

# SOUTH DUNEDIN FUTURE WORKSTREAM 4: ADAPTATION

## **STAGES 1 & 2:** LONG LIST OF GENERIC ADAPTATION APPROACHES

### - CONTEXT SUMMARY REPORT

29 NOVEMBER 2023



## SOUTH DUNEDIN FUTURE GENERIC LONG LIST CONTEXT SUMMARY REPORT

WSP New Zealand Ltd  
Dunedin  
197 Rattray Street  
Dunedin 9016, New Zealand  
+64 3 471 5500  
wsp.com/nz

| REV | DATE     | DETAILS                                                         |
|-----|----------|-----------------------------------------------------------------|
| 0.1 | 13.11.23 | Draft issued for peer review.                                   |
| 0.5 | 24.11.23 | Final version in response to peer-review and DCC/ORC comments.  |
| 0.6 | 29.11.23 | Final version following ORC Emergency Management Office review. |

|                             | NAME                                                                | DATE       | SIGNATURE                                                                             |
|-----------------------------|---------------------------------------------------------------------|------------|---------------------------------------------------------------------------------------|
| Prepared by:                | Laura Robichaux,<br>Nola Smart, Carlos<br>Carvajal, Mary<br>Coulton | 29/11/2023 |   |
| Technical Reviews<br>by:    | Mike Allis, Paddy<br>Pringle, Liam<br>Foster                        | 29/11/2023 |   |
| Technical Approval<br>by:   | Cushla Loomb                                                        | 29/11/2023 |  |
| Review for release<br>by:   | Joao Machado                                                        | 29/11/2023 |  |
| Approved for<br>release by: | Kevin Wood                                                          | 29/11/2023 |   |

## Disclaimer and Limitations:

WSP New Zealand Limited ('WSP'), Beca Limited ('Beca') and Tonkin & Taylor Limited ('T&T'), provide the South Dunedin Futures Project services in association with each other using the "Kia Rōpine" brand. WSP is engaged by the Dunedin City Council in accordance with the LTES Contract No. 10458 ('Agreement') as the lead consultant and each of Beca and T&T are engaged by WSP as subconsultants pursuant to separate subconsultant agreements. Beca and T&T only assume liability to WSP in relation to the services, and only to the extent of the terms of their respective subconsultant agreements. WSP, Beca, and T&T are separate and independent legal entities and no party is another's agent, partner or joint venture party, nor do they have authority to bind each other or act on each other's behalf.

This report ('Report') has been prepared by WSP (via the Kia Rōpine group) exclusively for the South Dunedin Future Programme team (Dunedin City Council and Otago Regional Council) ('Client') in relation to the South Dunedin Future Programme – Long List Generic Adaptation Approaches stage of the programme ('Purpose') and in accordance with the Agreement. The findings in this Report are based on and are subject to the assumptions specified in the Report, the Agreement and associated attachments, and Client Data supplied during the data request phase. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

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

# TABLE OF CONTENTS

|       |                                                                                     |    |
|-------|-------------------------------------------------------------------------------------|----|
|       | GLOSSARY/ACRONYMS.....                                                              | 1  |
| 1     | INTRODUCTION.....                                                                   | 6  |
| 1.1   | SOUTH DUNEDIN FUTURE PROGRAMME .....                                                | 6  |
| 1.2   | REPORT SCOPE .....                                                                  | 7  |
| 2     | SOUTH DUNEDIN FUTURE PROGRAMME<br>AREA.....                                         | 8  |
| 2.1   | SOUTH DUNEDIN FUTURE PROJECT<br>BOUNDARIES .....                                    | 8  |
| 2.1.1 | GEOGRAPHIC AREA.....                                                                | 8  |
| 2.1.2 | INTERACTING ONGOING WORK.....                                                       | 8  |
| 2.2   | MANA WHENUA CONTEXT AND PARTNERSHIP .....                                           | 10 |
| 3     | SOUTH DUNEDIN: THE NEED FOR<br>ADAPTATION PLANNING .....                            | 11 |
| 3.1   | PROBLEM DEFINITION .....                                                            | 12 |
| 3.2   | HAZARD MANAGEMENT FOCUS.....                                                        | 14 |
| 4     | ADAPTATION PLANNING<br>METHODOLOGICAL APPROACH.....                                 | 16 |
| 5     | LONG LIST OF GENERIC ADAPTATION<br>APPROACHES .....                                 | 18 |
| 5.1   | DEVELOPMENT METHODOLOGY .....                                                       | 18 |
| 5.2   | LONG LIST OF GENERIC ADAPTATION<br>APPROACHES .....                                 | 20 |
| 6     | APPROACH FRAMING.....                                                               | 24 |
| 6.1   | CHARACTERISTICS.....                                                                | 24 |
| 6.2   | STRATEGIC OBJECTIVES .....                                                          | 25 |
| 6.3   | CRITICAL SUCCESS FACTORS AND FATAL FLAWS.....                                       | 27 |
| 7     | NEXT STEPS.....                                                                     | 28 |
|       | APPENDIX A-1: GENERIC LONG LIST APPROACH FACT<br>SHEETS .....                       | 29 |
|       | APPENDIX A-2: REPORTS REVIEW.....                                                   | 46 |
|       | APPENDIX A-3: DOMESTIC AND INTERNATIONAL GOOD<br>PRACTICE CASE STUDIES REPORT ..... | 47 |

