors:

Arsalan Ali, Asset Management Engineer

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April 2024

Document ID:

Cover Image

Photograph showing the Clutha River/Mata-Au looking downstream as it flows past Balclutha central business district, before bifurcating into the Koau and Matau Branches at Inch Clutha.

Executive Summary

ORC manages eight flood protection and land drainage schemes and a portfolio of river management assets across the region in order to carry out its statutory role to promote soil conservation and mitigate damage caused by floods and riverbank erosion.

Communities are dependent on the effective performance of these flood protection and land drainage schemes and the river management assets for their safety and economic wellbeing. Providing and maintaining this infrastructure requires good asset management practices.

Asset management is considered internationally as the preferred choice for driving improvement in most organisations that derive value by managing and operating infrastructure assets. It is now widely recognised that asset management can provide a framework and systematic approach to enable organisations to achieve improved performance and resilience.

This Asset Management Plan (AMP) is a key document for achieving community outcomes and plays a key role in meeting ORC's vision and strategic priorities. Thus, the AMP acts as ORC's tactical plan for the delivery of community outcomes and informs operational activities for infrastructure assets.

1. Contents

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1. Introduction

Otago Regional Council (ORC) provides flood protection and land drainage to approximately 21,000ha of rural and urban land in Otago. This is achieved through infrastructural assets that include 218km of floodbanks, 12 pumping stations, 42 bridges, 369 culverts and various river assets (e.g. Shotover delta training line, Albert Town riverbank rock work, Lindsay Creek floodwalls and channel lining).

The community is dependent on the effective performance of this infrastructure for their safety and economic wellbeing. This includes part of the Dunedin Central Business District, University of Otago city campus, Dunedin International Airport and the townships of Balclutha, Alexandra, Milton, Outram and Mosgiel. It includes key transport routes such as state highways and the railway network. Approximately 7,462ha of land that relies on ORC's flood protection and land drainage infrastructure is less than one metre above current mean sea level.

This Asset Management Plan (AMP) has been prepared for these infrastructural assets, consolidating existing plans and documents. It has been developed using material and guidance from the following nationally and internationally recognised authorities:

- International Standards Organisation ISO 55000:2014 Asset Management – Overview Principles and Terminology.
- Institute of Public Works Engineering Australasia (IPWEA)
- Association of Local Government New Zealand (LGNZ)
- International Infrastructure Management Manual (IIMM): The IIMM manual was developed with public and private sector input from New Zealand, Australia, United States, United Kingdom and South Africa.
- The The Āpōpō Guide : A comprehensive compilation of available international standards tailored specifically to the context of Aotearoa New Zealand.

1.1 What is the purpose of this plan?

Infrastructure assets represent a significant portion of Otago Regional Council's (ORC) expenditure. The way that ORC manages iis infrastructure has a significant influence on the extent to which it will contribute to the community outcomes for its Resilience and Climate Focus Areas.

This Asset Management Plan (AMP) formally documents and defines how ORC manages its infrastructural assets across the Flood Protection, Land Drainage & River Management activities and services. Given the large capital and operating expenditure involved, the long asset lives, and the lead times required in planning for upgrades or new assets, a long-term and strategic planning approach for managing assets is essential.

It is important to acknowledge that one of the many unique challenges faced by managers of flood protection and drainage infrastructure is that due to the nature of the infrastructure, they are rarely fully tested up to design standards. However, they must perform effectively when they are tested by events, due to the consequences associated with failure. Noting this criticality of some of the assets associated with flood protection and drainage infrastructure, it is prudent that organisations manage their assets as efficiently as possible.

The key objectives of this plan are to:

- Help achieve the community outcomes for the Resilience and Climate Focus Areas.
- Improve knowledge of the assets and the activities they provide.
- Ensure the appropriate level of service is provided at the lowest long-term costs.
- Anticipate and plan for potential demand for the activities and associated assets.
- Recognise and balance a variety of risks affecting the assets and activities.

- Ensure sustainability and resilience are integrated within the activity.
- To give effect to the Infrastructure Strategy.

1.2 How does the plan fit in ORC

The ORC has a number of key strategic documents, all working towards achieving the ORC's Strategic Direction and community outcomes. The relationship between these documents is illustrated in Figure 1, with some examples discussed further below.

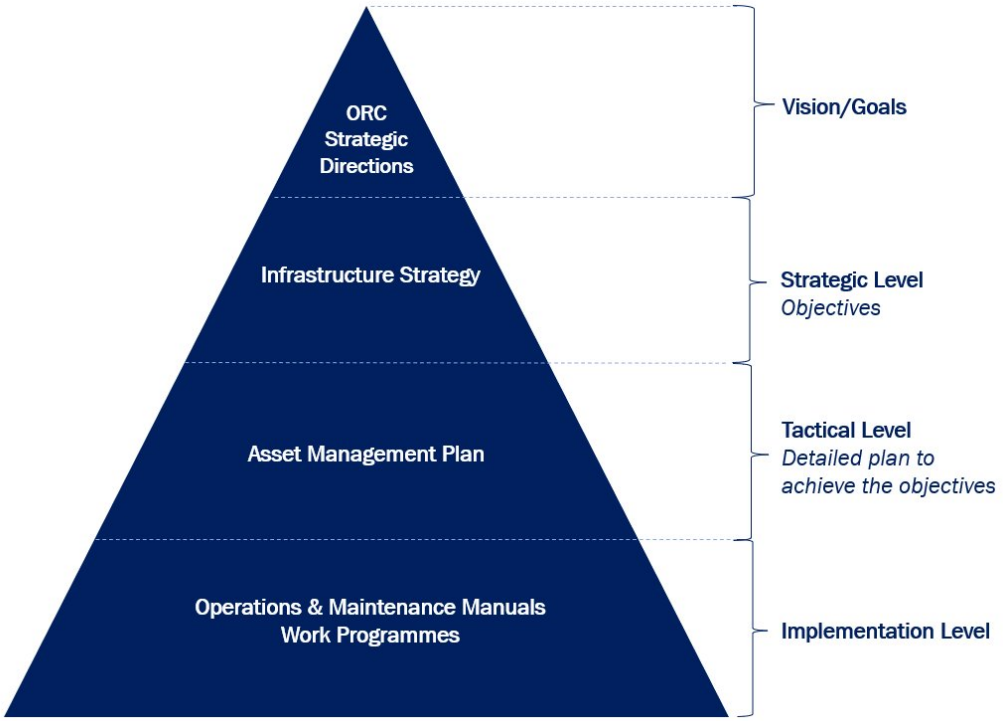


Figure 1. Linking Community outcomes, levels of service & operational actions, through a tiered hierarchy of plans.

The AMP acts as ORC's tactical plan for the delivery of community outcomes, informs operational activities for the aforementioned activities and associated infrastructure assets, while being guided by ORC's Infrastructure Strategy that sits within the Long Term Plan. It is to be noted that although this version of the AMP is guided by ORC's Infrastructure Strategy, it is envisioned that future versions of the AMP will see the information between the AMP and the Infrastructure Strategy flow largely two way.

1.3 Structure of the AMP

This document is structured into the following sections.

1. **Introduction**
   Introduces the AMP by presenting the purpose of the AMP. It also outlines the structure of the AMP and strategic relationships within the organisation.

2. **Strategic Context**
   Provides a high level strategic overview of the strategic considerations in this AMP.

3. **ORC's Assets**
   Provides a summary of ORC's assets, and their health.

4. **Levels of Service**
   A distillation of; ORC's strategic objectives, and statutory and legislative requirements; into statements, measures, and targets.

5. **Future Demand**
   A high level analysis of key elements which may influence ORC's flood protection, land drainage, and river management activities. What may happen and how they will be managed.

6. **Risk and Resilience**
   Provides overview of ORC's risk management framework, and provides details on identifying, analysing, evaluating and treating risks associated with our assets.

7. **Lifecycle Management**
   This section details approaches to managing infrastructure at different lifecycle stages. Ways to balance capital and operational costs with performance delivery and risk management.

8. **Financial Summary**
   This section aims to demonstrate that decisions are aligned with available funding sources by providing overviews of; funding strategies, asset valuations, and financial forecasts (in part with the Infrastructure Strategy).

9. **Asset Management Practices**
   This section provides an overview of key asset management processes, people, and tools.

10. **Improvement Plan**
    This section demonstrates ORC's commitment to improvement in asset management practices. Details of actionable points for improvement are summarised here, in the context of asset management maturity.

2. Strategic Context

This section provides a high level overview of the strategic level considerations for this plan.

The ORC is responsible for sustainably managing Otago's natural resources of land, air and water on behalf of the community, for the benefit of present and future generations. The role of ORC is to lead and represent communities, encouraging participation in decision-making, and promoting their social, economic, environmental, and culture well-being.

This AMP focuses on the management of flood protection, land drainage, and river management activities and associated infrastructure. For clarity, this AMP does not include other areas of ORC's work within the same river catchments such as natural hazards, catchment action planning, biosecurity, biodiversity and land management. Whilst this work falls under integrated catchment management, River Management functions collaborate with other ORC teams, as and where necessary, to assist with delivering integrated catchment management outcomes.

This section of the AMP will provide a high-level overview of strategic elements, a change in which has the potential to have an impact on flood protection, drainage and river management activities in Otago. A detailed overview can be found in *ORC's Infrastructure Strategy 2024-2054.* This section will also cover the alignment between the Asset Management System (AMS) and ORC's strategic planning processes.

2.1 Strategic Overview

All organisations operate within specific environments and are guided and affected by numerous external and internal elements (social, environmental, economic, cultural, technological and regulatory). Each of these variables is to some degree in a state of change, with some variables having a greater propensity for change than others (environmental); and others where the change is cyclic and predictable (regulatory). Any change in the variables can have cascading effects on other variables, and have a significant impact on the overall operating environment. The *ORC Infrastructure Strategy 2024-2054* assesses the impacts of any changes in these variables, and provides details for options that can be used to mitigate any negative impacts.

2.2 Alignment of Asset Management System (AMS) with ORC

An asset management system (AMS) is a disciplined approach to ensure that a required outcome is achieved in a controlled and sustainable manner. Specifically, the AMS is the set of inter-acting elements of an organisation to establish AM policies and objectives, and processes to achieve those objectives. It is designed for the purpose of achieving defined objectives, with data, processes, plans and other tools being mechanisms to help achieve these goals. Figure 2 below has been developed inhouse by contextualising best practice (IIMM and ISO 55000) to visually illustrate ORC's AMS.

The framework diagram, details the various components of the AMS, and their connectivity. The framework diagram also outlines the cyclic nature of the flow of information within the AMS (Figure 2).

Figure 2. Framework diagram of Council's asset management system (AMS).

3. Our Assets

This section provides a summary of our assets, and their health.

ORC owns and manages an array of flood protection, land drainage and river management assets across Otago.

3.1 Scheme Overviews

ORC owns and manages three flood protection schemes, three drainage schemes, and one combined flood protection and drainage scheme (Table 1). ORC owns but commissions external management for parts of the Lower Waitaki River Control Scheme. ORC also owns and maintains river management assets across the region.

The flood protection schemes are designed to mitigate the risk of flooding to people, property and stock during a flood event, and the land drainage schemes are designed to drain land so that it remains viable for farming.

Table 1. Flood protection and land drainage scheme overviews.

Scheme	Description
Alexandra Flood Protection Scheme	This Scheme was built in 2001 to protect Alexandra's central business area against flooding from the Clutha and Manuherikia Rivers. Stormwater drainage systems owned by Central Otago District Council normally drain into the river by gravity, but in some events high river levels prevent the drains from discharging into the river. This is where the scheme pumps serve their function. The total length of floodbanks is just over 1 km. Two roads penetrate the floodbanks. These roads must be closed, and stoplogs installed, during severe floods.
Leith Flood Protection Scheme	The Water of Leith catchment is located to the north of (and includes) the Dunedin Central Business District, and has a catchment area of approximately 42 square kilometres. This scheme mitigates the risk posed by the steep headwaters overwhelming the shallower grade channels through the North Dunedin floodplain. Key Dunedin infrastructure such as the hospital, University of Otago, Otago Polytechnic and stadium are afforded some level of protection by the scheme.
Lower Taieri Flood Protection Scheme	The scheme mitigates the risk of flooding to the Taieri Plain. It was the first to be developed, alongside the East and West Taieri Drainage Schemes, when works commenced in 1870. It is complex, with multiple rivers affecting the scheme. This means flows can increase dramatically in widespread and prolonged rainfall events. The Silver Stream is part of the scheme and flows out of the Silver Peaks area and has a far quicker response time than the Taieri River. Other rivers managed in this scheme are Waipori River and Ōwhiro Stream.
West Taieri Drainage Scheme	The West Taieri Drainage Scheme covers the area bounded by the Taieri River, Lake Waipori, and the West Taieri Contour Channel. A small part of the scheme lies in the Henley Floodway. The West Taieri area differs from the other drainage schemes in that water cannot drain out of the scheme under gravity: it must be pumped out. There are three pump stations in the West Taieri Drainage Scheme: Waipori; Henley; and Lake Ascog.
East Taieri Drainage Scheme	The East Taieri Drainage Scheme is physically divided into two areas by the Silver Stream, which flows across the Taieri Plain in a south-westerly direction. Drains on the northern side of the Silver Stream generally flow toward what is called the East Taieri Upper Pond area. Drains on the southern side of the Silver Stream flow toward the East Taieri Lower Pond area. When the Taieri River is at low flow these drains flow out to the river by gravity, whereas when the Taieri River is at high flows, gravity gates close and pumps must be used.
Lower Clutha Flood & Drainage Scheme	This scheme combines both flood protection and drainage works. Construction of this scheme started in 1960 and was completed in 1991. The area protected by the flood protection component is the Clutha Delta, which extends from 4km north of Balclutha to the sea. The Clutha is the second longest river in New Zealand, and the largest by mean flow. The Clutha's headwaters are in the Southern Alps above lakes Wakatipu, Wanaka, and Hawea. The Clutha River splits into two just downstream of Balclutha. Between 60% and 70% of the flow goes down the Koau Branch and 30% to 40% down the Matau Branch. The island formed between the branches is called Inch Clutha. There is a floodway designed to carry floodwaters when the river level rises at the top of Inch Clutha. Land drainage is provided by a network of 153 km of drains in four regions: Barnego; Stirling/Kaitangata; Inch

	Clutha; and Otanomomo/Paretai. Drainage in Balclutha and Finegand is not ORC's responsibility.
Tokomairiro Drainage Scheme	The Tokomairiro Drainage Scheme is located in the flat basin surrounding Milton, surrounded on three sides by inland hills, and by coastal hills to the southeast. The scheme consists entirely of open drains, with associated culverts and bridge crossings. It has no pumps or control structures. Many of the drains were originally creeks that have been realigned.
Stoney Creek Flood Protection Scheme	The Stoney Creek Flood Protection Scheme is located at the Stoney Creek catchment located to the west of Wanaka. The Scheme was established in response to a debris flow event in January 2004 resulted in blockages of culverts with alluvium. This blockage caused water and debris to flow down Studholme Road. The Scheme consists of two debris traps and an overflow channel to mitigate blockages of culverts and debris flow.
Lower Waitaki River Control Scheme	River control assets (groynes, anchored tree protection and tree buffers) on the right bank of the lower portion of the Waitaki River are owned by ORC. The management of this infrastructure is contracted to Environment Canterbury as part of their overall management of the Lower Waitaki River Control Scheme. There are also three floodways that assist in conveying flows from the foothills, across low lying farmland to the Waitaki River. Flows in the river are moderated by a series of dams that were constructed on the river, starting with the Waitaki Dam in the 1920s and 1930s.

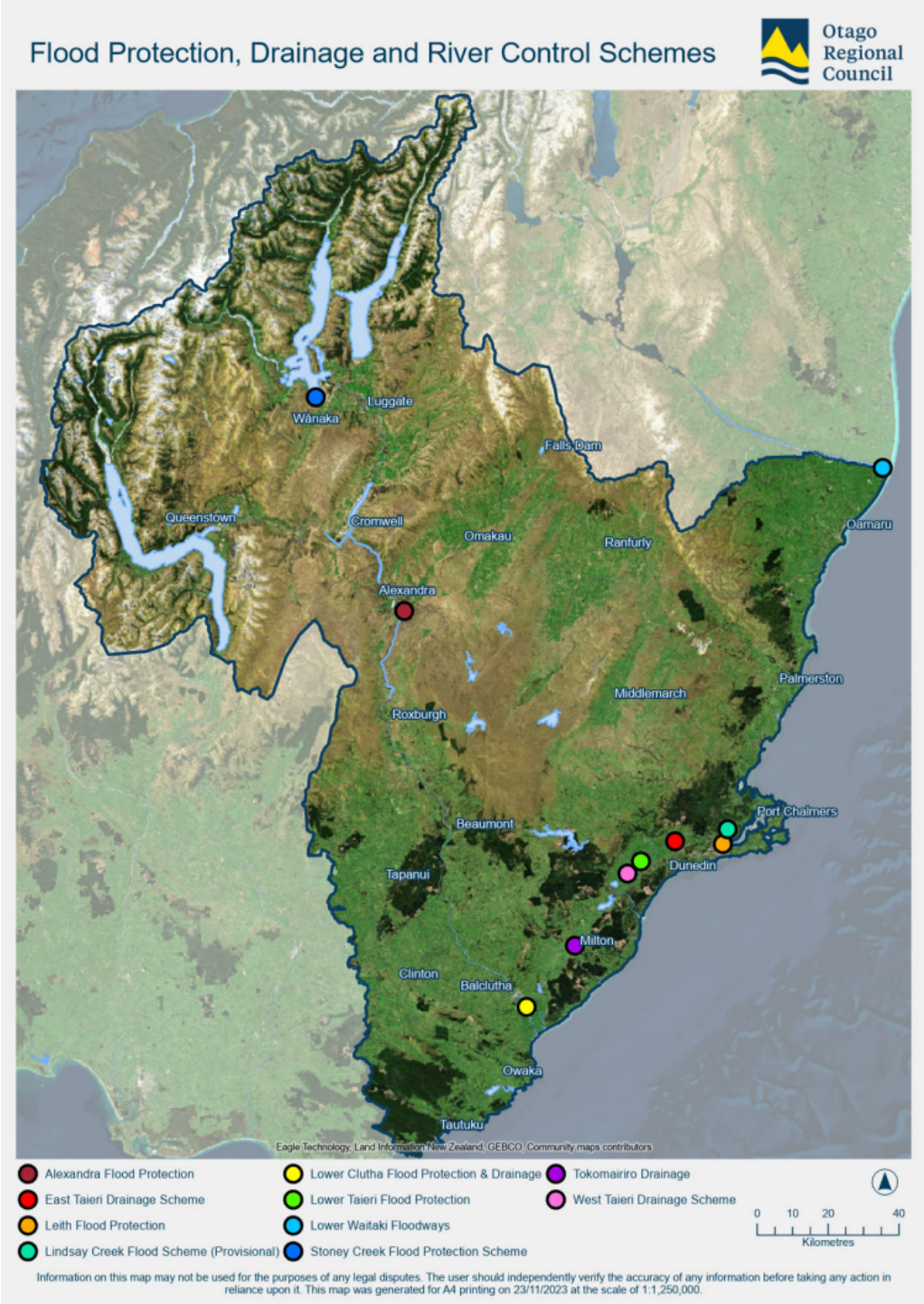


Figure 3. ORC Schemes.