# GLOSSARY/ACRONYMS

| Term / Acronym                                         | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accommodate<br>(for PARA framework reference purposes) | The process of making adjustments or modifications to systems, infrastructure, policies and practices to cope with the impacts of climate change in place. This involves implementing measures such as changes to buildings and infrastructure that enhance resilience, thereby not changing exposure to hazard extents but reducing vulnerability to changing climatic conditions, ensuring societies can adapt effectively.                                                                                                             |
| Adaptive Capacity                                      | The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                          |
| Avoid<br>(for PARA framework reference purposes)       | Minimising exposure by staying away from areas at risk (or where risk is above an acceptable threshold).                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Climate Adaptation<br>(also referred to as Adaptation) | The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. <sup>2</sup>                                                                                                                                                                                                                                        |
| Climate Change                                         | Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes or trends in the mean and/or the variability of its properties, and that persists for an extended period, typically decades to centuries. Climate change includes natural internal climate processes or external climate forcings such as variations in solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land-use. <sup>3</sup> |
| Climate Hazard                                         | The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. <sup>1</sup>                                                                                                                                                                                                                                                 |
| Compound hazards and stressors                         | Combined occurrences of multiple hazards and stressors (that is, cumulative hazards) which will become more significant in the future as adaptation thresholds are reached, for example, for a low-lying coastal area, a persistent wet season (high groundwater, reduced field capacity) is followed by a coastal storm on the back of sea-level rise, coinciding with intense rainfall, leading to compound flooding impacts. <sup>4</sup>                                                                                              |

<sup>1</sup> ISO 14090:2019 (Adaptation to Climate Change)

<sup>2</sup> ISO 14090:2019 (Adaptation to Climate Change) and IPCC definition as per IPCC, 2014: Annex II:

<sup>3</sup> IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

<sup>4</sup> Ministry for the Environment (2019). Environment Aotearoa 2019: New Zealand's Environmental Reporting Series. Wellington. Ministry for the Environment. Retrieved from <https://www.mfe.govt.nz/publications/environmental-reporting/environment-aotearoa-2019>.

| Term / Acronym       | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Criteria             | Critical success factors, principles, standards and strategic objectives used to assess and compare approaches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DAPP                 | Dynamic Adaptive Planning Pathways, a series of actions which provide a way to act now in the face of uncertain futures, and make decisions early to alter adapt actions over time in response to changing social, environmental, or other factors                                                                                                                                                                                                                                                                                                                                                                                                       |
| DCC                  | Dunedin City Council                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Exposure             | The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by a change in the external stresses a system is exposed to. In the context of climate change these are normally specific climate and other biophysical variables. <sup>9</sup> The number, density or value of people, property, services, or other things of value that are present in an area subject to one or more hazards (i.e., within a hazard zone), and that may experience potential loss or harm. <sup>5</sup> |
| Flooding             | The covering or submergence of an area of land below water. In the context of this report, flooding includes coastal flooding (temporary submergence during storm events), coastal inundation (when sea levels rise and the land is now intertidal or permanently submerged), surface or pluvial flooding (caused by rainfall events), and groundwater flooding (when groundwater rises and emerges above the surface). The report does not include riverine or fluvial flooding due to geography of South Dunedin.                                                                                                                                      |
| Green infrastructure | Green infrastructure refers to the use of natural and semi-natural elements in infrastructure planning and design. It involves utilizing and enhancing the existing natural systems, such as forests, wetlands, rivers, and green spaces, to provide multiple benefits for both the environment and society, including to manage flooding.                                                                                                                                                                                                                                                                                                               |
| Hard infrastructure  | Hard infrastructure is typically characterized by physical structures, engineered systems, and technological components. Also known as grey infrastructure.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Hazard               | <p>The potential occurrence of a natural or human-induced physical event, trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.<sup>3</sup></p> <p>Natural hazards refer to naturally occurring events or phenomena. These hazards are typically beyond human control and result from natural processes such as geological, meteorological, hydrological, or biological forces.</p>                                                                                                     |

---

<sup>5</sup> Ministry of Civil Defence and Emergency Management. (2019). National Disaster Resilience Strategy. Retrieved from <https://www.civildefence.govt.nz/assets/Uploads/publications/National-Disaster-ResilienceStrategy/National-Disaster-Resilience-Strategy-10-April-2019.pdf>.

| Term / Acronym                                   | Definition                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Intergovernmental Panel on Climate Change (IPCC) | Intergovernmental Panel on Climate Change – a scientific and intergovernmental body under the auspices of the United Nations.                                                                                                                                                                                          |
| Integrated Systems Planning (ISP)                | Integrated Systems Planning provides a 50 year strategy for the three waters systems operated by DCC.                                                                                                                                                                                                                  |
| Land use                                         | Refers to the purpose or activity for which a particular area of land is utilised or managed. It describes how land is allocated and used by individuals, communities or institutions for various specific purposes, such as residential, commercial, agricultural, industrial, recreational or conservation purposes. |
| Land use change                                  | The process or transition from one type of land use to another within a specific geographical area. It involves altering the purpose or activity for which a particular piece of land is utilised, leading to shift in its functional character and associated activities.                                             |
| Liquefaction                                     | Liquefaction is a phenomenon that occurs in saturated, loose, or poorly compacted soil during seismic events, such as earthquakes. It refers to the transformation of solid soil into a liquid-like state, temporarily losing its strength and ability to support structures and foundations.                          |
| Mana Whenua                                      | Refers to the authority, power and connection to the land that Māori hold as traditional custodians.                                                                                                                                                                                                                   |
| Mātāwaka Māori                                   | Māori living in the Ōtepoti Dunedin region who are not mana whenua.                                                                                                                                                                                                                                                    |
| Mātauraka                                        | Māori knowledge or ways of knowing                                                                                                                                                                                                                                                                                     |
| Mahika kai                                       | Garden, cultivation, food-gathering place                                                                                                                                                                                                                                                                              |
| MCA                                              | Multi-Criteria Assessment                                                                                                                                                                                                                                                                                              |
| MfE                                              | Ministry for the Environment                                                                                                                                                                                                                                                                                           |
| Nature-Based Solutions                           | Nature-based solutions (NBS) refer to actions that utilize or mimic natural processes to address societal and environmental challenges. They involve working with nature rather than against it and recognising the value of natural systems in providing essential services and resources.                            |
| ORC                                              | Otago Regional Council                                                                                                                                                                                                                                                                                                 |
| Adaptation Pathways                              | Sequences of actions or options over time to reduce risk of climate change impacts                                                                                                                                                                                                                                     |

| Term / Acronym                                                                                                            | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PARA Framework                                                                                                            | <p>The PARA (Protect, Accommodate, Retreat, Avoid) Framework provides four strategies or categories through which to manage risk and adapt to climate change.</p> <p>Definitions of the categories under 'PARA' are provided individually in the glossary.</p> <p>There are growing trends to add a fifth category – Re-purpose – to include options for re-purposing land use after hazards change the character of the site. This category is included within the context of retreat (e.g. post-retreat actions) herein.<sup>67</sup></p>                                                                                                                             |
| Protect<br>(for PARA framework reference purposes)                                                                        | Building physical measures in place, thereby changing the extent of hazards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Representative concentration pathway (RCP)                                                                                | A suite of representative future scenarios of additional radiative heat forcing at the Earth's surface by 2100 (in Watts per square metre), which is the net change in the balance between incoming solar radiation and outgoing energy radiated back up in the atmosphere. Each RCP can be expressed as a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014. <sup>3</sup>                                                                                                                                                                                                                      |
| Retreat (including proactive managed relocation/retreat, and reactive retreat)<br>(for PARA framework reference purposes) | <p>Managed retreat or managed relocation refers to purposefully moving away from areas where the risk is too high, noting that retreat is not a 'do nothing' approach but can be an opportunity for regeneration and that these opportunities need to be proactively identified.</p> <p>Reactive retreat refers to moving away from areas after a climate event has occurred that has made the area unsafe/uninhabitable.</p> <p>Retreat includes the re-purposing of land (land use change).</p>                                                                                                                                                                       |
| Resilience                                                                                                                | The capacity of social, economic, and environmental systems to cope with a hazardous event, trend or disturbance by responding or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation. <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                  |
| Risk                                                                                                                      | The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends, multiplied by the impacts if these events or trends occur. The term risk is used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure. Risk results from the interaction of hazard, exposure and vulnerability. <sup>3</sup> |