3.2 Asset Summary

Figure 4 below provides an illustrated summary of assets within ORC's portfolio of flood protection and land drainage, as of December 2023. It shows key assets only, and not all assets have been included.

Figure 4. Asset portfolio infographic for flood protection and land drainage schemes (not all assets included).

Otago Regional Council also owns and maintains river management infrastructure across Otago. This includes several smaller schemes and isolated pieces of infrastructure outside of the main flood protection and drainage schemes discussed previously. Figure 5 depicts the location of key river management infrastructure across Otago and is summarised as follows:

- Shotover Training Line, Queenstown – Guides flows and sediment in the Shotover River.
- Matukituki Training Line, Matukituki River – Training line structure that deflects flood waters to the true left of the Matukituki River so that the downstream floodplain on the right bank could be re-established as farmland.
- Albert Town Rock Buttress, Albert Town – Mitigate the risk of erosion and land movement.
- Lower Waitaki Floodways, North Otago – Conveyance of flows from foothills to the Waitaki River.
- Lindsay Creek, Dunedin – Some rockwork and concrete walls exist to mitigate the flood and erosion hazard and help retain the creek within its existing channel.
- Kaikorai Stream Stilling Basin, Green Island, Dunedin – Dissipates energy in the channel.
- Trees that are planted and maintained along river channels and margins to mitigate the risk of erosion and manage channel migration.
- Placed rock to mitigate the risk of erosion.

Some of these assets are not fully captured in the asset management database. Recognising the need for accurate data to support informed decision-making and effective asset management, we have planned improvements to ensure comprehensive data capture within the next three years.

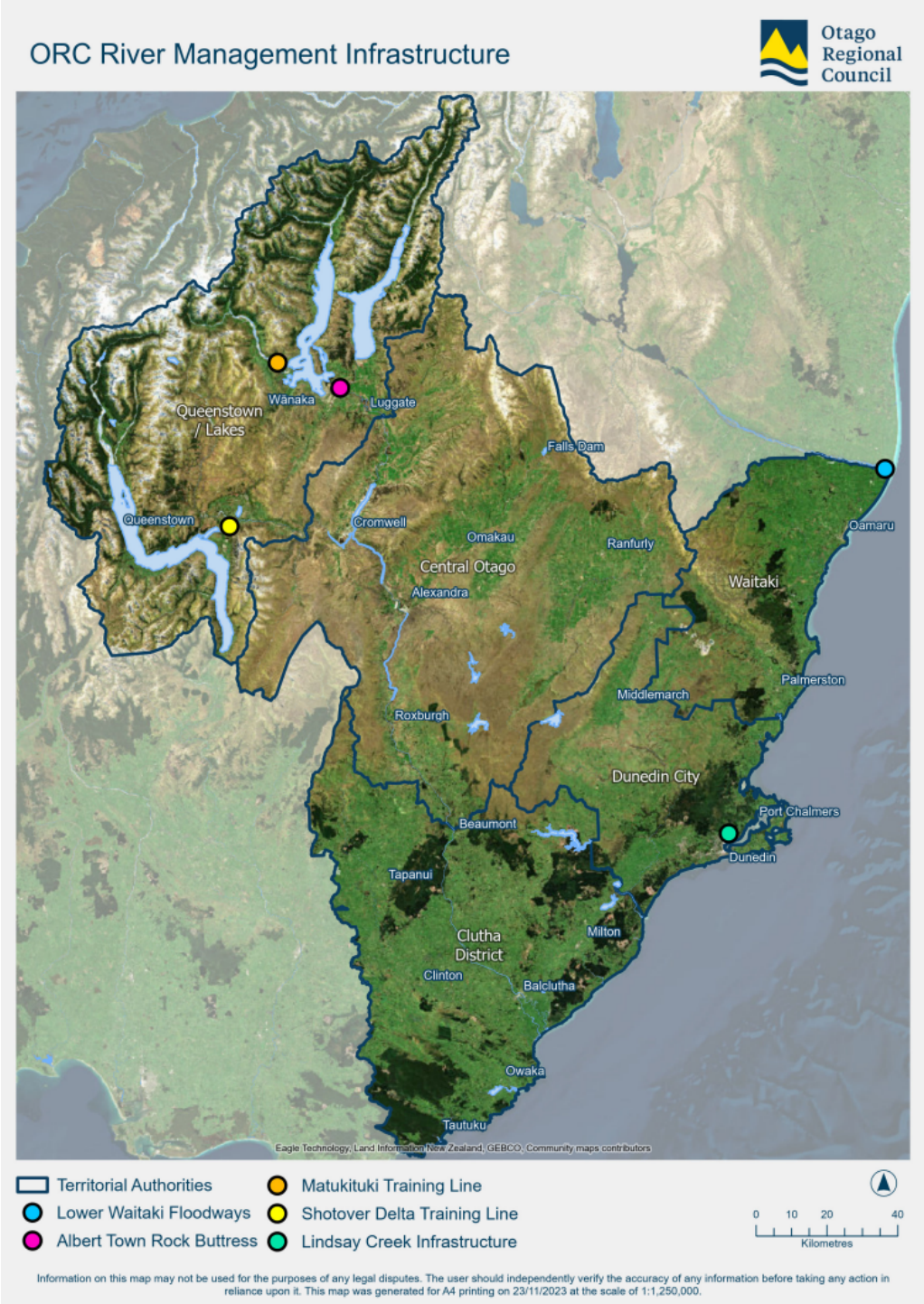


Figure 5. Location of key infrastructure within river management areas.

3.3 Asset Age

At present, ORC is in the process of verifying information with regards to the age profile of most of its flood protection and land drainage assets. By ensuring that we have reliable age information and estimated useful lives for applicable assets, these will be used to inform more accurate lifecycle management, such as asset renewals. An improvement item for completing age verification for all of ORC's infrastructure assets has been recorded. Currently accessible information in relation to age of the assets has been included in relevant asset type sections below.

3.4 Asset Condition

Asset condition reflects the actual physical condition of an infrastructure asset, which can significantly affect its performance. This makes assessing asset condition an essential part of infrastructure management. Currently, data collected through visual inspections informs the ORC's assessments of scheme and asset performance, annual maintenance work programs, and asset renewal/replacement programs.

ORC operations and maintenance teams undertake routine inspections. Although asset condition is recorded during these inspections, the primary function of these inspections serves for recording maintenance items. An improvement item has been identified to enable inspections to also capture reliable and consistent data in regards to condition.

Formal (Principal) inspections are undertaken by external consultants. These inspections occur at regular frequency, typically a matter of years. Formal inspections are also carried out post-event (weather or accident), and at the discretion of the Manager of Engineering, as deemed necessary.

The subsequent sections summarise the condition of various flood protection infrastructure assets based on the latest available information for each. The confidence of the data in some cases in uncertain due to the age of the inspections, however this is reflected in the data confidence scores at the end of this section.

3.4.1 Floodbanks

Based on available records, construction of floodbanks in Otago first commenced in the Lower Taieri in the 1870s. From that time, flood protection and drainage works were undertaken by either private landowners or independent boards, until 1960 when construction of the government-funded Lower Clutha Flood Control Scheme began, the majority of the works being completed in 1991. The flood of 1980 also resulted in raising/rebuilding much of the floodbank network in the Lower Taieri, in addition to other work being undertaken to enhance the Scheme. A short stretch of floodbank, approximately 1km, was constructed in Alexandra in 2001 to mitigate flooding of the Alexandra Central Business District (CBD) from the Clutha and Manuherikia Rivers.

A formal assessment of all floodbanks along the Lower Taieri, Lower Clutha, and Alexandra flood protection schemes was conducted in August 2017. Condition ratings, based on a range of criteria, were assigned to 1288 points along floodbanks. For each floodbank, scores across the criteria were combined using a weighted average to produce an overall condition score. Figure 6 below presents a summary of the overall asset condition for each floodbank. As of August 2017, 85% of floodbanks were in Very Good to Average (1-3) condition. In addition to formalised condition inspection, floodbanks are inspected on a bi-annual routine by ORC internal Operations and Maintenance staff, to address and manage minor issues. These issues are typically associated with grazing, rabbit holes and minor damage.

Historical and ongoing problems include stock damage, minor erosion around culverts, slope slumping on the outside of river bends, and trees or other features located near or on the floodbanks. Stock damage is considered the most common issue, along with the quality of initial construction.

Asset Condition	No. of Inspections	%	%
1 – Very Good	227	17.7	85
2- Good	511	39.8	
3- Average	354	27.5	
4 - Poor	125	9.7	15
5 – very Poor	68	5.3	
Total	1288	100	100

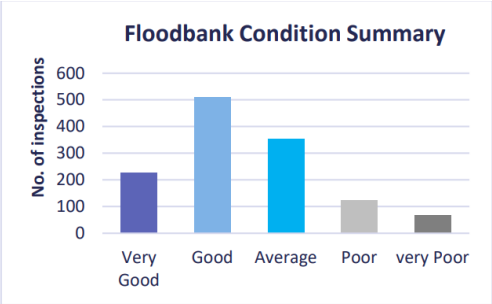


Figure 6. Summary of floodbank condition by grade.

3.4.2 Pump Stations

There are 14 pump stations within the flood protection and drainage schemes. The condition of major pump station components are assigned scores in accordance with the NZWWA[1] asset grading guidelines (Table 2).

The first pump station constructed was the Waipori Pump Station in the 1920s. Since then, pump stations have been constructed in the 1940s (Henley), 1970s (Silverstream, Mill Creek, Barnego, Kaitangata, Paretai), 1980s (Rutherfords, Scroggs) 1990s (Lake Ascog), and 2000s (Left Bank, CBD, Linger and Die). Since the first construction, the pumps and pump stations have been replaced, modified, and overhauled over time.

ORC Operations and Maintenance teams have been undertaking regular mechanical and electrical testing, undertaken by the engagement of an external contractor. A continuous programme of maintenance and repairs, as recommended by manufacturer O&M Manuals, has also been in place. As of August 2023, Engineering has also engaged an external specialist contractor to undertake manufacturer recommended maintenance, for a period of up to five (5) years.

Whilst limited up-to-date and reliable condition data currently exists, operational personnel are confident on the condition of the pump stations based on maintenance undertaken and ongoing operational inspections. However, we recognise the need for more regular, formal assessments to validate this confidence. This will be addressed once the formal condition assessment programme is implemented.

However, age is not the only determinant factor that has driven replacement/renewal of the pumps as a priority. Overtime, ecological and environmental priorities for the Otago community and ORC have shifted. The infrastructure and capabilities of the pumps and pump stations, as they exist today, do not necessarily provide a suitable contribution to current environmental and ecological outcomes. The delivery of these outcomes and with respect to pump station infrastructure will be a key criteria for renewal and/or replacement. The grading of major pump station components are assigned scores in accordance with the New Zealand Water and Waste Association asset grading guidelines.

[1] New Zealand Water and Waste Association

Table 2. Condition grading system for pump stations (NZWWA).

Grading	Condition	Description	Pump station condition
1	**Very Good**	Only planned maintenance required	Sound plant designed to current standards, all operable and well maintained to high standards.
2	**Good**	Minor maintenance required plus planned maintenance	Sound plant, all operable and well maintained but showing some signs of wear and tear. Minor oil leaks; gland wear evident although protective coatings intact and efficiency undiminished. Deterioration causing minimal influence on performance.
3	**Average**	Significant maintenance required	Functional sound plant and components. Acceptable but showing significant wear with minor failures and some diminished efficiency. Bearing and gland wear and corrosion of metal components more evident. Starting to affect performance.
4	**Poor**	Significant renewal/ rehabilitation required	Plant and components functional but require significant maintenance to remain operational. Likely to cause a marked deterioration in performance. Some asset replacement or rehabilitation needed.
5	**Very Poor**	Physically unsound and/or beyond rehabilitation	Plant and component effective life exceeded and excessive maintenance costs incurred. A high risk of breakdown with a serious impact on performance. Urgent replacement/ rehabilitation required.

3.4.3 Bridges

Bridges owned and maintained by ORC have been installed, and replaced over time, with the most recent one being installed in 2023. ORC maintains 42 bridges across the flood protection and drainage schemes. These bridges primarily provide pedestrian, livestock, and vehicular access over drainage channels into private properties.

Calibre Consulting Ltd undertook condition assessments of 31 bridges in 2018, with the remaining 14 bridges excluded primarily because they were no longer in operation. A summary of the bridge condition assessment, can be found in Table 4 and Figure 7.

From the inspected bridges, 51% were found to be in Very Good to Average condition, while the remaining 49% were in Poor or Very Poor condition. This suggests that significant repair or replacement work is required for a large portion of bridge assets. Table 5 indicates that over half of the bridges inspected (sixteen) have less than five years of their remaining life, indicating a substantial amount of work over the short term. The ORC LTP 2024-2034 contains a programme of bridge renewals and significant maintenance.

Table 3. Location of ORC Bridges.

Scheme	Quantity
East Taieri	1
West Taieri	19
Tokomairiro	17
Lower Clutha	5
Total	42

Table 4. Asset condition summary.

Grade	Quantity	Ratio
1 - Very Good	2	6%
2 - Good	8	26%
3 - Average	6	19%
4 - Poor	7	23%
5 - Very Poor	8	26%
Total	31	100%

Table 5. Remaining life.

Remaining Life	Quantity
<5	16
5-15	5
>35	8
TBD	2
Total	31

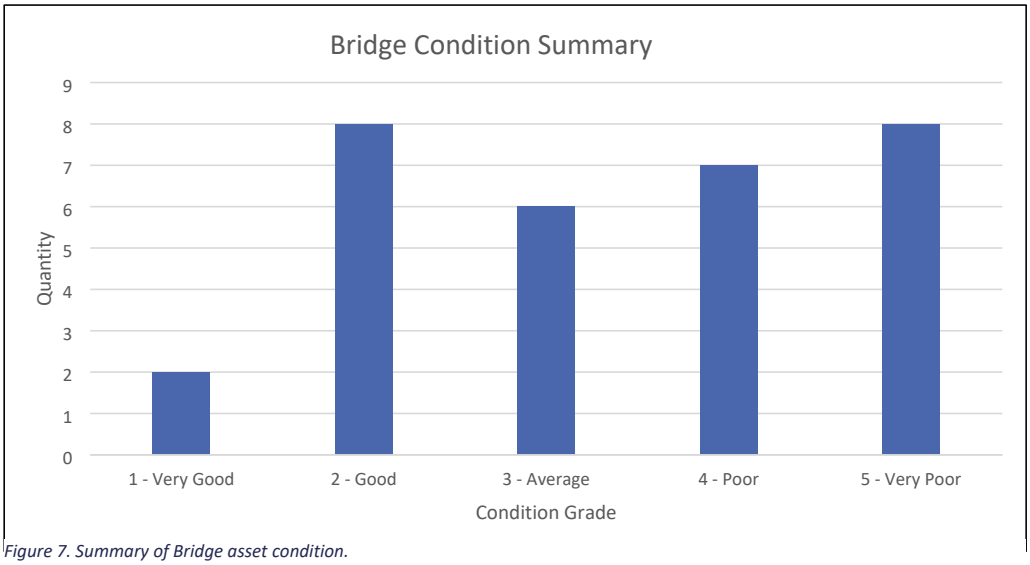


Figure 7. Summary of Bridge asset condition.

3.4.4 River Structures

The ORC owns and maintains river management infrastructure across Otago. These structures include the Albert Town Rock Buttress, training lines, groynes, debris traps, and the Kaikorai stilling basin. Though there are existing condition assessment programs for some these structures, these programs largely sit independently of each other. Verification and review of condition assessment for river structures is in process and on-going. This is unlike the structures located within Lindsay Creek and Water of Leith, which are subject to a rigorous condition assessment program, discussed below.

Various structures on the Water of Leith and Lindsay Creek were visually inspected and assessed by WSP Opus in 2019. The structures comprise retaining walls (stone, Gabion, rock), debris traps, and concrete channelling and weirs. In addition to receiving a condition grading, each structure was also assigned a durability rating (Table 6). A summary of asset condition and durability for all structures assessed is provided in Table 7.

Table 6. Durability rating for structures.

Grading	Description
1 – Very Good	Recently built structure unlikely to require attention for many years.
2 – Good	Unlikely to require attention within the next ten years.
3 – Moderate	May require attention in the next ten years.
4 – Poor	Likely to require attention within the next five years.
5 – Very Poor	Requires urgent attention.
Not Applicable	Does not apply.

44 structures were inspected on the Water of Leith, from Dunedin Harbour to Islay Street.
31 structures were inspected on Lyndsay Creek from the Confluence to Bethunes Gulley.

While over 70% of structures were assessed as being in Very Good to Moderate condition, 25% were in Poor or Very Poor condition, with 20 structures requiring attention within the next five years, including three requiring urgent attention. Furthermore, of the 70% of structures assessed as being in Very Good to Moderate condition, the majority of these (64%) were in Moderate condition. ORC recognises the need for more proactive maintenance and renewal strategies for these assets. The ORC LTP 2024-2034 contains a programme to undertake inspections of the historic walls, and budget has been allocated for repairs and renewals.

Table 7. Asset condition and durability for Water of Leith and Lindsay Creek structures.

Grading	Condition			Durability		
	Quantity	Ratio		Quantity	Ratio	
1 - Very Good	3	4.0	70.7	3	4.0	69.4
2 - Good	2	2.7		2	2.7	
3 - Moderate	48	64.0		47	62.7	
4 - Poor	16	21.3	25.3	17	22.7	26.7
5 - Very Poor	3	4.0		3	4.0	
Not Applicable	3	4.0	4.0	3	4.0	4.0
Total	75	100	100	75	100	100

3.5 Culverts and Outfalls

ORC owns and maintains 369 culverts across its flood protection and drainage schemes. The primary function of these culverts is to enable drains to be crossed whilst allowing the flow of water and preventing flooding by ensuring efficient drainage. An outfall consists of a typically top-hinged, non-return valve structure attached to a culvert. The flap gate is constructed to keep water fluctuations from backflowing through a culvert.

Whilst there is condition information available on culverts within the region, ORC is currently in the process of verifying condition information on culverts across the region. This has been identified as an improvement item. As part of this improvement, the process of applying condition grading to culverts as by means of visual inspection is being standardised by the use of a visual condition grading system. Please see table below which summarises the different conditions and their associated descriptions.

Table 8. Condition grading system for culverts.

Grade	Condition	Description
1	**Very Good**	Cosmetic defects that will have no effect on performance; routine maintenance only.
2	**Good**	Minor defects that will not reduce overall performance; minor maintenance required.
3	**Moderate**	Defects that could reduce performance of the asset; moderate maintenance required.
4	**Poor**	Defects that would significantly reduce the performance of the asset.
5	**Very Poor**	Defects resulting in complete performance failure. Asset requires upgrading/replacement.

This approach ensures that observations during the inspection are recorded consistently, resulting in accurate and reliable information. Consistent and reliable condition data regarding culverts will provide confidence in data that will help with increased efficiency in, planned maintenance, renewals and capital budgeting, and effective targeted intervention, where required.

3.6 Trees

ORC uses tree planting and tree maintenance to assist with flood protection, drainage, and river management activities. Works on tree management are undertaken by the River Engineering team, and the Operations and Maintenance team. For clarity, this section pertains specifically to Trees that are considered as assets.

Trees serve a number of purposes, based generally on the location that they have been planted. Rows of trees planted and maintained in the Lower Taieri and Lower Clutha can help act as debris traps during inundation. Trees are also planted and maintained along river channels to mitigate risk of erosion and channel migration.

This AMP acknowledges that there are existing tree management processes and systems which can be optimised to increased efficiency of tree management activities. In addition to this being identified as an improvement item in this AMP, ORC is currently engaged in the on-going verification and digitisation of tree assets across the Otago region.

3.7 Critical Assets

Critical infrastructure assets are characterised by their significant impact on the system's overall performance, safety, and stability. The identification of these critical assets in flood

protection context is particularly important due to their high significance in mitigating flood risks. The failure or loss of a critical asset could result in severe consequences, such as wide-scale flooding, property damage, disruption of essential services, public health and safety risks and environmental impacts.

Council's infrastructure Engineering team has taken proactive approach to identify critical assets for each scheme. This process employed a combination of expert engineering judgement, informed by a deep understanding of the system, and was validated by modelling and investigative studies.

Table 9 below presents the identified critical assets for each scheme, providing a concise view of the assets that carry high importance within each scheme. The list was formulated to help prioritise maintenance activities effectively and efficiently.

Table 9. Identified critical assets across the schemes.

Scheme	Critical assets
Alexandra Flood Protection Scheme	Floodbanks that protect the town and industrial areas.
Leith Flood Protection Scheme	Protection works through the university area (Dundas St to Forth St). Failure of these assets would result in flooding of much of the Dunedin CBD, including SH1.
Lower Taieri Flood Protection Scheme	Key assets include sections of floodbank protecting Outram and parts of Mosgiel. The bulk of the Lower Taieri floodbank network also carries high importance as its failure could inundate large areas (>2,000 hectares) of productive farmland.
West Taieri Drainage Scheme	The Waipori Pump Station, which services approximately 95% of the drainage area, is particularly critical. Additionally, the south-western half of the drainage area (the area south-west of Miller Road), which lies below the mean level of Lake Waipori, is completely reliant on the drainage network. Three arterial drains are particularly important: Lee Creek, Kirks Drain and the Main Drain.
East Taieri Drainage Scheme	Four sets of gravity gates and the three pump stations, followed by the arterial drains that lead to the pump stations and gravity gates.
Lower Clutha Flood & Drainage	Floodbanks that protect the towns and industrial areas of Balclutha and the Silver Fern Farms Finegand Plant.
Shotover Training Line	Critical to the performance of the Shotover Delta infrastructure. If this did not function correctly, then there would be effects to Lake Wakatipu and potential flooding to surrounding townships, including Queenstown CBD.

3.8 Data Confidence

The foundation of all asset management activities is asset data information. Knowing exactly what assets exist, where they are, and in what physical condition they are in is not fundamental to infrastructure planning but also instrumental in providing clarity to decision makers about the robustness of the plans presented in this document.

Table 11 offers a detailed breakdown of our data confidence across various aspects including our asset inventory, asset condition, performance, and criticality. Scores are based on technical estimates from a professional team within ORC's Infrastructure Engineering team, using the grading system presented in Table 10.

Table 10. Data confidence score definitions.

Confidence Grade	Description
Highly Reliable	Data based on sound records, procedures, investigations and analysis, documented properly and agreed as the best method of assessment. Dataset is complete and estimated to be accurate ± 2%
Reliable	Data based on sound records, procedures, investigations and analysis, but has minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Dataset is complete and estimated to be accurate ± 10%
Uncertain	Data based on sound records, procedures, investigations and analysis which is incomplete or unsupported, or extrapolated from a limited sample for which grade A or B data are available. Dataset is substantially complete but up to 50% is extrapolated data and accuracy estimated ± 25%
Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis. Dataset may not be fully complete and most data is estimated or extrapolated. Accuracy ± 40%
Unknown	None or very little data held.

Table 11. Data confidence scores for various asset information.

Data	Unknown	Very Uncertain	Uncertain	Reliable	Highly Reliable
Asset Inventory:					
Location	■	■	■	■	
Quantity	■	■	■	■	
Value	■	■			
Condition:					
Flood protection schemes	■	■	■		
Drainage schemes	■	■	■	■	
River assets	■	■			
Performance:					
Flood protection schemes	■	■	■	■	
Drainage schemes	■	■	■		
Criticality:					
Asset Criticality	■	■	■	■	

4. Levels of Service

This section provides a distillation of; ORC's strategic objectives, and statutory and legislative requirements; into statements, measures, and targets.

Asset management aims to deliver agreed levels of service to current and future customers in the most cost-effective way, while adhering to any legislative requirements. The concept of "Levels of Service" refers to the measurable standards set to ensure efficient delivery of a community service such as flood protection or land drainage.

Levels of service provide the basis for the lifecycle management strategies and works programmes detailed later in this AMP. Improvements have been identified to enhance our approach to levels of service, such as implementing a more formal levels of service framework and community engagement process, and developing more specific and targeted performance measures.

4.1 Overview

In this section, we will explore the key drivers for our levels of service, including community outcomes and legislation, as well as who our customers and stakeholders are. We will also discuss the framework used to determine these levels of service, the performance measures associated with them, reporting procedures, and any key issues in our current performance.

4.1.1 Community outcomes

This AMP contributes to achieving the community outcomes for the Resilience and Climate Focus Areas.

4.1.2 Legislative and Regulatory

The ORC operates under various statutory requirements and responsibilities, which significantly influence how it fulfills its obligations and provides services to its communities and stakeholders. Key legislation relevant to flood protection, land drainage and river management is presented below.

Table 12. Legislative requirements related to flood protection, land drainage and river management is presented below.

Legislation	Requirement
Local Government Act 2002 and Amendments	The Local Government Act (LGA) 2002 has prescribed that levels of service must in future be developed from a community perspective. The LGA 2002 requires local authorities to consult their communities on funding and financial policies, the types and levels of service ORC propose and how they will be paid for, and the relationship between costs and levels of service provision.
Soil Conservation and Rivers Control Act 1941	Assigns regional authorities the responsibility of control and management of all land with SCRC status within respective regions. This Act gives regional authorities the authority to do works that: ▪ Control the flow of water towards, within and from watercourses; ▪ Prevent overflow of banks and reduce damage caused by such events; ▪ Reduce erosion by undertaking soil conservation activities.
Civil Defence Emergency Management Act 2002	The Otago Regional ORC, territorial authorities and emergency services have responsibilities in planning for and responding to emergencies, including river flooding. Under this Act, the Engineering activities in relation to flood prevention constitute risk reduction measures. Engineering therefore needs to be part of the planning for and response to emergencies in order to minimise the effects of any hazards, particularly river flooding.

Resource Management Act 1991 and Amendments	Under this Act, ORC has an obligation to provide for the sustainable management of natural and physical resources in the region. The ORC has two main roles in relation to this Act: ▪ ORC is tasked with protecting the environment, and specifically the natural resources, whilst still slowing communities to provide for the economic and social wellbeing; ▪ In terms of service delivery, the ORC has a responsibility to avoid, remedy and mitigate any adverse effects of its Engineering activities.
The Public Works Act 1981	Authorises the ORC to grant a lease, tenancy or licence to occupy on land held for public work on terms and conditions as determined by the ORC.
Land Drainage Act 1908	This Act describes the duties of Territorial Authorities for the provision and maintenance of drainage schemes in New Zealand. ORC has been given power over some drainage districts and follows the guidance on land drainage and rivers protection in the Local Government Act mentioned above.
Taieri River Improvement Act 1920	Prevents development of flood protection works on the Taieri Plains, particularly East Taieri, that impacts on West Taieri.
Flood Protection Bylaws 2022	Controls activities that may affect the integrity or operation of flood protection works.

Under the Local Government Act (LGA), local authorities have a role in fostering the social, economic, environmental, and cultural wellbeing of their communities. The LGA offers a framework for local authorities to decide how they will undertake activities, and it also mandates the development of service levels in collaboration with the community to ensure that there is a community perspective applied to the development of any technical service levels.

Schedule 10 of the LGA outlines the general requirements for the development of service levels. These requirements are:

- Statement of intended levels of service for the activity, including performance measures.
- Statement of performance measures and targets that enable the community to assess whether major aspects of the service have not been covered as standard measures.
- A summary of any material changes to the cost of providing the service, and the associated reasons for the change.

The Non-Financial Performance Measures Rules 2013 include a performance measure that must be used with major flood protection and control works.

Changes in government and legislation are anticipated throughout the ongoing implementation of this Asset Management Plan. These changes are proactively monitored with Engineering continuing to engage with territorial authorities and central government on the development of policies and plan implementation. This will enable Engineering to transition and incorporate changes into internal operations.

4.1.3 Customers and Stakeholders

There are many individuals and organisations that have an interest in the management of ORC's infrastructure and services. Examples include landowners, iwi partners, elected members, Department of Conservation, Fish & Game, and utilities/service providers.

To facilitate equitable contribution to ORC decision-making, the ORC has a 'Significance, Engagement & Māori Participation Policy'. This policy outlines our approach to engagement, including principles of practice, how we facilitate partnerships with Māori, and when and how stakeholders and communities can engage in decisions about issues, proposals, assets, decisions, and activities.

Customers, who directly benefit from the assets, and stakeholders, who share an interest in the assets/services, shape our service levels.

4.1.4 Iwi Partners

Te Rūnanga o Ngāi Tahu is the tribal representative body for the Otago Region. ORC values its relationship with Kāi Tahu Papatipu Rūnaka, and is committed to work in partnership with mana whenua to incorporate Te Ao Māori in our work. Part of the ORC's vision is that Otago mana whenua have a strong voice in shaping Otago's environment and its management.

The environment of Otago holds profound values for Aukaha and Kāi Tahu, ranging from the spiritual to the practical. Its placenames are a record of the history, traditions, and customs. The coast of Otago is still a major source of food, livelihood, and recreation for many.

A 'Memorandum of Understanding and Protocol' is in place between ORC and local iwi - Kāi Tahu and Aukaha. ORC is committed to continuing the process of consultation with Māori in the region, ensuring their perspectives are incorporated into our service planning and delivery, and to try to achieve mutual understanding and agreement on those issues that concern us all.

There are four Kāi Tahu ki Otago Rūnaka and three Ngāi Tahu ki Murihiku rūnanga with interests in the Otago region.

Kāi Tahu ki Otago Rūnaka
- Te Rūnanga o Moeraki; - Kati Huirapa Rūnanga ki Puketeraki; - Te Rūnanga o Ōtākou; and - Hokonui Rūnaka.

Ngāi Tahu ki Murihiku rūnanga
- Awarua Rūnanga; - Waihopai Rūnanga; and - Ōraka-Aparima Rūnanga

4.2 Levels of Service Framework

4.2.1 Development Process

ORC's levels of service (LoS) undergo a systematic review every three years as part of LTP process. The LoS stated in this AMP are those outlined in the 2024-2034 LTP.

4.2.2 Consultation

Maintaining an understanding of changing customer expectations is an ongoing process and is carried out through formal and informal consultation with stakeholders.

ORC engages stakeholders in a variety of ways to understand the needs and values, and communicate our decisions and programmes.

ORC engages the community by:

- Seeking public input to proposals through Long Term Plans and Annual Plans.
- Annual public information meetings.
- Engaging with the community on specific projects and programmes.

4.2.3 Reporting

Every quarter, staff report on progress with Annual Plan measures and targets.

At the end of each financial year, the progress made over the 12-month period is reported to the community through the ORC's Annual Report, which is audited.

4.3 Levels of Service (LoS) Statements & Performance Measures Targets

Summarised below are the LoS statements, associated measures and targets. These have been taken from ORC's Draft Long Term Plan 2024-2034.

Level of Service: Protect communities, their livelihoods and infrastructure from the impacts of flood events.

PERFORMANCE MEASURES	BASELINE RESULTS	2024/2025 TARGET	2025/2026 TARGET	2026/2027 TARGET	2027-34 TARGET
Percentage of scheme maintenance programme: Major flood protection drainage and control works are maintained, repaired, and renewed to the key standards defined in relevant planning documents	2022-2023: Achieved	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*
Percentage of scheme renewals programme: Major flood protection and control works are maintained, repaired, and renewed to the key standards defined in relevant planning documents.	2022-2023: Achieved	≥ 85% of renewal programmes completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of renewal programmes completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of renewal programmes completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of renewal programmes completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*

Level of Service: Respond efficiently and effectively to community issues relation to rivers, schemes and floods.

PERFORMANCE MEASURES	BASELINE RESULTS	2024/2025 TARGET	2025/2026 TARGET	2026/2027 TARGET	2027-34 TARGET
Respond within defined timelines for reported issues and to flood events in a timely manner	to check	Flood repair programme: Damage identified, prioritised and a repair programme is made available to affected communities within 3 months of the event/100% Reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days	Flood repair programme: Damage identified, prioritised and a repair programme is made available to affected communities within 3 months of the event/100% Reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days	Flood repair programme: Damage identified, prioritised and a repair programme is made available to affected communities within 3 months of the event/100% Reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days	Flood repair programme: Damage identified, prioritised and a repair programme is made available to affected communities within 3 months of the event/100% Reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days

Level of Service: Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.

PERFORMANCE MEASURES	BASELINE RESULTS	2024/2025 TARGET	2025/2026 TARGET	2026/2027 TARGET	2027-34 TARGET
Percentage of planned maintenance programme: Channel works are maintained, repaired, and renewed to the key standards defined in relevant planning documents	to check	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*	≥ 85% of planned maintenance programme completed *Note:< 80% not achieved; 80% - 85% partially achieved; ≥ 85% achieved*

Flood Protection: The primary purpose of the flood protection activity is to manage river flows and flood zones during adverse weather events. Our performance target varies depending on the agreed design standards of the weather event the area is being protected from.

Land Drainage: The primary purpose of ORC's land drainage activity is to manage water tables and clear ponded water to sustain pastoral farming. It is designed to help clear ponded water from paddocks to minimise pasture damage.

River Management: The primary purpose of ORC's river management activity is to maintain channel capacity along each reach of the river and to minimise riverbank erosion where possible. The primary assets are structures, such as weirs, groynes, and debris traps to maintain river flow rates and channels.

Levels of service provide the link between higher-level community outcomes and the more detailed, operational activities. This alignment ensures that we are delivering services that directly contribute to achieving our community's broader goals and priorities.

4.3.1 How we have performed

The following table outlines how ORC has performed over the past two years since these measures were implemented, and includes commentary on the results. This includes highlighting trends in results and providing reasons for underperformance.

Table 13. Current and past performance on levels of serve.

Level of Service Statement	Performance Measure	Current Target	21/22	22/23	Commentary
Major flood protection and control works are maintained, repaired, and renewed to the key standards defined in relevant planning documents.	Percentage of planned maintenance programme completed.	>90%	80%	94%	Percentage of maintenance programme completed was variable across schemes, but on average met it's target (for 21/22 it was 80%). Lower Taieri only achieved 39%.
	Schemes function to their constructed design standards.	100% compliance	100 %	100%	
	Percentage of renewals programme completed.	>90%	30%	87%	Renewals programme did not progress as planned in 20/21 and the majority of projects did not fully meet their targets due to challenges with scoping, consenting and prioritisation. Renewals progressed well in 22/23, being only just shy from target of >90%.
Respond efficiently and effectively to damage from natural hazard events.	Damage identified, prioritised and a repair programme developed and communicated with affected communities in a timely manner.	Within 3 months	N/A	N/A	There were no flood events in 2021-June 2023.
Maintain channel capacity and stability, while balancing environmental outcomes and recognising mana whenua values in rivers.	Percentage of identified and reported issues that have been investigated and appropriate action determined and communicated to affected landholders within 20 working days.	100%	94%	100%	
	Percentage of planned maintenance actions achieved each year.	>90%	78%	94%	105 of the planned 135 river maintenance actions were completed. Performance was affected by Covid19 restrictions, staff shortages, delays with global consent renewals, weather and river conditions.