<sup>6</sup> Kool et al (2020) <https://doi.org/10.3390/infrastructures5110092>

<sup>7</sup> White et al (2023), <https://doi.org/10.1016/j.gecadv.2023.100002>

| Term / Acronym                     | Definition                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Risk Assessment                    | The overall qualitative and/or quantitative process of risk identification, risk analysis and risk evaluation, with multiple entry points for communication and engagement and monitoring and reviews (AS/NZS ISO 31000:2009, Risk Management Standard).                                                                                                                                      |
| SDF                                | South Dunedin Future programme                                                                                                                                                                                                                                                                                                                                                                |
| Sea Level Rise                     | Sea level rise refers to the long-term increase in the average global sea level relative to the land. It is primarily driven by two main factors: thermal expansion of seawater and the melting of land-based ice, including glaciers and ice sheets.                                                                                                                                         |
| Seismic hazards                    | Seismic hazards refer to potential sources of harm or risk associated with earthquakes and related phenomena. These hazards are specifically concerned with the geologic activity and movement of the Earth's crust, which can result in seismic events such as earthquakes, liquefaction aftershocks, tsunamis, and ground shaking.                                                          |
| Sensitivity                        | The degree to which a system or species is affected, either adversely or beneficially, by climate variability or climate change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise). <sup>8</sup> |
| Shared SocioEconomic Pathway (SSP) | A collection of pathways that describe alternative futures of socioeconomic development in the absence of climate policy intervention. The combination of SSP-based socio-economic scenarios and RCP based climate projections, should provide a useful integrative frame for climate impact and policy analysis. <sup>9</sup>                                                                |
| STAT                               | Signals, triggers and adaptation thresholds                                                                                                                                                                                                                                                                                                                                                   |
| Three waters                       | Three waters refers to drinking water, wastewater and stormwater infrastructure.                                                                                                                                                                                                                                                                                                              |
| Threshold                          | A critical limit where a system responds drastically when exposed to an external forcing, resulting in the system changing into a different state.                                                                                                                                                                                                                                            |
| Uncertainty                        | A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. <sup>3</sup>                                                                               |
| Vulnerability                      | The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. <sup>3</sup>                                                                                                                                                                 |

<sup>8</sup> IPCC definition as per IPCC, 2014: Annex II:

<sup>9</sup> IPCC (2023); Glossary of terms [https://www.ipcc-data.org/guidelines/pages/glossary/glossary\\_s.html](https://www.ipcc-data.org/guidelines/pages/glossary/glossary_s.html)

# 1 INTRODUCTION

## 1.1 SOUTH DUNEDIN FUTURE PROGRAMME

South Dunedin is a low-lying coastal area vulnerable to flooding, particularly due to intensifying rain events, rising sea levels, coastal inundation and erosion and groundwater as the climate changes. Seismic hazards such as earthquakes, landslides and liquefaction also present a risk. The South Dunedin Future (SDF) programme is a collaborative initiative between the Dunedin City Council and Otago Regional Council to develop and implement a long-term (100+ years) adaptation strategy for the area. The SDF programme purpose is “to enable South Dunedin to prepare for, and adapt to, the impacts of climate change, while also realising the opportunities that come with change.”