5. Future Demand

This section provides a high-level analysis of key elements which may influence ORC's flood protection, land drainage, and river management activities. What may happen and how we will manage it.

This section looks at what drives demand for ORC's flood protection, drainage, and river management assets, and how ORC plans to manage each one. This is crucial for ensuring that future requirements for these assets are identified and adequately prepared for, ultimately delivering economical and sustainable services that meet the needs of Otago communities.

There are two main demand drivers that impact the need for ORC's flood protection, drainage, and river management assets:

- People, including the built environment around them e.g., homes, businesses, transport routes, utilities etc.
- Natural environment e.g., waterways and rainfall.

The intersection of people, and the exposure of their lives and built environment to waterways and the weather that influences them, is where the demand for the services provided by flood protection, drainage, and river management assets arises (Figure 8).

The following sections take a closer look at the two demand drivers and the impact that each may have on ORC's flood protection, drainage, and river management assets.

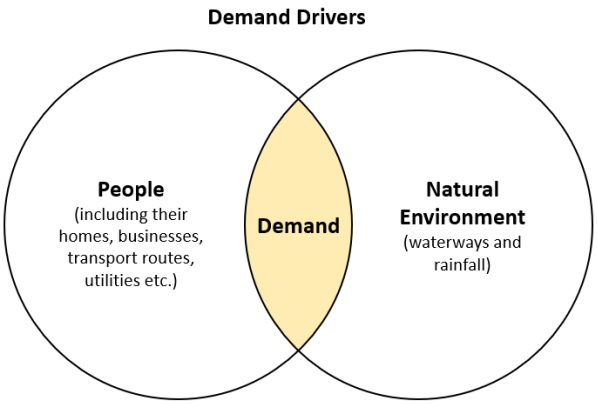


Figure 8. Demand drivers.

5.1 People

People are one of two key drivers for flood protection, drainage, and river management infrastructure. People drive demand for this infrastructure by:

- Living in areas where flood hazards exist or may be increasing due to climate change effects. This in turn results in homes, businesses, and associated infrastructure such as transport routes and utilities, also being exposed to the flood hazard.
- Increasing personal knowledge of the potential impact of flood events based on seeing the impacts of significant events in other parts of New Zealand.
- Expecting a level of protection for their property and livelihoods from flood hazards.

ORC aims to manage how people impact on demand for flood protection, drainage, and river management infrastructure by:

- Undertaking natural hazards analysis to determine exposure to flood hazards and other hazards that may impact on the performance or risk associated with this infrastructure.
- Maintain and improve hazard readiness, response and recovery procedures alongside ORC's Natural Hazards and Civil Defence Emergency Management (CDEM) teams.
- ORC continues to seek co-funding opportunities with central government to support works that provide improved infrastructure resilience and environmental outcomes.

5.2 Natural Environment

The natural environment also drives the need for flood protection, drainage, and river management assets. The natural environment drives demand for this infrastructure by:

- Waterways existing naturally within the diverse landscape of the Otago region.
- Rainfall being a natural process and waterways being necessary for the conveyance of flood and stormwater from the mountains to the sea.

ORC aims to manage how the natural environment impacts on the demand for flood protection, drainage, and river management infrastructure by:

- Investing in understanding future climate change effects on this infrastructure and incorporating learnings into wider community led adaptation planning.
- Align future decisions on the levels of service provided to communities with learnings about future climate change effects.

5.3 Intersection of People and the Natural Environment

The intersection of people and the natural environment is the overarching driver for flood protection, drainage, and river management infrastructure. If people or their exposure to the natural environment are removed, then there is no demand for this infrastructure to exist.

ORC aims to manage how this overarching driver impacts on the demand for flood protection, drainage, and river management infrastructure by:

- Communicating current and forward work programmes, risk assessment outputs, and significant decisions by meeting with landowners in areas impacted by ORC schemes.
- Increasing interaction with impacted communities in relation to future adaptation where people and the natural environment exist, and where climate change will require some form of adaptation of infrastructure.
- Having an Infrastructure Strategy that identifies issues that ORC expects will impact people or the natural environment. The significant issues identified in the Infrastructure Strategy may influence decision-making associated with levels of service and subsequent investment decisions within the 30-year lifetime of the Strategy.
- Being proactive in collaborating with territorial authorities, communities, and stakeholders to maintain key relationships and better enable information sharing and knowledge in relation to hazards and impacts. ORC also aims to participate in the

consideration of the impacts of land use changes in advance of needing to provide feedback or make decisions under the existing regulatory timeframes, e.g. Future Development Strategy (see below).

The demand drivers are also a key factor that influence the Future Development Strategy (FDS) that is being jointly developed by ORC and Dunedin City Council (DCC). The FDS aims to promote long term planning by setting out how the ORC and DCC will achieve well-functioning urban environments in Dunedin and provide enough housing and business land capacity for the next 30 years. This will assist ORC and DCC in further understanding the identified demand drivers and ensuring the necessary infrastructure to support these goals is considered in infrastructure and funding decisions. It will be reviewed every three years and updated at least every six years to further inform ORC's Infrastructure Strategy and Long-term Plan in relation to works within the Dunedin City area.

6. Risk and Resilience

This section provides overview of the risk management framework, and provides details on identifying, analysing, evaluating and treating risks associated with our infrastructure assets.

This section covers the risk management approach implemented by the Engineering department, ensuring alignment with the overarching principles within ORC's Risk Management Strategy established in 2016. Infrastructure resilience is identified as one of ORC's Strategic Risks within the Risk Management Strategy. This facilitates a consistent approach to risk management, while also aligning to the international standard for risk management ISO 31000:2018 and the flood risk management standard NZS 9401:2008.

An overview of risk management is provided, followed by our systematic processes for identifying, assessing, evaluating and treating risks.

6.1 Overview

A risk is any event that has the potential to impact on the achievement of the ORC's objectives. The potential impact of a risk is measured by a combination of the likelihood of the risk occurring, and the magnitude of its consequences should it occur. Risk management is the systematic application of management policies, procedures and practices to the task of identifying, analysing, assessing, treating and monitoring risks. Risk assessment is a part of the risk management process. Risk management will support ORC in being able to meet its values and deliver its objectives.

ORC has a responsibility to assess risks associated with the management and delivery of flood protection, river management and drainage activities, and to best manage these activities with the resources available, to avoid, mitigate or transfer the effects of any risks.

Thus, the objective of risk management within this activity is to identify risks associated with the ownership and management of infrastructure assets, specific to the organisation, together with any possible risks to the health and safety of employees, contractors and the general public.

Figure 9. Tiered levels of risk within the organisation.

Levels of Risk: Risks can arise from internal or external sources, and from a variety of levels (Figure 9). This requires approaching the risks from many perspectives including financial, environmental, operational, organisational, and public health and safety. For this AMP, the aim is to identify the risks associated with the activity and associated infrastructure assets.

6.2 Risk Management Process

Our approach to risk management is aligned with the objectives and processes set out in ORC's Risk Management Strategy from 2016. While ORC continues to evolve its organisational risk framework, the Engineering group manages risks in a systematic manner, illustrated in Figure 10.

This process is based on the international risk management standard ISO31000:2018, and the flood risk management standard NZS 9401:2008.

Our risk management methodology is a structured, analytical process that aids in the identification, assessment, and prioritisation of risks. Application of this process will occur at both the asset level and across Schemes to ensure that risk is managed appropriately at both, a targeted level and a holistic level. The complexity of procedures are commensurate with the level of risk involved. This guides us in selecting effective treatment strategies and management actions that safeguard the community from the highest risks deemed unacceptable. This proactive approach underscores our commitment to responsible asset stewardship.

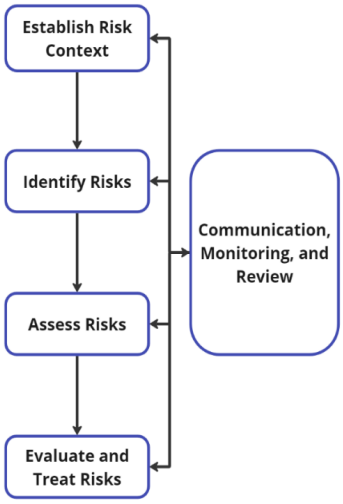


Figure 10. Risk management process.

6.2.1 Establishing Risk Context

The initiation of the risk management process involves clearly defining the objectives and scope within which the risk management will be administered, with careful consideration of the environment in which the organisation operates. While a formal risk policy has yet to be established, the ORC's Risk Management Strategy outlines core risk management objectives and an overarching process for managing risk (the framework).

The Engineering department has adopted this organisational framework, while tailoring the approach to the unique challenges and responsibilities inherent in managing flood protection, land drainage, and river management infrastructure. This is achieved by carefully considering the specific context within which the department functions. More specifically, this includes:

- Adopting organisation wide guidance on managing risks, while ensuring it is applicable to the complex nature of engineering operations and infrastructure.
- Implementing methods to identify, assess, and evaluate risks that are better suited to our department's specific operational context.
- Updating the organisational risk register template to better reflect the scope within which we manage risks.
- Defining clear responses to various levels of risk that are directly relevant to the Engineering department's activities, and who is responsible.
- Bespoke processes for communicating, monitoring and review risks.

The ORC Engineering register has been developed and work is underway and on-going. In operationalising ORC's risk management strategy, we focus on:

- Risk identification: Systematically identifying risks across all flood protection, land drainage, and river management schemes and associated infrastructure through a combination of technical analysis, historical data review, and stakeholder engagement.
- Risk assessment: Employing robust methodologies to assess the likelihood and impact of identified risks, ensuring that all evaluations are comprehensive and data-driven.
- Risk treatment: Implementing appropriate measures to mitigate identified risks, ranging from engineering solutions to policy interventions and community awareness initiatives.
- Monitoring and review: Establishing monitoring processes that track the effectiveness of risk treatment strategies and incorporates regular reviews to adapt to changing circumstances.

6.2.2 Identify the Risks

The proactive identification of risks is a critical initial step in the risk management process, particularly pertinent to our work in flood protection, land drainage, and river management. This activity establishes the foundation for all subsequent risk management efforts, from assessment to mitigation and monitoring.

All practically possible risks affecting the asset activity need to be considered. To facilitate a consistent and comprehensive approach to risk identification, our department utilises a risk identification form. This form is a key part of the risk register document, serving as a standardised tool for capturing and communicating potential risks. Once identified, risks are validated and then entered into the risk register (if applicable). The risk register is then used to assess and evaluate each risk and outline current mitigation measures and possible future options.

Risks are identified through an array of avenues, including direct site inspections, analysis of historical incident data, stakeholder interviews, and expert consultations. Due to the level of subjectivity and judgement required in risk identification, workshops are a useful way of getting a wide range of input and knowledge on each risk identified. Workshops are also a useful tool in consolidating individual perceptions of risk into a consistent approach.

The following questions are considered as part of the risk identification process:

- What is the source of each risk?
- When, where, why, and how are these risks likely to occur?
- What might happen? What would the effect be? Who might impacted?
- What controls currently exist? How effective are they?

6.2.3 Assess Risks

Risk assessment allows the identified risks to be analysed in a systematic manner in order to derive a risk rating. These risk ratings enable the organisation to evaluate its levels of risk exposure, prioritise mitigation of risks, focusing on the addressing the highest (most extreme) risks first.

A risk rating is derived by assigning a score for the likelihood of the risk event occurring (Table 14), and the consequences should it occur (Table 15). Information to determine scores for likelihood and consequence may be sourced from a variety of places or may be more subjective and opinion-based. Although risk perception can be quite subjective, scores are based on as much as data as possible.

The initial risk rating involves determining the inherent likelihood of each risk occurring and the inherent consequences should the risk materialise, without considering any existing risk controls. Following this, we derive a residual risk score by assessing the effectiveness of any existing controls that are already in place to manage the risk. This approach provides insights into the effectiveness of current controls, while ensuring that we are responding to the actual level of risk we face.

Table 14. Risk likelihood scoring system.

Likelihood	Likelihood Description	Scoring	Probability % (to assist assessment)
Frequent	Almost certain to occur, and at least once in a month or continuous.	5	91-100
Often	Highly likely to occur, within 3-6 months/more than 6 times per year.	4	71-90
Likely	A likely chance to occur at least once in the next year.	3	51-70
Possible	Unlikely to occur in the next 1-3 years.	2	21-50
Rare	Extremely unlikely to occur. Not expected to occur in next 10 years.	1	1-20

Table 15. Risk consequence scoring system.

Rating Level	Consequence Description	Score
Severe/Extreme (catastrophic)	• Catastrophic failure, financial overspend or loss. • Critical operations affected with long term effects. • Significant recovery action required to restore effectiveness. • Severe loss of public or stakeholder confidence. • Significant negative economic, social, environmental or cultural impact on a large proportion of the Otago community. • Loss of life. • Prolonged national media and political attention.	5
Major	• Major unexpected failure, financial overspend or loss. • Very significant dissatisfaction expressed by stakeholders. • Major negative economic, social, environmental or cultural impact on a large proportion of the Otago community. • Very serious impact, injury, or long term loss of operations. • National media attention.	4
Moderate	• Significant failure leading to review of project or operation that will require changes to processes or goals. • Significant disruption to service, financial overspend or loss. • Significant negative economical, social, environmental or cultural impact on a small proportion of the Otago community. • Regional media attention, loss of image. • Injury to staff or contractor.	3
Minor	• Localised or isolated failure to meet stakeholder requirements or standards. • Minor negative economic, social, environmental or cultural impact on a small proportion of the Otago community. • Unlikely to cause damage or threaten the effectiveness of project/operations. • Minor financial impact, some disruption to service.	2
Inconsequential/ Insignificant	• Negligible impact that will not be visible. • Very low negative economic, social, environmental or cultural impact on Otago community. • No loss of operational activity.	1

6.2.4 Evaluate Risks

Risk evaluation is the critical next step after the initial assessment of risks. This stage is where we consider the assigned risk ratings against our established thresholds to determine the necessity and extent of further risk treatment measures. Four risk thresholds have been used (Table 16). This represents a change from the organisational three-tier level, in order to better facilitate the prioritisation of risk treatment. The risk levels enable distinction between those risks that are deemed unacceptable, and those with lower risks that may be managed without further treatment.

Table 16. Risk matrix.

	Consequence				
Likelihood	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Frequent (5)	5	10	15	20	25
Often (4)	4	8	12	16	20
Likely (3)	3	6	9	12	15
Possible (2)	2	4	6	8	10
Rare (1)	1	2	3	4	5

The table below defines the four risk levels that have been adopted, which effectively set out clear guidelines governing when a response is required and the type of response. Each threshold is defined by specific criteria that reflect the overall risk score, and therefore the severity of impact and the likelihood of occurrence, thereby guiding our judgment on the acceptability of risks.

Table 17. Comparative risk levels.

Risk Rating	Risk Category	Definition
15-25	Extreme Risk	Extreme risks demand urgent attention at the most senior level and cannot be simply accepted as a part of routine operations without executive sanction. **These risks are not acceptable without treatment.**
8-14	High Risk	High risks are the most severe that can be accepted as part of routine operations without executive sanction but they will be the responsibility of the most senior operational management and report upon at the executive level. **These risks are not acceptable without treatment.**
4-6	Moderate Risk	Medium risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action, maintained under review and report upon at senior management level. **These risks are possibly acceptable without treatment.**
1-3	Low Risk	Low risks will be maintained under review. It is expected that existing controls will be sufficient and no further action will be required to treat them. **These risks are/can be acceptable without treatment**

6.2.5 Treat Risks

Once a risk has been evaluated, treatment options should be identified for all risks requiring action, as defined in Table17, to determine the most appropriate option for managing a risk. Risk treatment options are categorised and defined in Table 18.

Effective risk treatment options can be developed via workshop sessions and engagement with knowledgeable people, including external consultants and stakeholders. When determining a preferred treatment option, consideration must be given to the cost of treatment and the likely risk reduction that will result. This may include an option analysis, assessing the efficacy and cost of treatments, enabling a thorough assessment and identification of optimal treatment option(s).

Table 18. Risk treatment option categories.

Treatment Option	Definition
Avoid	Using policies, technology, employee training and other steps designed to eliminate risk.
Mitigate	Using policies, technology, employee training and other steps designed to reduce risk (likelihood and/or consequence) to an acceptable level.
Transfer	Risk transfer involves shifting some or all of the risk to a third party (e.g. insurance).
Accept	Accepting the risk because it's potential to harm the organisation is very limited or the cost of mitigating it exceeds the damage it would inflict.

Where the cost of treatment outweighs the benefits, or where no cost-effective treatment is apparent, alternative strategies such as risk acceptance or transfer will be considered. This approach ensures that our risk treatment decisions are both economically rational and aligned with the ORC's wider objectives and tolerance for risk.

When a treatment option has been agreed, the following occurs:

- The cost of any action(s) should be incorporated into the relevant budget planning process;
- A responsible person(s) should be identified for delivery of the action;
- A realistic due date should be set;
- Risk register is updated to reflect the changes in risk following planned/implemented actions.

6.2.6 Monitoring and Review

Continuous monitoring and periodic review of risks are essential. As the operational and external environment evolves, so do the risks, underscoring the need for up-to-date risk information for informed decision-making. The Asset Management Engineer is responsible for the regular review and update responsibilities for each risk on the register, including the engagement of risk owners, ensuring that risk information remains current and accurate.

Risk ownership is assigned to personnel who are most capable of monitoring the risk and response effectiveness, typically those with substantial knowledge or responsibility within the affected operational area.

Any high or extreme risks are immediately escalated to the Manager Engineering. This ensures that high-level risks are managed by those with the authority to implement significant risk responses.

The risk management process, including the risk register, is subject to an annual review to evaluate the effectiveness of risk treatment actions and to determine the necessity for any adjustments to the risk management approach. The outcomes of the review will be reported to Manager of Engineering. The review schedule is as follows:

- Extreme risks are reviewed monthly.

- High risks are reviewed quarterly.
- Moderate risks are reviewed biannually.
- Low risks are reviewed annually.

6.3 Risk Management Action Plan

The engineering department currently operates without a formal risk action management plan, but this does not imply a passive approach to risk management. Interim measures, including proactive monitoring and risk mitigation strategies, are actively employed. These measures ensure that risks are managed consistently even as we transition to a more structured risk management framework.

A risk register is currently being populated which marks the initial steps towards a more formal risk management action plan. Upon completion, the next phase will involved the development of a formalised risk treatment action plan. This plan will be a living document, housed within the risk register document, and containing specific treatment strategies for risks deemed unacceptable. These strategies will include a range of responses, from avoidance and reduction to transfer and acceptance, tailored to the nature and severity of each risk.

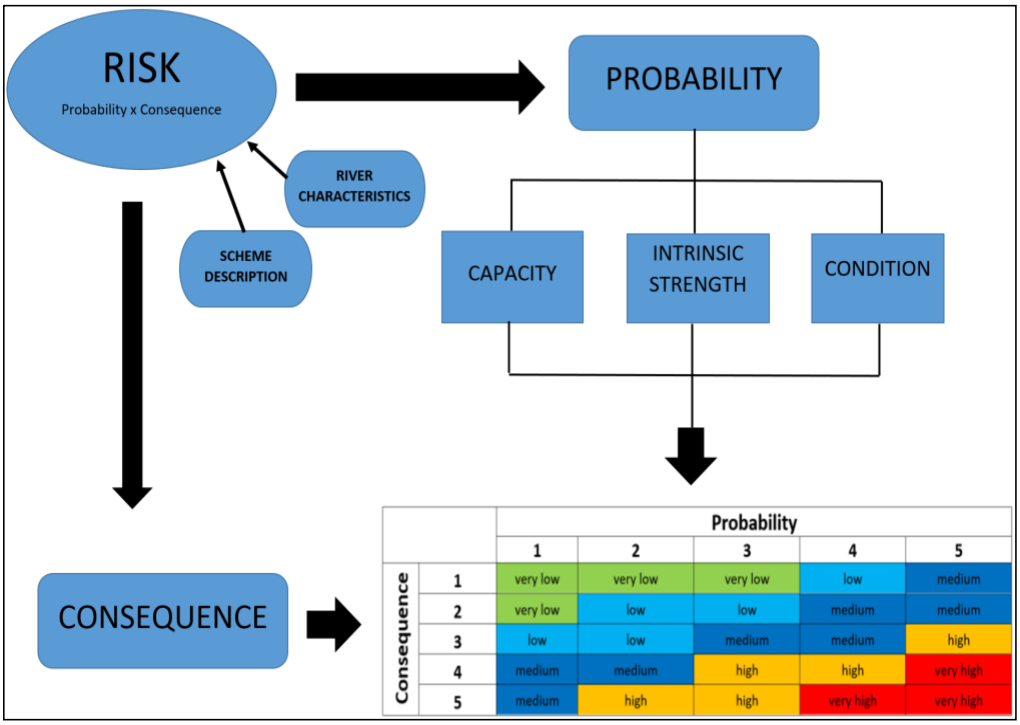
The risk treatment action plan will also outline how these strategies will integrated into our existing capital and operational work programs. It will detail the scheduling, resource allocation, and responsibilities for implementing risk treatments.

6.4 Flood Protection Performance Assessment

In 2015 the Rivers Managers SIG (Special Interest Group) developed and adopted an Asset Performance Tool (Tool). The purpose of the tool is to provide a consistent framework for assessing the performance of flood protection assets, across New Zealand. This is done by taking a risk-based approach, by assessing the condition, performance (capacity) and consequence. ORC has commenced the application of this tool within the Lower Taieri Flood Protection Scheme, and intend to extend the scope of the analysis to include Possible Maximum Flood (PMF) to undertaken performance assessments of our flood protection assets.

The performance framework is risk-based (Figure 11), where asset performance is assessed based on probability of failure, where a risk score is obtained by combining overall probability with associated consequences of failure. The overall performance criteria for flood protection assets can be summarised as:

- being of adequate **capacity;**
- having a high level of structural **intrinsic strength**; and
- remaining in an appropriate **condition** at all times.



Consequence	Probability 1	2	3	4	5
1	very low	very low	very low	low	medium
2	very low	low	low	medium	medium
3	low	low	medium	medium	high
4	medium	medium	high	high	very high
5	medium	high	high	very high	very high

Figure 11. Schematic diagram of Tool used for assessing performance of flood protection assets.

7. Lifecycle Management

This section details approaches to managing our infrastructure at different lifecycle stages. Ways to balance capital and operational costs with performance delivery and risk management.

Lifecycle management is the cycle of activities associated with planning for, creating, operating, maintaining, replacing, rehabilitating, and disposing of assets (Figure 12). Lifecycle management strategies and their associated work programmes aim to balance investment costs, performance, and risk throughout the lifecycle of an asset to deliver community outcomes.

Figure 12. Life cycle of an infrastructure asset (IIMM, 2020).

7.1 Lifecycle Management Categories

Lifecycle asset management aims to balance investment costs, performance and risks throughout the whole lifecycle of an asset. It is a vital component of our asset management strategy that focuses on delivering the performance measures and associated performance targets to ensure that the flood protection and land drainage schemes are delivering the levels of services agreed with communities. This is achieved through lifecycle management strategies and work programmes.

The lifecycle management programme covers the three key lifecycle categories necessary to manage an asset over its whole life, as well as addressing issues presented in the asset portfolio, delivering required levels of service, and addressing projected future demand. This approach ensures the long-term sustainability of the flood protection and land drainage infrastructure.

The lifecycle management categories are presented in Figure 13 and Table 19 and are discussed in more detail throughout this section.

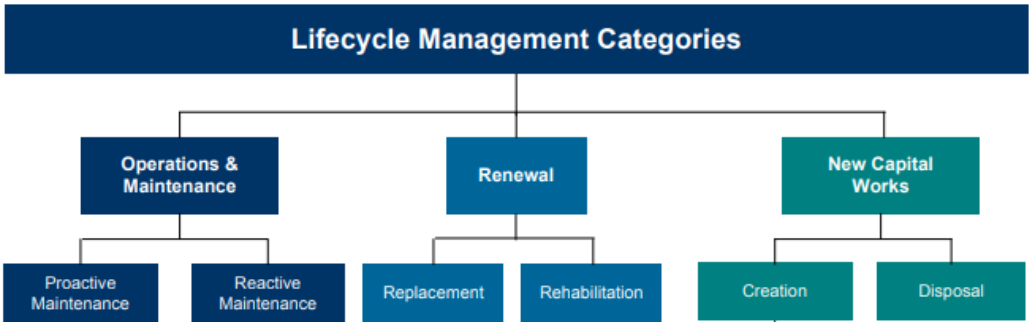


Figure 13. Lifecycle management categories.

Table 19. Description of lifecycle management categories and teams responsible.

Lifecycle Category	Description	Responsible Team(s)
Operations & Maintenance	Operations & maintenance activities are those required on an ongoing basis to keep the river, flood, and land drainage scheme assets operating. Maintenance includes all actions necessary for retaining an asset as near as practicable to the current levels of service, including the day-to-day work necessary and can include immediate repair work.	Operations & Maintenance River Engineering Contractors
Renewals	Renewal is major work which does not increase the asset's service level, but restores, rehabilitates, replaces or renews an existing asset to its original level of service, performance and/or capacity.	Infrastructure Engineering Project Delivery River Engineering Operations and Maintenance Contractors
New Capital Works	New capital works involves those that create a new asset that did not previously exist, or works which upgrade or improve an existing asset beyond its existing capacity. They may result from growth, social or environmental needs. New capital works also include	Infrastructure Engineering Project Delivery

Lifecycle Category	Description	Responsible Team(s)
	activities necessary to dispose of decommissioned assets.	

7.2 Operations and Maintenance

Operations and maintenance activities are those activities deemed necessary for retaining an asset in an appropriate condition to achieve its required level of service. This includes routine inspections and condition assessments, through to activities such as managing vegetation and clearing drains. Maintenance may be classified in to reaction or planned (proactive) work activities.

Reactive maintenance is unplanned repair work carried out in response to customer queries, and flood or other natural hazard events.

Planned (proactive) maintenance is routine work that is identified and managed through a systematic process, which involves inspection, condition assessment, action implementation and comprehensive reporting. A proactive approach that ensures assets remain in good working condition, reducing the likelihood of unexpected failures or more costly repairs in the future.

7.2.1 Objectives

The primary objective of operations and maintenance (O&M) is to ensure that all assets perform their intended functions efficiently, safely, and reliably. This translates to keeping assets in a state of good repair throughout their lifespan.

In general, key objectives of O&M activities are:

- Developing maintenance plans based on the O&M Manuals available;
- Maintaining a current hierarchy of critical assets and required O&M activities;
- Ensuring service delivery contracts for O&M work contain performance measures that have clear links to scheme/asset levels of service and performance objectives that the work is related to;
- Developing and regularly reviewing appropriate emergency response capability;
- Reviewing current/required skill base and implementing workforce training and development to meet required O&M needs.

O&M philosophy for Flood Protection schemes is to:

- Inspect and maintain the floodbank network and associated infrastructure to ensure effective operation up to the design standard of the scheme, and controlled failure when the design standard is exceeded.
- Provide the ability for scheme areas to be drained of any flood waters in adverse weather events.
- Monitor and periodically review scheme operation and design standards.

O&M philosophy for Land Drainage schemes is to:

- Maintain drainage network and associated infrastructure to ensure it functions efficiently and effectively all times.
- Provide efficient and effective land drainage to the protected areas to sustain pastoral farming.
- Reduce surface flooding from rainfall events.
- Monitor and periodically review scheme operation and design standards.

O&M philosophy for River Management assets is to:

- Inspect and maintain river management infrastructure across Otago to ensure effective operation up to their respective design standard.
- Monitor and periodically review river management infrastructure operation and design standards.

7.2.2 Maintenance Planning

A number of the flood protection and land drainage schemes, including key pumping stations have an 'Operations & Maintenance (O&M) Manual' which set out the specific procedures for operating and maintaining the scheme, the associated assets and activities, and the frequency of those activities. The O&M Manuals inform the development of the maintenance plans.

Maintenance plans are prepared annually and outline the maintenance activities required each year to maintain the assets at the required levels of service for each scheme. The maintenance plan is reviewed and updated regularly (at least annually) based on new information, changes in condition, or observed performance of maintenance activities. The maintenance plans are continuously aligned with the evolving requirements detailed in the Future Demand section of this AMP, such as changes to the operating environment, new regulations, or changes in asset usage.

The section below outlines source information that informs the planning of maintenance activities.

7.2.3 Reactive Maintenance

Reactive maintenance activities are undertaken by operational personnel. Investigations undertaken by external personnel also inform maintenance planning.

Fault Notification

Faults are identified during operational inspections, routine surveillance, public alerts, and pump station alarms. Operational personnel will record the fault in the field including any photographic evidence. The defect will then be assessed for severity and maintenance planned accordingly.

Pump Station Alarms

Alarms are displayed on the associated pumping station alarm screen indicating the alarm message, the alarm description, and the possible cause(s). Dependent on the alarm type, corresponding maintenance will be planned to remediate any issues.

Flood/Earthquake Damage

Flood/earthquake damage repairs are identified as those works required to repair, replace or upgrade existing assets to the levels of service that existed prior to the event. Observations made during/after the event are collated and contribute to maintenance plans.

Landowner Notification

Landowners typically notify operational personnel directly about any issue or defect they have observed. A site inspection is planned and undertaken to record the observed defect and plan maintenance accordingly.

7.2.4 Planned Maintenance

Regular inspection and maintenance are important to ensure the effective and efficient operation of the flood protection and drainage schemes and associated assets.

Asset Management Plan

This Asset Management Plan (AMP) outlines the proactive maintenance activities and strategies to be carried out based on the expected lifecycles of various asset types. Asset valuation information contained within the AMP supports lifecycle cost analysis.

Asset Condition and Performance
Regular inspections are essential for identifying areas requiring maintenance before major problems develop. Failure is pre-empted through monitoring and maintenance and paying particular attention to known weak areas and assets of higher criticality.

Operations & Maintenance Manuals
Several flood protection & land drainage schemes (and key pumping stations) have an Operations & Maintenance (O&M) Manual which set out the specific procedures for operating and maintaining the schemes and the frequency of those activities.

Manufacturer Specifications
Manufacturer's maintenance manuals are used for pumping stations to identify planned maintenance activities and their frequencies, which in turn inform the maintenance plan. The manufacturer's manuals are included within their respective O&M Manuals.

7.2.5 Prioritisation of maintenance activities.

Maintaining service levels agreed with the community requires a thoughtful approach to planning maintenance. Given the wide range of tasks and finite resources, ORC prioritises maintenance tasks based on a combination of criticality, risk, performance, and condition assessments.

Criticality: A big priority is to prevent failure of the critical assets, outlined in Section 3.7. These assets receive increased inspection frequency and higher maintenance intervention levels to mitigate failure and maintain agreed-upon service levels.

Risk: As discussed in the ORC's Assets (Section 3) and Future Demand (Section 5) sections, an asset that poses a high risk – either because it has a high probability of failure or because its failure would have severe impacts – will be given higher priority than lower risk assets.

Performance: If the performance of an asset is below the expected level, or it is deteriorating over time, any required maintenance will be prioritised. For instance, if a pump in a land drainage scheme is not effectively removing water, it may require maintenance and will be prioritised ahead of other assets that are not underperforming.

Condition: Assets assessed as having poor condition or showing signs of wear, are assessed against the previous three factors to determine whether maintenance is prioritised to prevent further deterioration and possible failure.

7.3 Renewals

Renewal expenditure relates to major work which does not increase the asset's design capacity but restores, rehabilitates, replaces or renews an existing asset to its original service potential. Work over and above restoring an asset to original service potential is new capital or upgrade works and this is discussed later in this section. Renewals works broadly fit into the following categories.

Replacement: Involves the complete replacement of an asset, such as a floodgate or pump, so as to provide a similar or agreed alternative equivalent level of service. This approach is considered when an asset has reached the end of its useful life, or the ongoing cost of continued maintenance and rehabilitation becomes too high.

Rehabilitation (Refurbishment): Involves work to repair or refurbish an assets or replace parts of an asset, like a portion of floodbank or drainage channel, to restore it to a required functional condition and extend its life. This may incorporate some modification. Generally, it involves repairing the asset to deliver its original level of service without resorting to significant upgrade.

This approach is considered when an asset has not reached the end of its useful life but requires intervention to maintain or enhance its functionality.

7.3.1 Objectives

The primary objective of renewals are to ensure that assets continue to deliver the agreed-upon service levels. Assets may be rehabilitated to bring them up to agreed standards, or replacement may be the most economical choice if maintenance costs become prohibitive.

The general approach for renewal of flood protection and land drainage infrastructure is to:

- Maintain floodbanks and drainage channels in perpetuity to reduce the need for renewal, but renew sections that have been identified as having a high level of risk.
- Renew pump station equipment based on age, condition and performance as reported during operational inspections and comprehensive 10-yearly condition assessments.
- Replace structures when assessed to be unable to perform their function during inspections.

In planning renewal projects, ORC aims to meet levels of service and performance measures and mitigate any existing service risks, while considering the future demands discussed.
To achieve this, we employ the following practices:

- **Project Scoping**: We undertake comprehensive scoping for all renewal projects to identify service delivery 'deficiencies' and risks, and identify optimum timing for renewal/replacement. This approach aims to address the significant asset renewal challenge discussed earlier.
- **Economic Renewal**: We aim to utilise cost-efficient renewal methods, which could include refurbishing parts of an asset rather than replacing it entirely. This approach supports long-term sustainability in the face of economic pressures and financial constraints.
- **Contract Performance Measures**: Our service delivery contracts for asset renewals include performance measures that align with the levels of service related to the work.
- **Stakeholder Engagement:** Engaging with stakeholders, landowners and communities, during the planning stages, to identify potential challenges and inform decision-making. This involves taking into account the changing needs and expectations.
- **Sustainability:** Consideration of sustainable solutions and practices during renewals planning, leading to more efficient assets and reduced environmental impact.
- **Resilience**: Implement resilience measures, where feasible, to withstand environmental changes and extreme events, which is crucial in preparing for the impacts of climate change.

7.3.2 Renewal Strategies

Deciding between replacement and rehabilitation requires careful analysis of various factors, including the asset's condition, expected remaining life, performance requirements, costs of different approaches, and the potential risks associated with asset failure. A combination of strategies is often employed to optimise the overall performance and cost-effectiveness of flood protection and land drainage scheme assets. This often depends on the data that is available.

ORC currently employs the following renewal strategies for flood protection and land drainage assets. These strategies serve as an overview of our decision-making approach for different circumstances. An example of each strategy is provided using a pump station asset.

Table 20. Asset renewal strategies for flood protection and drainage infrastructure.

Renewal Strategy	Description	Pump Station example
Age-based	Involves renewing assets based on their age and expected life. While this strategy can ensure a consistent level of service and reduce the risk of unexpected failures, it may also lead to some assets being replaced/rehabilitated earlier than their condition necessitates. A combination of rehabilitation and replacement can be applied, depending on the specific needs of each asset and the costs associated with each approach.	If the pump station is nearing its expected life of 40 years, a renewal activity might be planned around that age, even if it appears to be in good condition.
Condition-based	Involves monitoring the condition of assets to determine when they require renewal. Regular inspections and data collection help identify the deterioration rate of assets, allowing for targeted renewal to optimise asset life and performance. This approach can involve both rehabilitation and replacement depending on the asset condition and cost-effectiveness of each option.	Renewal actions would be initiated based on the condition of the components. For instance, if the impellers within the pump show signs of wear or corrosion, it may trigger a need for renewal.
Performance-based	This strategy bases renewal decisions on the current performance of the asset compared to its expected or required performance. If an asset is consistently failing to meet performance standards or targets, it may be highlighted for renewal.	If the pump is not able to meet its designated discharge capacity during peak flow periods, a renewal might be needed to improve the performance.
Risk-based	Assets are renewed based on the potential consequences of asset failure, focusing on the risks associated with flooding and drainage disruptions. This method prioritises assets with a higher risk profile, such as those protecting critical infrastructure or densely populated areas. The decision to rehabilitate or replace an asset will depend on the potential risk reduction and the costs associated with each option.	Given high consequences if the pump fails during a flood event, a risk-based strategy would involve proactive renewal of components that, if failed, could disrupt service or pose danger.
Demand-based	Changes in service demand inform the renewal strategy. If demand for a particular service increases significantly, assets supporting that service may require earlier renewal to cope with the increased load.	The area serviced by the pump station is expecting significant development, increasing the amount of water to be managed. The asset might be renewed to increase its capacity to meet demand.
Sustainability-based	This strategy considers the environmental impact of assets and prioritises renewals that improve environmental outcomes or sustainability.	An old pump station might be replaced with a more energy-efficient model, even if the older system is still functional.
Regulatory-based	This strategy is employed when there are changes in regulations or laws that necessitate the renewal of an asset.	Pump station refurbishment to enable monitoring of water quality.