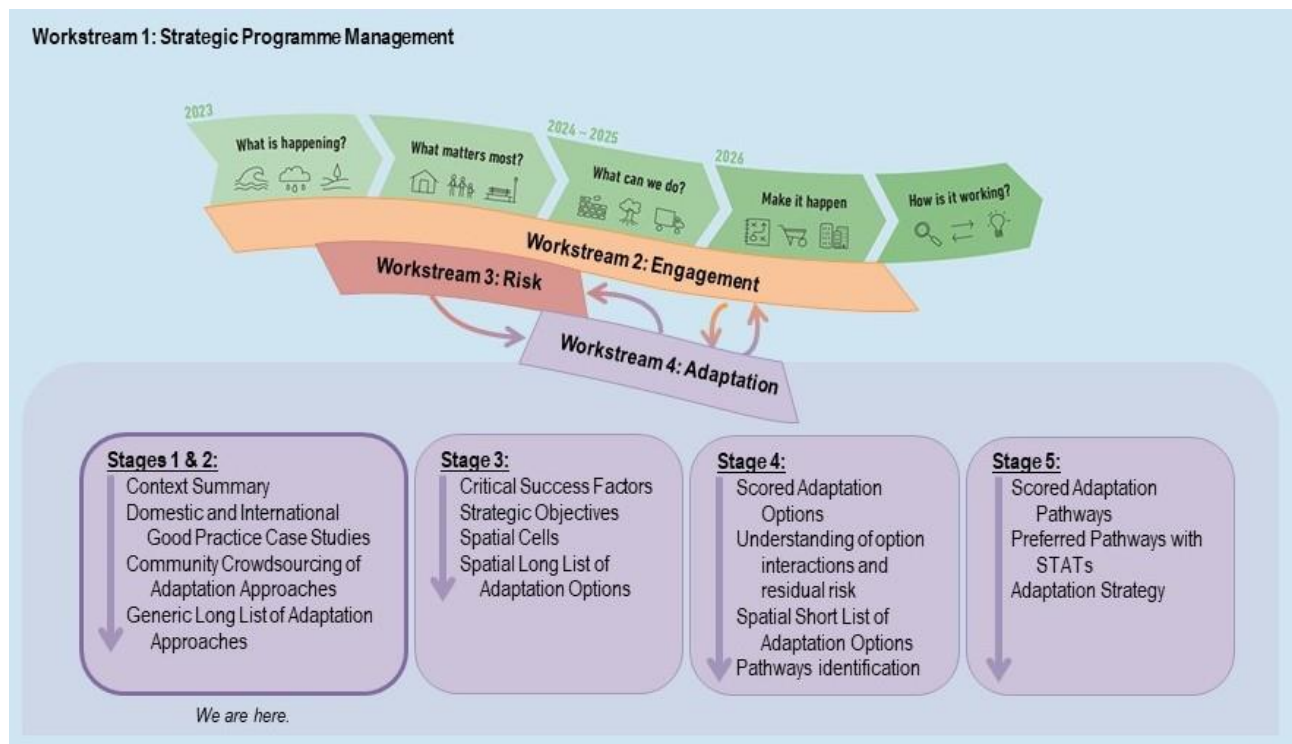


Figure 1: Programme Overview (note STATs are signals, triggers, adaptation thresholds)

Within SDF, the *Adaptation Workstream* is informed by the engagement and risk workstreams and consists of five stages, as shown in Figure 1:

- Stage 1: Review of Domestic and International Good Practice Case Studies and identify programme objectives,
- Stage 2: Develop a long list of generic adaptation approaches,
- Stage 3: Develop a spatial long list of adaptation approaches,
- Stage 4: Develop a spatial short list of adaptation approaches, and
- Stage 5: Develop preferred pathways and an adaptation strategy for South Dunedin.

This report presents the progress, findings, and challenges of Stage 1 to identify strategic objectives while also framing Stage 2, presenting the generic long list of adaptation approaches. This report builds on the risks identified in the South Dunedin Future Risk Identification Report (2023) and uses

these findings to help inform the potential adaptation approaches for South Dunedin. The Domestic and International Good Practice Case Studies Report has informed the generic long list development process and is included as an appendix (Appendix A-3). This, alongside the risk and community engagement workstreams, provides a baseline of “what is happening?” and “what matters most?”, and a foundation for the continued development of the SDF programme (“what can we do?”). The long list of generic adaptation approaches presented in this report will be refined over the course of the programme as shown in Figure 1. At the end of the Adaptation Workstream during the ‘What can we do about it’ stage for the South Dunedin Future programme, an adaptation strategy for South Dunedin will be recommended to DCC and ORC for approval and then implementation.

## 1.2 REPORT SCOPE

The objectives of this report are as follows:

- Provide a high-level overview of the project context, namely the project’s “problem definition” and draft strategic objectives;
- Present a summary of the proposed methodological approach for the adaptation workstream with a focus on the overarching frameworks, with detail to be developed as the SDF programme continues; and
- Outline the considerations/factors informing the long list of generic adaptation approaches building on site specific investigations over the past decade, including the long list itself and its development process.

Appendices to this report include:

- Fact sheets for each of the 16 generic adaptation approaches (Appendix A-1)
- An indicative list of reports reviewed in the generic long list development (Appendix A-2)
- Domestic and International Good Practice Case Studies Report used for interrogation of approaches and inspiration for implementation (Appendix A-3).

## 2 SOUTH DUNEDIN FUTURE PROGRAMME AREA

### 2.1 SOUTH DUNEDIN FUTURE PROJECT BOUNDARIES

#### 2.1.1 GEOGRAPHIC AREA

The project area lies within the low-lying flat area between the Otago Harbour, St Clair, Middle and St Kilda beaches, Dunedin's city, hill suburbs, and the Otago Peninsula. The boundaries of the project area on the western and eastern sides are roughly approximated by the 4 mRL elevation contour. The project area extends from the harbourside to the South Coast on the Pacific shoreline and includes the suburbs of South Dunedin, St Kilda North and St Kilda South, parts of St Clair, Caversham, Tainui and Musselburgh (Figure 2).