As infrastructure ages the condition generally degrades, or the technology used become redundant, and the asset needs replacement. This signals a bow wave of asset renewals, repair, or upgrade that will require significant investment and subsequent funding. This was identified as a significant issue in ORC's Infrastructure Strategy, as well within this AMP as a significant demand driver.

We recognise that the age of an asset is only one indicator of its need for renewal and that its physical condition, performance, and risk of failure are more crucial factors. While there are various renewal strategies applicable to flood protection, land drainage, and river management assets, individual asset types may benefit more from certain strategies due to their unique characteristics, performance requirements, and risk profiles.

The following table provides a guide to the preferred renewal strategies for each major asset type under our management. These are broad recommendations, and it's essential to remember that the optimal strategy for any individual asset will depend on its specific circumstances and context.

Table 21. Preferred renewal strategies by asset type.

Asset Type	Description	Preferred Renewal Strategy
Floodbanks	Given the significant risk associated with floodbank failure and the environmental factors influencing their condition, risk-based and performance-based renewal strategies are typically most effective for these assets.	Risk-based Performance-based
Drainage Channels	A combination of condition-based and demand-based renewal strategies are usually most suitable for drainage channels. Regular inspections can help monitor their condition, while changes in land use or climate patterns may increase the demand on these assets, requiring capacity upgrades.	Condition-based Demand-based
Pump Stations (& associated assets)	For pump stations, age-based, performance-based and demand-based strategies are usually most appropriate. These assets have a relatively predictable life cycle, but their performance can also significantly decline towards the end of their life, which can be monitored through regular performance assessments.	Age-based Performance-based Demand-based
Culverts	Culverts often benefit from a combination of age-based and condition-based renewal strategies. While they have a relatively predictable lifespan, environmental factors such as water chemistry and debris can accelerate deterioration, making regular condition assessments valuable.	Age-based Condition-based
Floodgates	Due to their critical role in flood events and the significant risks associated with their failure, condition-based strategies are typically most effective for floodgates.	Condition-based
Bridges	Bridges often benefit from a combination of age-based and condition-based strategies. Regular inspections can assess condition and identify any structural issues, while the age and importance of the bridge can also influence the timing and approach of renewals.	Age-based Condition-based
Rockwork	These assets are essential for water flow control and erosion prevention. Condition-based renewals address physical deterioration, while risk-based renewals prevent significant consequences such as increased erosion and potential flooding.	Condition-based Risk-based

7.3.3 Renewals Planning

Planning and prioritisation of renewal projects are crucial activities that ensure resources are optimally allocated and that the most pressing asset renewal needs are addressed first.

Renewal triggers - discussed in Table 20 - are monitored using various tools and strategies, including condition inspections, performance monitoring, risk assessments, geotechnical and modelling investigations, asset management planning, and operational data. The aim is to identify and respond to renewal triggers proactively to prevent asset failure, maintain service levels, and enable better budgeting and financial planning.

Upon identifying assets that require renewal, an iterative process involving cost estimation, project prioritisation, and scheduling is undertaken:

1. Estimate renewal costs: For each potential renewal project, an estimate of the costs involved is made. This typically includes a combination of the asset's replacement cost and the cost of the necessary materials and labour. To make these estimates as accurate as possible, historical cost data, predictive cost modelling, and supplier quotes can be used.

   Asset renewal plans and expenditure were calculated using technical estimates from a team of engineers and were developed based on operational knowledge, manufacturers guidance, structural inspections and investigations, and estimates of remaining useful lives.

2. Prioritise renewal projects: With a list of potential projects and an estimate of the costs for each, renewal projects are prioritised. The ranking of projects is usually based on factors such as:
   - Risk - The potential impact of asset failure on service delivery and community safety. Assets that are critical for flood protection, land drainage and river management are prioritised.
   - Cost-effectiveness - The balance between the cost of renewal and the value it provides in terms of improved performance and extended asset life. Depending on the scale of the renewal project, this would involve a cost-benefit analysis or equivalent.
   - Strategic Alignment - The degree to which a renewal project aligns with strategic goals will be given a higher priority, such as improving resilience to climate change, achieving sustainability goals, enhancing service delivery, or meeting regulatory requirements.

   Currently, there is no formal or quantitative prioritisation process for capital renewals and replacement projects. However, priority is typically given to assets that either have a high consequence or risk of failure, or those that have the highest average age (i.e., the lowest remaining useful life) relative to their expected lives.

3. Schedule renewal activities: Based on the priorities set, renewal activities are scheduled considering the available resources, dependencies between projects, seasonal constraints, the asset's remaining useful life, and the projected timing of asset failure.

   We understand that deferring renewals or maintenance of some assets might be necessary due to budgetary constraints. These decisions will be made based on both asset condition and age, and the criticality of the asset, thus ensuring that assets of high importance are maintained appropriately.

7.4 New Capital Works

New works are those works that create a new asset that did not previously exist, works which upgrade or improve an existing asset beyond its existing capacity, or works which dispose of an existing asset. They may result from growth, additional demand, changes to levels of service, social or environmental needs, or legislative requirements.

Asset Creation

Involves the creation of new assets, or works, which upgrade or improve an existing asset beyond its current capacity or performance This process is typically initiated to address identified needs, such as increased capacity, improved service levels, or enhanced resilience.

Asset Disposal

Includes any activity associated with disposal of a decommissioned asset that has reached the end of their useful life or is no longer required due to changes in demand, technology, or other factors. Asset disposal may include the sale, transfer, or recycling of materials and components, as well as the remediation and restoration of the affected site.

7.4.1 Objectives

Both asset creation and disposal play strategic roles in our overall asset management strategy. The primary objective of new capital works is to enhance and expand our asset portfolio to meet the evolving needs of our community, accommodate growth, improve service levels, and address emerging challenges. Meanwhile, asset disposal helps us optimise resource allocation, reduce maintenance obligations, and minimise environmental impact. By effectively managing these activities, we aim to achieve sustainable asset and financial management, meet service delivery expectations, and adapt to emerging needs and challenges.

7.4.2 New Capital Works Strategy

In general, the approach for new capital works are to:

- **Identify and address service deficiencies**: Through project scoping and needs assessments, we aim to identify service gaps or deficiencies that can be addressed through new capital works. This includes considering factors such as increased demand, changes in levels of service, emerging risks, legislative requirements, and community needs.
- **Enhance infrastructure performance and capacity**: We proactively plan for future growth by considering population trends, development plans, and climate change. New capital works allow for the creation of new assets or the upgrading of existing assets to improve their capacity and performance and manage growth and demand.
- **Promote sustainability and resilience**: Sustainability and resilience are fundamental objectives of new capital works. We strive to incorporate sustainable design principles, energy efficiency measures, climate change adaptation strategies, and environmentally friendly practices into our projects. By considering long-term resilience, we aim to future-proof our infrastructure assets and ensure they can withstand the impacts of climate change and other challenges.
- **Engage and collaborate with stakeholders**: Actively involve the community, landowners, iwi partners, local authorities, and other stakeholders to ensure their perspectives are considered, gather valuable input, and build consensus around project objectives and outcomes.

Capital upgrade and new projects will be planned to ensure alignment with service levels and performance objectives. The planning process includes comprehensive project scoping for each capital upgrade/new project to identify the:

a) Existing service delivery 'deficiency', the associated risks, and the required timeline for delivery;
b) Estimated capital and lifecycle costs for all potential options that could address the identified service deficiency;
c) The optimal option, considering both performance and cost-efficiency, to be included in the capital upgrade/new programme.

7.4.3 New Capital Works Planning

The process of identifying, evaluating, and prioritising new capital works projects is a crucial step in our overall asset management planning. It involves a systematic approach to ensure that our investments in new infrastructure align with our strategic objectives and deliver the desired outcomes for our community.

New capital works (including disposal) and the upgrading of existing assets are identified from various sources (Table 22) such as community requests, demand management, scheme reviews, performance assessments, inspections and investigations (including climate resilience).

Table 22. Identification of new capital works for flood protection and drainage schemes.

Source	Description
Inspections and investigations	Regular inspections and investigations of flood protection and land drainage assets to assess their condition, identify defects or issues, and evaluate their performance. These activities can help identify assets that may require new capital works or upgrades, as well as inform maintenance and repair strategies.
Asset performance assessments	Evaluating the performance of flood protection and land drainage assets in terms of their ability to provide the required services, such as reducing flood risk or managing land drainage. Performance assessments can help identify assets that are underperforming, nearing the end of their useful life, or in need of upgrades to meet current or future service level requirements.
Scheme reviews	Regular reviews of existing flood protection and land drainage schemes to evaluate their effectiveness, efficiency, and alignment with community needs and priorities. Scheme reviews can help identify opportunities for new capital works or upgrades.
Community requests	Feedback or requests from community members, local organisations, or interest groups regarding the need for new flood protection or land drainage assets, or upgrades to existing assets. This input can help identify local concerns and priorities.
Demand management	Assessing current and future demand for flood protection and land drainage services, including factors such as population growth, urban development, and climate change impacts. Demand management strategies can help identify areas where new assets or upgrades are needed to meet changing needs, enhance climate resilience, or accommodate growth.

Asset Disposal - Assets may become surplus to requirements for various reasons, including reaching the end of their useful life, under-utilisation, obsolescence, uneconomic to operate or upgrade, policy changes, and potential ownership risks (financial, environmental, legal, and social). Additionally, assets may be replaced before reaching their predicted economic life.

The process for asset disposal involves several steps, as illustrated below:

1. **Identification:** Assets that meet the criteria for disposal are identified based on factors such as obsolescence, technological advancements, or failure to provide the required service.
2. **Disposal Options:** Various options for asset disposal are considered, taking into account factors such as cost, environmental impact, legal requirements, and stakeholder considerations.
3. **Decision-making**: Based on the analysis of disposal options, a decision is made on the preferred method of disposal. This could involve selling the asset, transferring it to another party, recycling materials, or other appropriate methods.
4. **Execution:** The chosen disposal option is implemented, following the necessary procedures and requirements. This may include conducting legal and financial transactions, coordinating with relevant stakeholders, and ensuring proper documentation.

Currently, potential new capital works are recorded in the capital projects register on an annual basis. The intention is that a 3-5 year capital works programme will supersede the former. This more forward-looking strategy will include a ranking criterion to support decision-making and prioritise projects based on their criticality, potential impact on service levels, and alignment with strategic goals. Currently new capital works are prioritised based on performance and deficiencies.

8. Financial Summary

This section provides an overview of; funding strategies, asset valuations, and financial forecasts (in part with the Infrastructure Strategy).

This section outlines the financial requirements necessary to support the effective management and delivery of flood protection, land drainage and river management services. It provides insights into the financial policies, strategies and assumptions that underpin this AMP.

8.1 Financial Policies and Strategies

This sub-section provides an overview of the financial policies and frameworks that guide the financial planning process for flood protection, land drainage, and river management assets. These policies and frameworks ensure the effective allocation and management of financial resources to support the management of our infrastructure.

8.1.1 Finance Policy

Most infrastructural assets, are assigned to specific special rating districts. Ratepayers within these districts fund the depreciation on these assets. Each special rating district has a “Funded Depreciation Reserve” set up that represents the balance of the amount of depreciation revenue rates for, and any interest earned on, reserve balances. The purpose of this reserve is to fund capital expenditure and the cost of renewals on the infrastructure assets being depreciated.

It is prudent to note that floodbanks and drains are not depreciated. This is due to the fact that they consist of earthworked areas, and do not get replaced in the same manner as other flood protection and drainage asset classes.

Although culverts are not currently depreciated, there is an anticipated discussion around the decision to depreciate culverts in the future.

ORC’s policy is that infrastructural assets be financed by the “Funded Depreciation Reserve”, and if there are insufficient funds available in these reserves, borrowing (either internal or external) will be used.

Funding major capital projects will be considered on a case-by-case basis. Where necessary or appropriate, ORC may borrow either internally or externally to fund a major project. Such projects may be funded by any of the funding mechanisms available to ORC such as rating, dividend income, reserves, fees and charges, and cash balances held by ORC. In determining the appropriate funding mechanisms, ORC will consider matters such as the benefits arising from the project, the project costs and the impacts and consequences of the project.

8.1.2 Finance fixed assets and capitalisation policy

In June 2019, ORC's Finance department developed a capitalisation policy to provide guidelines for the recording and reporting of ORC's fixed assets and the approaches to capitalisation, depreciation and disposal of fixed assets. This policy is inclusive of infrastructural assets. The policy offers the following definitions:

- **Fixed asset**: A physical asset including land and buildings, items of equipment, self-constructed infrastructural assets and computer software held for use in the provision of goods or services produced by the ORC, or for administrative purposes.
- **Fixed asset register**: The Fixed Asset Register records the information on fixed assets. The register is currently held within the Conquest asset management system and is used by Finance and other areas of ORC for capitalisation, valuation, depreciation and disposal purposes.
- **Depreciable amount**: This is the gross cost of acquiring a capital asset and includes any subsequent capital improvements and additions.
- **Depreciation**: A systematic allocation of the depreciable amount of an asset over its estimated useful life.
- **Derecognition**: Derecognition of an asset occurs upon disposal or cessation of use when no future economic benefits are expected to arise from the continued use of the asset. Any gain or loss arising from derecognition of the asset is included in the surplus/deficit in the period in which the asset is derecognised.
- **Impairment loss**: An impairment loss is the recognition of a loss that occurs when the carrying amount of an asset exceeds its recoverable amount. The loss is included in the surplus/deficit of the period in which it occurs.
- **Residual value**: This is the estimated amount an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset were already of the age and in the condition expected at the end of its useful life.
- **Useful life**: This is the estimated lifespan of an asset, or the period over which an asset is expected to be available to provide service potential for the ORC.

8.2 Asset Valuation

Accurate asset valuation and effective accounting practices are vital for the financial management and decision-making processes related to our flood protection, land drainage, and river management assets. Valuing these assets correctly provides insights into their worth, enabling accurate financial reporting, while effective accounting ensures efficient tracking and management of assets.

Asset valuations are used for calculating long-term renewal requirements, identifying loss of service potential (depreciation), and for financial reporting purposes. Statutory financial reporting requires ORC to revalue its fixed assets at least every five years.

8.2.1 Valuation Method

ORC utilises various valuation methods to determine the value of its flood protection, land drainage and river management assets. These methods are applied based on the nature and characteristics of the assets.

When ORC constructs a depreciable infrastructural asset, all direct costs are included in the total cost of the asset. This includes items such as architectural, engineering, legal, consulting and project management from external consultant.

Floodbanks and drains are constructions or excavations of natural materials on the land and have substantially the same characteristics as land, in that they are considered to have unlimited useful lives. In the absences of natural events, these assets are not subject to

ongoing obsolescence or deterioration of service performance and are therefore not subject to depreciation.

Structures and bridges are depreciated on a straight-line basis to write off the cost of the asset to its estimated residual value over its estimated useful life.

Expenditure incurred to maintain these assets at full operating capability is charged to the surplus/deficit in the period incurred. Useful lives of ORC's infrastructure assets of each class group are summarised in Table 23.

Table 23. Useful lives of infrastructural within the Capitalisation Policy (June 2019).

Infrastructural Asset	Useful Life (years)
Floodbanks	Unlimited
Protection Works	Unlimited
Drains	Unlimited
Culverts	30-50 years
Pumps	25-30 years
Electrical Componentry	10-20 years
Structures	8-100 years
Bridges	33-100 years

8.3 Financial Forecasts

To ensure a long-term and sustainable approach to asset management, it is fundamental to prepare long-term financial forecasts. This provides a long-term view of how assets will be managed, the associated costs throughout their lifecycle, and the potential need for additional funding to accommodate changes in service levels, future demand, and risk management factors.

The financial forecasts encompass various aspects, including estimating the funding requirements for ongoing operations and maintenance, planned renewals and replacements, and potential new capital works, including asset disposal. These projections consider factors such as asset condition and performance assessments, service level requirements, anticipated demand, and the strategic objectives outlined in this Asset Management Plan.

Detailed financial forecasts can be found in the *ORC Infrastructure Strategy 2024-2054*.

9. Asset Management Practices

This section provides an overview of our key asset management processes, people, and tools

This section provides an overview of ORC's asset management systems, roles and responsibilities of different teams as they pertain to asset management, and the relationship between this AMP and key ORC documents.

9.1 Roles and Responsibilities

A general breakdown of asset management roles and responsibilities between the various teams to deliver the flood protection, land drainage and river management activities is outlined below.

Table 24. Key responsibilities relating to management of flood protection and river management infrastructure.