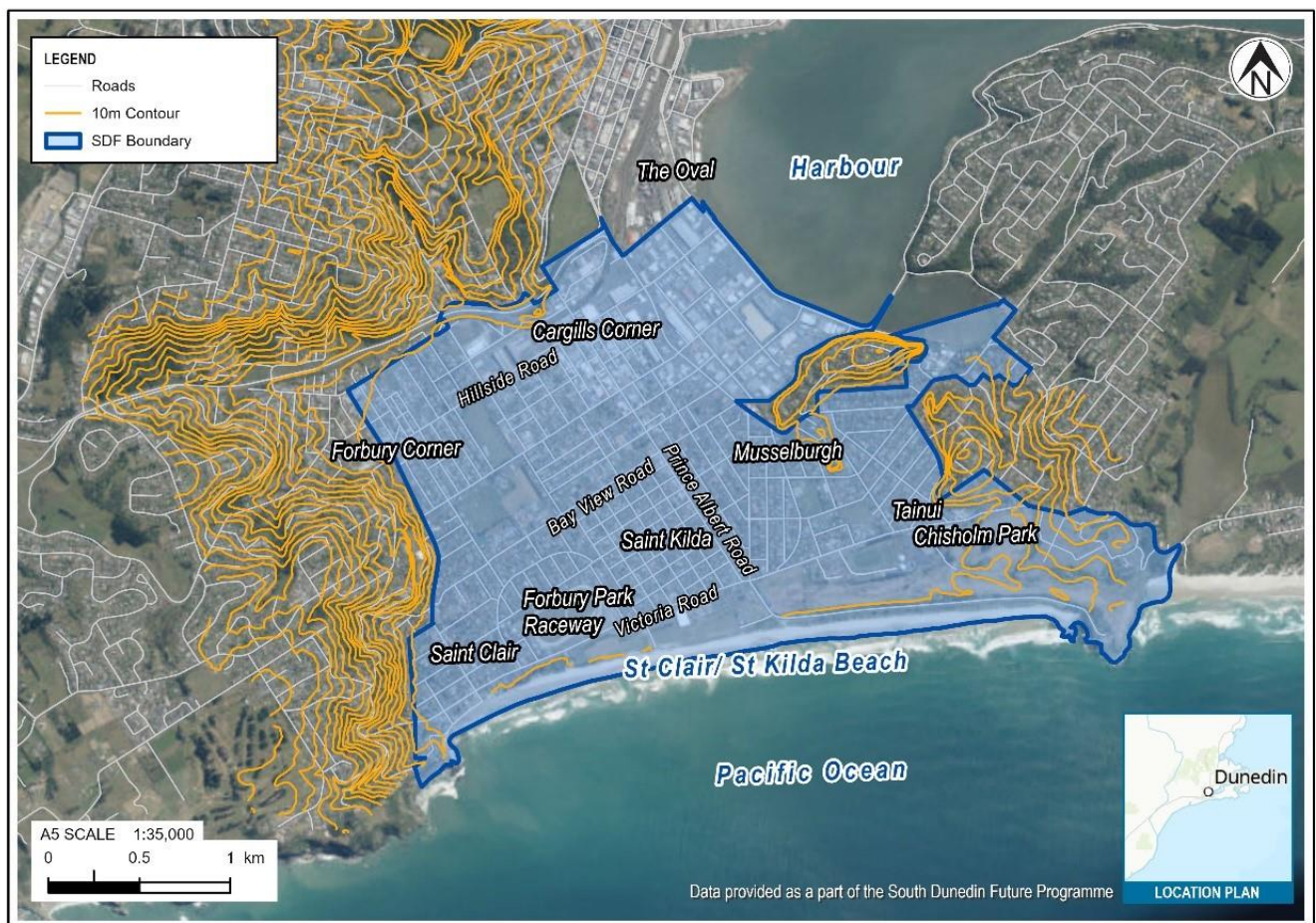


Figure 2: South Dunedin Future project area (in blue)

#### 2.1.2 INTERACTING ONGOING WORK

South Dunedin is home to approximately 10% of Dunedin's population and provides schools, cultural and recreational facilities, and other key city infrastructure. As such, decisions made in South Dunedin will impact the wider area. There are several ongoing programmes which will inform or be informed by the SDF programme as set out in Figure 3.

South Dunedin faces an array of natural hazards and climate related risks, including some that stem from or relate to St Clair – St Kilda coastline. Given the complex nature of this coastal system, and the immediate risks presented by coastal erosion, a dedicated programme was created for

the St Clair – St Kilda Coastal Plan | Whakahekerau – Rakiātea Rautaki Tai. The direct and indirect influences of hazards and risks arising at St Clair – St Kilda coast are material for wider South Dunedin and are therefore also within the wider scope of the SDF programme. Adaptation options for the South coast have already been identified and are being evaluated in parallel by this Coastal Plan and so have not been included within the South Dunedin Future longlisting process. Management of the St Clair to St Kilda shoreline is intrinsically linked to land use in the hinterland, and the project teams will collaborate accordingly to develop a holistic strategy. Consideration of how respective longlists of adaptation approaches can be integrated in the future is ongoing so as to ensure overall coherence and better outcomes for South Dunedin. This will be explored more fully in subsequent stages of the South Dunedin Future programme and Coastal Plan.