Responsibility	Description	Team
Writing and implementing asset management documents.	Prepares and implements strategies, plans, and programs that ensure the effective management of the infrastructure assets.	Infrastructure Engineering
Maintenance of flood protection & erosion protection assets.	Responsible for the regular upkeep and repair of the assets, ensuring they are in good working condition.	Operations & Maintenance
Asset inspection and condition assessments.	Conducts regular inspections and assessments to monitor the condition of assets and determine the need for repairs or replacements.	Operations & Maintenance; River Management
Performance monitoring	Tracks and evaluates the performance of assets to ensure they are meeting the desired levels of service.	Infrastructure Engineering; Natural Hazards
Contract & procurement management	Manages contracts and oversees the procurement of goods and services to ensure value for money.	Commercial & Regulatory; Project Delivery; Operations & Maintenance; River Management; Infrastructure Engineering
Capital works	Oversees major construction projects that are meant to improve or expand the infrastructure.	Project Delivery
Flood protection bylaw	Ensures compliance with legal requirements associated with the effective operation and integrity of flood protection and drainage works.	Commercial & Regulatory
Risk management	Identifies and assesses risks associated with the infrastructure, including risk mitigations.	Infrastructure Engineering
Asset valuations	Valuation of infrastructure assets for financial reporting and investment decision-making	Finance
Financial planning	Oversees budgeting, forecasting, and financial analysis related to the infrastructure.	Infrastructure Engineering; Finance
Continual improvement	Implements processes for continual improvement of asset management practices.	Infrastructure Engineering

9.2 Information Systems and Tools

ORC has developed its information infrastructure around a number of key systems and tools. Table 30 outlines some key functions in the delivery of flood and erosion protection activities. ORC are actively planning an upgrade to our central asset management information system, ConQuest. This upgrade will enhance our data management capabilities, further improving efficiency and service delivery. Specific details about this upgrade and its implementation will be shared as plans are finalised.

Table 25. Key systems and tools used to deliver the activities.

System/Tool	Function	Purpose
ConQuest	Information System	Repository for asset information, valuation data, condition information, work planning and scheduling.
ArcMap	Geographic Information System	System for storing and presenting information spatially.
Survey123	Data collection; work planning	Mobile data collection and work planning/scheduling.
Objective/Tiaki (transition underway)	Document management system	Information management and storage; archiving.

10. Improvement Plan

This section demonstrates ORC's commitment to improvement in our asset management practices. Details of actionable points for improvement are summarised here, in the context of asset management maturity.

The continuous improvement of asset management practices is a critical objective for our flood protection, land drainage and river management infrastructure. ORC acknowledges the valuable insights provided by Audit NZ through their review of Long-Term Plans (LTP) and Asset Management Plans (AMP) in the local government sector over the last decade. The reviews have identified areas for improvement, guiding us towards enhancing our asset management maturity and aligning our practices with industry best standards.

ORC is committed to advancing its asset management system. This requires a comprehensive and ongoing review of our asset management practices, with a focus on identifying and implementing improvements. By developing and implementing an asset management improvement plan, we aim to continually enhance our asset management practices and optimise the value, performance, and sustainability of our asset portfolio.

This section outlines our updated improvement plan, which serves as a roadmap for advancing our asset management practices.

10.1 Continuous Improvement Cycle

In order to advance asset management at ORC, the Infrastructure Engineering group have adopted a continuous improvement cycle (Figure 14). This cycle involves a systematic assessment of the current asset management performance, setting a vision for the desired future state, and identifying specific improvement initiatives to bridge the gap between the two. Establishment of a robust, continuous improvement process ensures that the ORC is making the most effective use of resources to advance asset management practice.

Improvements identified during this process will need to be prioritised to ensure the most effective improvements are progressed with the resources available. As improvements are implemented, ORC will monitor the effectiveness of the outcomes, making any changes necessary.

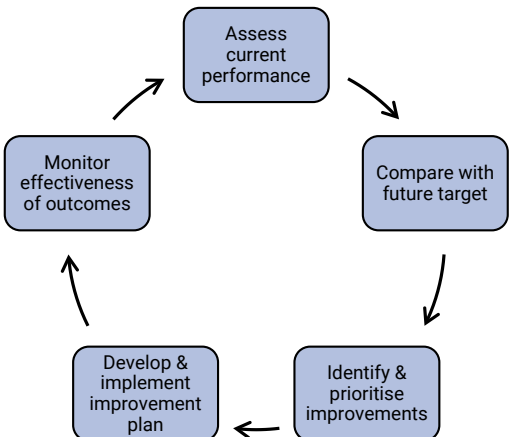


Figure 14. Continuous improvement cycle.

10.2 Improvement Plan

The improvement plan serves as a roadmap for implementing targeted improvement initiatives that will bridge the gap between the current state and the desired future state of asset management.

In addition to the improvement items identified through the maturity assessments, continuous improvement was a key theme during the development of this Asset Management Plan. These improvement items have been summarised and prioritised in Table 26. As maturity improves over time it is anticipated that new improvement items will be identified to further advance and enhance ORC's Asset Management System.

Table 26. Improvement Plan.

Item	Description	Priority
1	Support the development of an organisation wide Asset Management Policy.	Medium
2	Update AMP to align with 2024-2034 Strategic Direction.	Medium
3	Improve asset inventory datasets with targeted improvement programmes focused on data capture, cleansing, standardisation and validation.	High
4	Collaborate with ORC departments in upgrading the Asset Management Information System, ensuring Engineering requirements are understood and incorporated in the upgrade.	High
5	Develop and implement an asset inspection and condition rating programme cognisant of asset management outcomes.	High
6	Undertake assessments for all flood protection schemes using National framework and tool for assessing asset performance.	High
7	Develop a performance framework for the drainage schemes.	High
8	Develop and implement a framework for developing and reviewing levels of service.	Medium
9	Develop additional customer and technical performance measures to support service level delivery.	Medium
10	Develop and maintain records for past and track current performance, and report within future versions of AMP.	High
11	Consult with community on service level options and costs, and ensure community inputs are represented in levels of service decision making.	Medium
12	Improve demand forecasts using quantitative data and analyses, starting with climate change & land development demand drivers.	Medium
13	Undertake more robust analyses of impacts to infrastructure from demand forecasts, particularly for climate change and land development, and assess impacts on capital and operational expenditure.	Medium
14	Develop an integrated, demand management programme, adjusting existing and planning new initiatives to manage demand impacts.	Medium
15	Develop a maintenance plan for each scheme and major asset, to capture activities, frequencies and costs. Review performance annually and adjust plan accordingly.	Medium
16	Implement risk-based, asset performance framework to identify and prioritise asset renewals.	High
17	Implement formalised risk management processes aligned to risk framework.	High
18	Complete the risk register and develop and implement a risk management action plan.	High
19	Establish and maintain good lines of communication with Finance department.	Medium
20	Identify projects for asset improvements in accordance with risk framework.	High
21	Review and enhance processes around management of Trees for flood protection, land drainage, and river management activities.	High
22	Champion and foster a culture that promotes the adoption of asset management principles across departments, teams, and activities.	High
23	Promote and facilitate workshops to increase adoption of asset management principles across departments, teams, and activities.	High

Appendix A: Scheme Summaries

Alexandra Flood Protection Scheme

Scheme Overview

The Alexandra Flood Protection Scheme mitigates the risk of flooding, caused by high flows in the Clutha and Manuherikia Rivers, to approximately 10 hectares of the Alexandra township, including residential and commercial properties. Three major floods entered the town and flooded residential and commercial areas in 1994, 1995 and 1999, exacerbated by sedimentation caused by the Roxburgh Dam. The Alexandra Flood Protection Scheme was subsequently built in 2001 and consists of approximately 1.1km of floodbanks and three pump stations. The stormwater drainage system in Alexandra drains to each of the three pump stations. Two roads penetrate the floodbanks, so these roads are closed and stoplogs installed during severe floods.

Functional Description

The design philosophy of the flood protection works to provide protection for a conservative flood water level at the Alexandra bridge of RL 142.75 m. This is approximately the level that the largest flood on record, the 1878 flood, would reach if it occurred now. The maximum flow of this flood is estimated to have been 4650 m^3/s at Alexandra. The table below summarises the key design parameters for the Alexandra Flood Protection Scheme.

Design Parameters	Linger and Die	CBD	Left Bank (Alexandra Bridge)	Left Bank (upstream end)
Design crest level	143.25 m	RL 143.25 m	RL 143.25 m	RL 143.40 m
Design flood level	142.75 m	RL 142.75 m	RL 142.75 m	RL 143.0 m
Freeboard	500 mm	500 mm	500 mm	400 mm

At the upstream end of the Left Bank floodbank the design flood level is RL 143.0 m, this level incorporates an allowance for hydraulic gradient on the surface of the water. The design water level for the Linger and Die and CBD areas is RL 142.75 m.

The crest levels of the floodbanks also incorporate a freeboard allowance to allow for wave action and settlement of the floodbank foundations. The freeboard allowance at the upstream end of the Left Bank area is less than the other areas because of the low nature of the floodbank in this area and the low risk of waves because the ground is relatively level at this location.

The existing stormwater drainage system was redirected into each of the three pump stations. Under normal, non-flood, conditions storm water will drain to the pump station and flow through the pump station and to the stormwater outlets into either the Manuherikia or Clutha Rivers. In flood conditions the flap gate valve at the stormwater outlet closes with hydrostatic pressure and the knife gate valve in the pump station is closed manually. Stormwater and seepage is drained to the pump stations. The table below summarises the pump station capacities to pump stormwater and seepage water.

Site	Factored Seepage Flow	Calculated Stormwater Flow (2 Year Return Flood)	Total Pump Capacity
Linger and Die	130 l/s	1,670 l/s	1,800 l/s
CBD	210 l/s	400 l/s	610 l/s
Left Bank	720 l/s	880 l/s	1,600 l/s

Stoplogs are installed at two locations along the floodbank where roads penetrate the floodbank – Tarbert Street (road level of 142.4m) and State Highway 8 (road level of 142.75m). The stoplogs are transported from site and prepared to

be installed when the Clutha River (at Alexandra) is at a level of 141m and rising. The stoplogs are also tested within three months of any change of contractor and every two years following.

The pump stations each have provision for back-up generators should the power supply to the sites be lost.

Leith Flood Protection Scheme

Scheme Overview

The Leith Flood Protection Scheme mitigates the risk of flooding to an area of approximately 200 hectares extending from Malvern Street in Glenleith to the north, to Rattray Street in the Dunedin CBD to the south.

The Water of Leith catchment is located to the north of the Dunedin Central Business District (CBD) and has a catchment area of approximately 42 square kilometres. Key Dunedin infrastructure such as the existing and new Dunedin Hospitals, University of Otago, Otago Polytechnic Te Pūkenga, and Forsyth Barr Stadium are afforded some level of protection protected by the scheme. The upper section of the catchment and its tributaries, that include Lindsay Creek that flows through North East Valley, are relatively steep hydraulically compared to the flatter lower reaches. These catchment characteristics allow floodwaters to rise quickly.

Functional Description

There are approximately three mechanisms that can result in damage to property on the floodplain:

- If the flow in the Water of Leith exceeds the channel capacity in any reach, overtopping onto the floodplain will occur.
- High velocities in the Water of Leith can result in erosion of the banks. This may occur at flows lesser than peak flows. Buildings and roads that are located close to the bank are vulnerable to bank erosion.
- Debris and detritus being transported by flood flows may catch on bridges or create an obstruction. Water that backs up may overflow onto the floodplain.

The flood protection scheme design developed in the mid-1900s by the City of Dunedin for the Water of Leith proposed a high-velocity concrete channel to convey flood flows from upstream of George Street to the Otago Harbour. Due to budgetary constraints and increased environmental awareness, the concrete channel was only partially completed.

Flood mitigation measures in the Water of Leith include:

- Substantial lengths of concrete and stone wall to minimise bank erosion and facilitate urban development of the floodplain (e.g. University Campus);
- A boulder trap upstream of George Street (constructed in the 1950s) and a debris/boulder trap upstream of the Lower Malvern Street Bridge (constructed in 1963);
- Straightened channels including a high-velocity channel between George Street and Cumberland Street;
- Grade control weirs of varying heights along the Water of Leith;
- A double concrete-lined channel between Clyde Street and the Otago Harbour; and
- Channel enhancements downstream of Dundas St, constructed progressively since 2013. The improvement works increase the channel capacity below Dundas St, providing greater protection for properties in the lower reaches of the Leith.

Lower Clutha Flood Protection and Drainage Scheme

Scheme Overview

The Lower Clutha Flood Protection and Drainage Scheme mitigates the risk of flooding and facilitates land drainage to the Lower Clutha Delta, which extends from 4km north of Balclutha to the sea. The flood and drainage scheme covers an area of approximately 9,300 hectares (flood and drainage scheme combined).

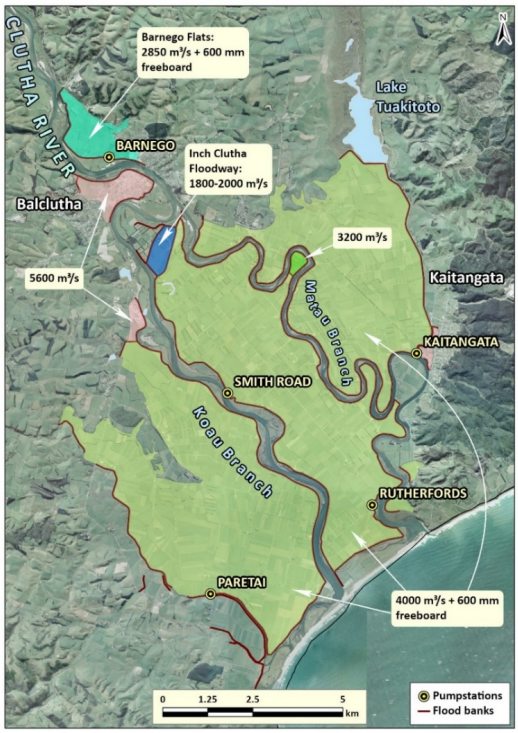
This scheme combines both flood protection and drainage works. Construction of this scheme started in 1960 and was completed in 1991. The Clutha is the second longest river in New Zealand, and the largest by mean flow. The Clutha's headwaters are in the Southern Alps above lakes Wakatipu, Wānaka, and Hāwea. The island formed between the branches is called Inch Clutha. There is a floodway (area designed to carry floodwaters when the river level rises) at the top of Inch Clutha. As well as the Clutha River/Mata-Au, water flows into the delta from several other sources including Lovells Stream and Lake Tuakitoto; Waitepeka River; Puerua River and Barrata Creek. Land drainage is provided by a network of 153 km of drains in four regions: Barnego; Stirling/Kaitangata; Inch Clutha; and Otanomomo/Paretai. Drainage in Balclutha and Finegand is not owned or operated by the ORC.

Functional Description

Flood Protection

The highest level of flood protection is provided to Balclutha and the Finegand meat works (5,600 m3/s). Most areas are protected up to 4,000 m^3/s, but some smaller areas are protected to lower levels. The scheme has 110 km of floodbanks.

The Clutha River bifurcates (splits into two) just downstream of Balclutha. Between 60% and 70% of the flow goes down the Koau Branch and 30% to 40% down the Matau Branch. The island formed between the branches is called Inch Clutha. There is a floodway (area designed to carry floodwaters when the river level rises) at the top of Inch Clutha, which starts operating at about 2,000 m3/s. The figure below summarises the protection levels and freeboard for each area of the scheme.



Land Drainage

Land drainage is provided by a network of 153 km of drains in four regions: Barnego; Stirling/Kaitangata; Inch Clutha; and Otanomomo/Paretai:

- Barnego – The Barnego Flats, on the left bank of the Clutha upstream of Balclutha, is a small area with a relatively large catchment in the hills above the flats. Drainage is normally through two flap-gated culverts, but when the river rises the Barnego pump station pumps water through the floodbank into the river.
- Kaitangata – The low-lying land bounded by the Matau Branch left bank, Stirling, Lake Tuakitoto, and the Kaitangata Contour Channel, has a network of drains that direct water to the Kaitangata Pump Station, located near the junction of the Kaitangata Contour Channel and the Matau Branch.
- Inch Clutha – The drainage network on Inch Clutha falls toward the southeast end of the island, where the Rutherford Locks allow water to flow into the Matau Branch. Rutherford Locks is a road bridge structure housing three square flap gates. The Rutherford Locks are in the tidal zone, so they open to allow water out of the drain at low tide, and close on the rising tide to prevent the river flooding back into the drain. When tidal variations or high river levels prevent the gates opening for long enough, two submersible pumps at the Rutherfords Pump Station pump water from the drain into the Matau Branch. At the seaward end of Inch Clutha, there is a flap-gated culvert that lets water flow into Spit Lagoon. Only a small portion of the Inch Clutha water flows out through this culvert. Further up Inch Clutha, the Smith Rd Pump Station operates during high rainfall events to reduce the load on the Rutherfords Pump Station, pumping into the Koau Branch. Pumping capacity at Smith Rd is about a fifth of the Rutherfords capacity.
- Paretai – The Puerua Contour Channel diverts the Puerua River around the Otanomomo/Paretai area. The old riverbed is now a drain. Where that drain re-joins the Contour Channel, the Paretai Pump Station pumps water from the drain into the Puerua River. There is also a gravity gate at the Paretai Pump Station and two flap-gated culverts closer to the coast. The Puerua Estuary flows into the Koau Branch of the Clutha River via culverts in the training line.

Lower Clutha pump capacities are shown in the table below.

Pump station	Pump – Type – Model	Flow (m^3/s)
Barnego	P1 – Submersible – KSB PA4 600-350	0.45
	P2 – Dry mount – Gwynne	0.3
Kaitangata	P1 – Submersible – ABS VUP 0401	0.40
	P2 – Dry mount – MacEwans 18/22	0.50
	P3 – Dry mount – MacEwans 30/30	1.42
Rutherfords	P1 – Submersible – KSB-PNT-500B-306	1.0
	P2 – Submersible – KSB-PNT-500B-37.6	1.0
Smith Road	P1 – Dry mount – SFP3	0.2
	P2 – Dry mount – SFP3	0.2
Paretai	P1 – Dry mount – MacEwans 30/30	1.5
	P2 – Submersible – ABS VUP 0502	1.0
	P3– Dry mount – MacEwans 30/30	1.5

For more information on the operation of the scheme refer to the Lower Clutha Flood Protection and Drainage Scheme Operations and Maintenance Manual.

Tokomairiro Drainage Scheme

Scheme Overview

The purpose of the Tokomairiro Drainage Scheme is to ensure the provision of effective and reliable land drainage for the Tokomairiro area surrounding Milton, and to reduce flooding impacts on Milton and its surrounds.