Consistent with the Ministry for the Environment Interim Guidance on the use of new sea-level rise projections (2022), the adaptation strategy will provide adaptation pathways extending 100 years into the future.

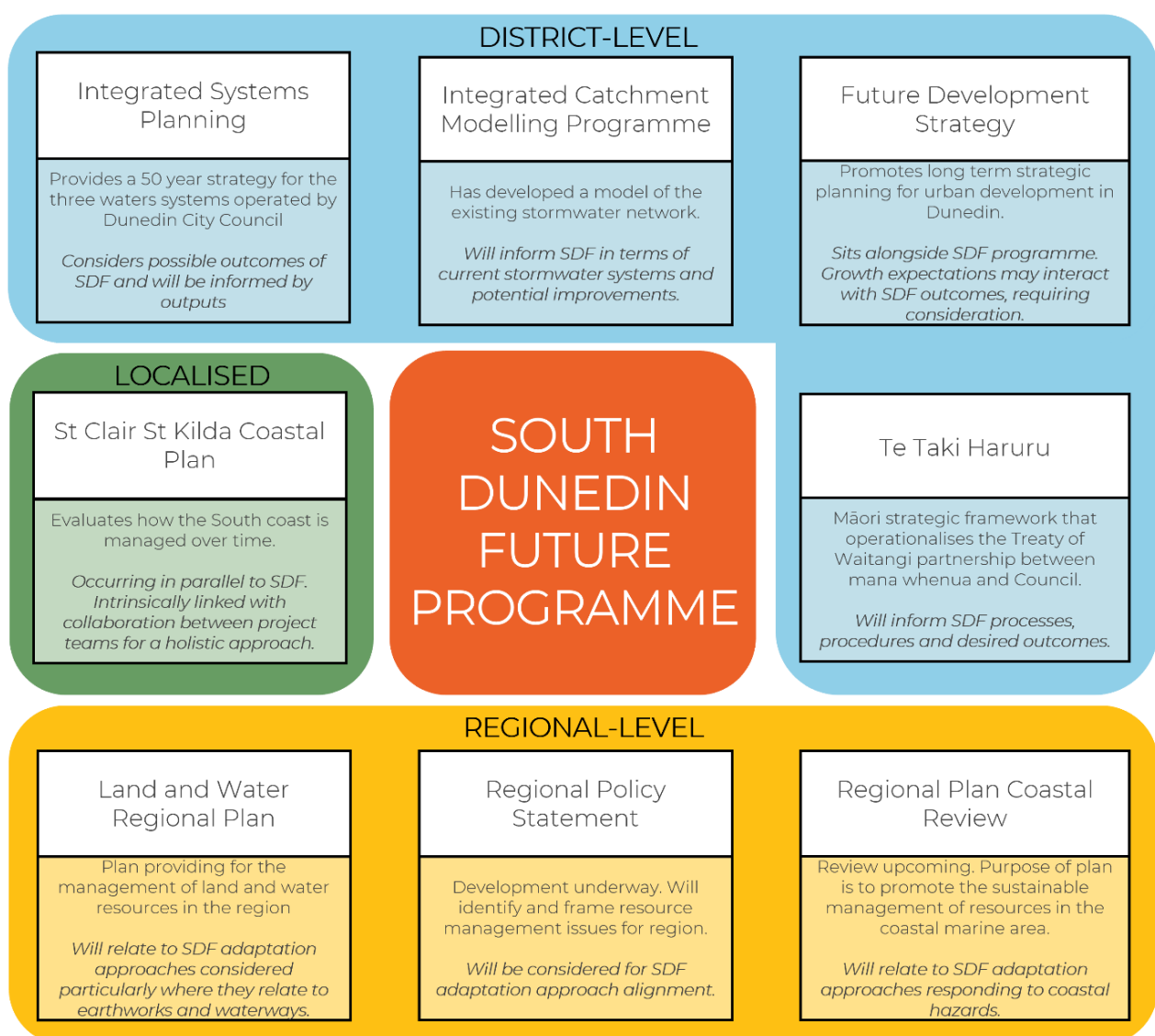


Figure 3: Interactions of ongoing programmes with South Dunedin Future programme (SDF)

## 2.2 MANA WHENUA CONTEXT AND PARTNERSHIP

The South Dunedin area is within the rohe of Te Rūnaka o Ōtākou and the Kāi Tahu iwi. While the Ōtākou Marae is on Muaupoko (Otago Peninsula), the South Dunedin area was an important site for Ōtākou with evidence of their presence dating back to the 13<sup>th</sup> and 14<sup>th</sup> centuries (with the Sydney Packet arriving in 1836 and signing of the Treaty of Waitangi in 1840). The historic wetland area (now South Dunedin) was a moa butchery as well as a tuna (eel) fishery.