The Tokomairiro Drainage Scheme is situated in the flat basin surrounding Milton, surrounded on three sides by inland hills, and by coastal hills to the southeast. The scheme consists entirely of open drains, with associated culverts and bridge crossings, designed to assist in the drainage of relatively low-lying farmland in this area. It has no pumps or control structures. Many of the drains were originally creeks that have been realigned.

Functional Description

Drainage within the scheme is achieved through gravity alone. There are no ORC pump stations or gated structures within the scheme.

Drains within the scheme flow into the East and West Branches of the Tokomairiro River upstream of Milton, and the Tokomairiro River downstream of Milton.

Key operational parameters for the scheme include:

- Ensuring drain and channel flow paths are open and without obstruction.
- Ensuring that drain and channel vegetation is controlled to ensure adequate hydraulic capacity.

Note that there is a short section of floodbank located along the true left of the Tokomairiro River East Branch between State Highway 1 and the Milton Sewage Treatment Plant, however this is a Clutha District Council asset, as is the associated stormwater pumping station.

Lower Taieri Flood Protection Scheme

Scheme Overview

The Lower Taieri Flood Protection Scheme mitigates the risk of flooding to the Taieri plains, including the townships of Mosgiel, Outram and Henley, as well as critical infrastructure such as key transport routes (state highway and railway networks), Dunedin Airport and power and three waters utility infrastructure.

The Lower Taieri Flood Protection Scheme was the first scheme to be developed in Otago, alongside the East and West Taieri Drainage Schemes, when works commence in 1870. It is a complex network, with multiple rivers affecting the scheme. The scheme makes use of ponding areas that act to detain peak flows and ease pressure on downstream portions of the scheme, subsequently minimising the risk of failure of the scheme. Silver Stream, Waipori River and the Ōwhiro Stream are also tributaries to this lower portion of the Taieri River.

Functional Description

The Taieri River flows on to the Taieri Plain at Outram. During floods, the river can flow out to the surrounding floodbanks or high ground, turning some farmland into river floodway between the floodbanks on either side of the river.

The Riverside Spillway is located on the true left bank downstream of Outram. The purpose of the spillway is to relieve pressure on the floodbanks within the downstream section of the Taieri River, a section known as 'The Chute', by allowing floodwater to flow into the East Taieri Upper Ponding area and thereby reducing downstream peak flood flows and levels. Riverside Spillway has both controlled and uncontrolled sections. The uncontrolled section consists of a length of low rock-armoured floodbank whose crest is about 1.2 metres below that of the adjoining main floodbank. When the floodwater level in the Taieri River reaches the spillway crest level, uncontrolled spill will begin into the Upper Ponding Area, while the main floodbanks continue to contain the river flow. The controlled spillway is located at the upstream end of the uncontrolled section and consists of a 75 metre long series of bottom-hinged steel gates whose base is lower by 0.5 metre than that of the adjoining uncontrolled spillway crest. This provides the opportunity to lower the gates to increase the flow into the upper ponding area, thereby further reducing the flow in the Lower Taieri River downstream of this point. In a design flood, 2,500 m^3/s of water flows past Outram, however only 1,400 m^3/s can flow down The Chute. As the flood recedes and river levels fall, two sets of large gravity gates open and allow water to flow out of the ponding area, back into the river. The gravity gates are located at the confluence of the Taieri River and the Silver Stream (the A1 Gravity Outfall), and beside the Silver Stream Pump Station.

A second spillway, on the right bank of the Silver Stream immediately downstream of Gordon Road, allows excess water in the Silver Stream to flow on to pastures. This helps to reduce pressure on the floodbanks that mitigate flood risk to Mosgiel. The spilled water flows overland , toward the eastern end of the East Taieri Upper Ponding Area, until it reaches the Upper Pond Cut-off Bank. The Cut-off Bank was constructed to limit how far the Upper Ponding Area can extend up the Taieri Plain. There are three flap-gated culverts through the Cut-off Bank that allow water to flow into the Upper Ponding Area, but if there is already water in the Upper Pond, water from the Gordon Road Spillway backs up against the Cut-off Bank, and can only drain away as the Upper Pond empties.

The East Taieri Lower Ponding Area can be filled from two sources. The main source is the Owhiro Stream, beside the Scroggs Pump Station. The Owhiro Outfall is located on the Owhiro Stream at its confluence with the Taieri River, near Allanton. As the Taieri River rises, the Owhiro Outfall gates close, thereby preventing the Taieri River from backflowing into the Owhiro Stream, but also preventing water in the Owhiro Stream from draining away. Water is able to pond between a floodbank on the right side of the Owhiro Stream and the hills on the Owhiro Stream's left side, but will eventually overtop the floodbank and flow into the Lower Pond.

The second way the Lower Ponding Area can fill is by the Taieri River overtopping its left floodbank between the Mill Creek Pump Station and the Owhiro Outfall. That will only happen during extreme floods.

As the water level in the Taieri River recedes, two sets of gravity gates in the Lower Ponding Area allow water to drain out of the Lower Pond, back into the Taieri River. One set of gravity gates is located beside the Mill Creek Pump Station, the other is a dedicated structure about 100 m from Owhiro Outfall (Lower Pond Gravity Gates).

The Henley Spillway is located on the right bank of the Taieri River immediately downstream of the SH1 bridge. The low floodbank protects the lower part of the Henley Floodway during moderate flows but allows water to spill into the floodway during high flows.

The West Taieri Contour Channel was constructed in the 1920s. Starting near Woodside, it diverts Lee Creek around the base of the Maungatua Range to the Waipori River, preventing a significant volume of water from flowing into the area of the West Taieri Drainage Scheme, from which it would have to be pumped out via the Waipori Pump Station. There are two spillways located along the Contour Channel:

Miller Road Spillway - The Miller Road Spillway is the further upstream of two spillways on the West Taieri Contour Channel. It is located on the Contour Channel's left bank just upstream of Miller Rd. While the spillway's origins appear to be informal, there is a designated floodway across which spilled water flows before entering the West Taieri drains leading to the Waipori Pump Station.

Otokia Road Spillway – The Otokia Road Spillway is the more downstream of the two West Taieri Contour Channel spillways. It is located on the Contour Channel left bank immediately downstream of Otokia Road. The spillway crest is approximately 0.6 metres below that of the adjoining floodbank. Spilling will begin when the water level in the Contour Channel reaches the spillway crest level. The spilled water flows a short distance overland via a designated floodway before entering the West Taieri drainage system, leading to the Waipori Pump Station. The outer face of the floodbank is rock lined although some minor erosional damage is to be expected when it operates.

West Taieri Drainage Scheme

Scheme Overview

The West Taieri Drainage Scheme facilitates the effective and reliable drainage of the land in West Taieri. The Scheme covers the area bounded by the Taieri River, Lake Waipori, and the West Taieri Contour Channel. A small part of the scheme lies within the Henley Floodway. The West Taieri area differs from the other drainage schemes in that water cannot drain out of the scheme under gravity: it must be pumped out. A significant portion of the scheme lies at or below 1m of sea level. There are three pump stations in the West Taieri Drainage Scheme: Waipori; Henley; and Lake Ascog.

Functional Description

The drainage network operates under gravity, however pump stations are needed to pump water from the scheme into Lake Waipori (Waipori Pump Station), the Taieri River (Henley Pump Station), and the Contour Channel (Lake Ascog Pump Station).

Waipori Pump Station

The Waipori Pump Station is the most significant pump station within the scheme and has the largest capacity at 8 m^3/s. A network of drains conveys water to Waipori Pump Station, which is located at the southern end of the Taieri Plain, adjacent to Lake Waipori. Like many parts of our schemes, Waipori pump station has evolved over the years. The first pump station was built in 1929, and the structural parts of that station are still in use. Nowadays, Waipori is effectively two pump stations jointly controlled by one automatic control system.

There are two 'D' (Drainage) pumps and two 'F' (Flood) pumps, each with a capacity of approximately 2 m^3/s. The F pump station is the remnant of the original pump station, reconfigured to house two modern submersible pumps. There is potential to add another F pump, as the original station had three pumps. The D pump station was originally built in 1988 using secondhand pumps, and rebuilt in 2008-2010 using modern new pumps, when the current D pumps were bought. The pumps turn on sequentially as the level in the main drain rises.

A relocatable tractor pump supplements the operation of the pump station, as required.

Lake Ascog Pump Station

Lake Ascog is a low-lying area on the western side of West Taieri. The pump station has two rail-mounted submersible pumps of relatively low capacity that pump water directly into the Contour Channel. These pumps were installed in 1996, but the brand was discontinued in 2011, and the pumps have not had any manufacturer support since then.

Henley Pump Station

This is a small pump station, with one pump, draining water from 355 ha of land that lies in the Henley Floodway. Most of the time the land can be farmed successfully, but the area is expected to be inundated once every 5-10 years.

West Taieri Pump Capacities

The table below summarises the capacities of the pumps at each of the pump stations within the scheme.

Pump station	Pump – Type – Model	Flow (m^3/s)
Waipori	D1 – Submersible – Flygt PL7101/765	2.0
	D2 – Submersible – Flygt PL7101/765	2.0
	F1 – Submersible – KSB PA4 1000–700	2.0
	F2 – Submersible – KSB PA4 1000–700	2.0
Henley	P1 – Dry Mount – MacEwans SFP3	0.3
Lake Ascog	P1 – Submersible – Pumpex K302	0.3
	P2 – Submersible – Pumpex K302	0.3

For more information on the operation of the scheme refer to the West Taieri Drainage Scheme Operations and Maintenance Manual, and applicable pump station Operations and Maintenance Manuals.

East Taieri Drainage Scheme

Scheme Overview

The East Taieri Drainage Scheme facilitates the effective and reliable drainage of the land in East Taieri. The Scheme is physically divided into two areas by the Silver Stream, which flows across the Taieri Plain in a south-westerly direction.

Functional Description

Drains on the northern side of the Silver Stream generally flow toward the Upper East Taieri Ponding Area, that forms part of the operation of the Lower Taieri Flood Protection Scheme. Part of the Mill Stream drainage network (the 'M' drains) flows into the Silver Stream via the Mill Creek Diversion Channel (MCD). The other drain network flowing into the Upper Pond area is the Ayrshire Park, or 'A' drain network.

There are three ways water can leave the Upper Pond area:

1. Through the A1 Gravity Outfall, located at the confluence of the Silver Stream and the Taieri River. Under normal conditions, this is how most water leaves the Upper Pond area. As the Taieri River level rises following a rainfall event, the A1 gates will shut, normally when flow in the Taieri at Outram is around 45 m^3/s. They typically reopen when the Taieri flow drops back to 45 m^3/s again.
2. Through the Silver Stream Pump Station, which has three pumps that turn on progressively as the level of water in the drain increases. These pumps will remove most water following a moderate rainfall event but become ineffective when the Upper Pond fills above about 103-104 m in elevation.
3. Through gravity gates beside the Silver Stream Pump Station. These gates are mounted quite high and will only operate following a flood.

Drains flowing toward the Lower East Taieri Ponding Area are mostly called 'O' (Owhiro) drains, although there are also some 'M' drains. Stormwater collected by the Dunedin City Council (DCC) drainage network in Mosgiel is pumped into the Silver Stream via DCC owned pump stations, and some flows into the Owhiro Stream. Runoff from Saddle Hill is caught by Owhiro Stream, so doesn't ordinarily flow to the Lower Ponding Area. Water can leave the Lower Pond area by five means:

1. Through the gravity gates beside the Mill Creek Pump Station. This is how most water gets out of the Lower Ponding Area. The gravity gates typically shut when flow in the Taieri River at Outram reaches about 45 m^3/s and reopen when the flow drops below that figure.
2. Through a flap-gated culvert beside the Scroggs Pump Station. Again, this is a normal dry-weather way for water to drain, but the flap gate closes as the Owhiro Stream level rises following a rainfall event.
3. By being pumped out by the Mill Creek Pump Station, which has two dry-mount pumps.
4. By being pumped out by the single submersible pump at the Scroggs Pump Station.
5. Through the Lower Pond Gravity Gates, a gravity gate structure that allows ponded floodwater to escape back into the Taieri River following a flood.

East Taieri Pump Capacities

The table below summarises the capacities of the pumps at each of the pump stations within the scheme.

Pump station	Pump – Type – Model	Flow (m^3/s)
Silver Stream	P1 – Dry Mount – MacEwans 18/22	0.43
	P2 – Dry Mount – MacEwans 24/30	1.15
	P3 – Dry Mount – MacEwans 30/30	1.62
Mill Creek	P1 – Dry Mount – MacEwans 18/22	0.52
	P2 – Dry Mount – MacEwans 24/30	1.30
Scroggs	P1 – Submersible – EIM MSP 7055 D	1.0

For more information on the operation of the scheme refer to the East Taieri Drainage Scheme Operations and Maintenance Manual, and applicable pump station Operations and Maintenance Manuals.

Lower Waitaki River Control Scheme

Scheme Overview

The purpose of the Lower Waitaki River Control Scheme is to maintain the system of braided river channels within defined fairway and active riverbed widths, and to limit erosion of the active bed vegetated margins.

The Lower Waitaki River Control Scheme is made up of groynes and riparian plantings that aid in the limiting the position of the fairway. Most of this infrastructure was initially established by the former Waitaki Catchment Commission in the 1960s and 1970s. The Otago Regional Council owns this infrastructure within its boundary on the right back of the lower portion of the Waitaki River. The management of this infrastructure is contracted to Environment Canterbury as part of their overall management of the Lower Waitaki River Control Scheme[2] that falls predominantly within the Canterbury region. Flows in the river are moderated by a series of dams that were constructed on the river, starting with the Waitaki Dam in the 1920s and 1930s. In 2023 Meridian Energy applied for consents for the continued operation of the Waitaki Hydro Scheme.

There are also three floodways that assist in conveying flows from the foothills, across low lying farmland to the Waitaki River, however these are managed separately as river management infrastructure.

Functional Description

The flood hydrology of the length of the Waitaki River is dominated by the upper catchment and lakes. Flood flows from the upper catchment are significantly dampened by natural lake storage due to the construction and operation of hydro dams. These hydro dams include Tekapo (generation commenced 1951), Pukaki (1951 for Low Dam, 1979 for High Dam), Ohau (1979), Ruataniwha (1981), Benmore (1965), Aviemore (1968) and Waitaki (1935). The catchment area of the Lower Waitaki tributaries (downstream of the Waitaki Dam) is approximately 2,300 km^2. The main tributaries are the Hakataramea, Maraewhenua, Awakoko, and Otekaieke Rivers. These rivers have a much lower average rainfall than the upper catchment with a combined mean flow of 10.3 m^3/s and a mean annual flood flow of 240 m^3/s.

The scheme management objectives are to:

- Maintain a cleared fairway below the Waitaki Dam that is 400 metres wide at Kurow and increasing to 700 metres at the coast.
- Maintain an active riverbed generally 1,000 metres wide at Kurow and increasing to 1,300m at the coast.
- Limit erosion of the active bed vegetated margins.

Scheme maintenance activities aim to provide minimisation of lateral erosion directly affecting developed farmland and the containment of flows of up to 800 m^3/s within the cleared floodway and 1,700 m^3/s within the river system (fairway plus vegetated berms). These activities involve removing vegetation from the fairway to reduce flood levels and maintain the propensity for the river to braid. This in turn minimises the number of large channels that are more likely to promote erosion, supports nesting bird habitat, promotes sediment transport, and increases recreational opportunities through enhanced aquatic habitat and access.

The lower portion of the scheme within Otago includes several groynes and cross-banks designed to help minimise erosion along the edge of the riverbed. A buffer of trees of variable width (approximately 45m or greater) is maintained along the length of the river within Otago. This buffer is made up of a line of Anchored Tree Protection (ATP) installed in the river- or land-ward side of the buffer. ATP consists of rows of willows that are tied together with wire rope and anchored in place with concrete blocks or railway irons).

[2] *Lower Waitaki River Control Scheme Operation Agreement, Otago Regional Council and Canterbury Regional Council, signed 2023.*

Stoney Creek Flood Protection Scheme

Scheme Overview

Stoney Creek has a steep alpine catchment that discharges into Lake Wanaka across an alluvial fan. Increased urban development of the alluvial fan in the early 2000's led to the need for infrastructure to be established to mitigate the risk of alluvial fan migration and flood risk. The work consisted of developing a system of natural and engineering features, including channel modifications and debris traps, as part of Stage 1 of the work. Stage 2 of this work is planned to be completed within the lifetime of the Infrastructure Strategy 2024-2054.

Functional Description

Geomorphological processes (weathering, erosion, and mass movement) result in mostly fine gravels entering Stoney Creek in the upper parts of its catchment. These fine gravels are transported during low flow conditions and deposit on the fan where the catchment gradient decreases. These types of depositional fans are prone to sporadic movement of the stream over the fan and produce remnant channels on the fan surface as a result. Flooding by Stoney Creek in 1999 and 2004 demonstrates that a significant flood hazard exists along the terrace from First Cully Creek to Waterfall Creek, where the apex of the Stoney Creek alluvial fan is formed. The downstream floodplain has progressively become more urbanised as the urban development of Wanaka increases on the fan, subsequently increasing the risk of flooding to residential properties.

In 2009 work as part of Stage 1 of the Stoney Creek Flood Protection Scheme was completed. This included:

- Construction of the debris trap on Middle Creek;
- Restoration of the hydraulic capacity of the race connecting Middle Creek to Stoney Creek (race capacity up to 1 m^3/s).
- Creation of overland flow paths near the intersection of Mt Aspiring Road and Meadowstone Drive;
- Enlargement of sections of the Stoney Creek channel upstream of Studholme Road; and
- Construction of the upper debris trap on Stoney Creek.

These works increased the capacity of Stoney Creek between Studholme Road and upstream end of the Meadowstone Stages 6 and 7 development to a 50 year flood flow, based on the understanding of catchment hydrology in the early 2000's. Localised erosion and deposition are still to be expected during flood flows, however the risk of breakout and avulsion over this section of Stoney Creek have been reduced.

Stage 2 comprises enhancements that are planned to be undertaken as part of future roading and property developments, and work higher up the catchment to further mitigate the impact of flood and debris flows.