In this report, and in subsequent reports, Kāi Tahu place names<sup>10</sup> will be used alongside English names, these include:

- Ōtepoti | Dunedin (George Street area in particular)
- Te Rakiātea | Tahuna
- Whakahekerau | St Clair beach
- Te Rakiātea | Musselburgh
- Kaituna | Bathgate (historically was a lagoon near the Gas Works)
- Puketāi | Andersons Bay

The Ōtākou | Otago Harbour is an important water body for both Te Rūnaka o Ōtākou and Kāti Huirapa Rūnaka ki Puketeraki to the north.

To operationalise the partnership commitment of the Treaty of Waitangi, Te Rūnaka o Ōtākou, Kāti Huirapa Rūnaka ki Puketeraki, and Dunedin City Council have developed Te Taki Haruru – Māori Strategic Framework. Te Taki Haruru promotes four principles – autūroa, autaketake, autakata, and auora – and associated values – mana, tapu and noa, whakapapa, and mauri – across the four wellbeings. This framework is intended to be operationalised in DCC programmes, and the SDF programme has identified the commitments below:

- Mana whenua can actively participate in the programme, and exercise rakatirataka (chieftainship, right to exercise authority, right of self-determination), including rights to make decisions on issues affecting the wellbeing of South Dunedin.<sup>11</sup>
- Mana whenua exercise kaitiakitaka (guardianship) over te taiao (environment) and taoka (natural treasures) to shape restoration and regeneration of South Dunedin environments. The programme supports the social and economic wellbeing of Māori communities in Ōtepoti Dunedin.
- Integration of tikaka (customs) and kawa (practice) into the programme ensure balance (utu) and outcomes that contribute to the wellbeing of te taiao, our whānau and wider community.
- The programme will draw on mātauraka Māori (knowledge) and te ao Māori (world view) to support a strengthened Māori presence in South Dunedin.

Throughout the programme, engagement and further refinement of the commitments will endeavour to meet the aspirations of mana whenua, and cultural values and Rūnaka perspectives will be operationalized to inform decision making. A cultural narrative to further inform the SDF programme is being prepared by Aukaha.

---

<sup>10</sup> <https://www.otakourunaka.co.nz/language-history>

<sup>11</sup> A decision making framework is under development

### 3 SOUTH DUNEDIN: THE NEED FOR ADAPTATION PLANNING

---

South Dunedin, also commonly known as ‘The Flat’, was originally a low-lying marsh that pre-European settlement provided Māori with abundant mahika kai resources and reserves. It was not until the 1800s that the area was drained and expanded by reclamation of land, with flood hazards becoming apparent as early as 1923. With the additional reclamation along Portsmouth Drive in the 1970s, there is no natural outlet for water to drain. The low elevations of South Dunedin, coupled with aging water infrastructure, high groundwater and a history of flooding mean that there are inherent risks driven by the local geography and historic development.



Figure 4: South Dunedin, prior to reclamation in 1856 (source: Hocken collections)

The area is at high risk from natural hazards and climate change with exposure to coastal, rainfall, groundwater and seismic hazards.<sup>12</sup> Infrastructure in South Dunedin is already struggling, particularly with regards to the wastewater and stormwater network, as identified in the South Dunedin Future Risk Identification Report. The effects from exposure to hazards have already been felt to varying extents, and the impacts are expected to increase as our changing climate brings heavier rain, rising seas and rising groundwater. This poses significant challenges for South Dunedin and its communities.<sup>12</sup>

South Dunedin is already experiencing effects of climate change, and the need for resilient solutions has been apparent for the past decade following the impacts of the 2015 flooding. These solutions will not be simple and in order to achieve the vision of Dunedin being “one of the world’s

---

<sup>12</sup> The South Dunedin Future Risk Identification Report provides further detail on these hazards.

great small cities", multiple sequential adaptation actions will be required over time to respond to changes in South Dunedin.

The consequences of these hazards are informed by their social, economic, infrastructure, and cultural context. Climate change is expected to worsen existing inequities, particularly the ability for communities to respond, adapt, or manage impacts from climate hazards. With South Dunedin's existing vulnerabilities, this reinforces the need for a pro-active climate resilience response to support the communities.

In responding to these hazards and associated risks<sup>13</sup> there is an opportunity to enhance wider community outcomes beyond the immediate natural hazard response. For this future state to be realised, a clear adaptation pathway is needed, and this will require a documented case for improvement.

While this introduction to adaptation planning views South Dunedin in isolation, as the project progresses from the long list of generic adaptation approaches to spatially defined options, a wider system perspective will consider the cascading impacts and interdependencies between South Dunedin and its surroundings to inform spatial implications.

## 3.1 PROBLEM DEFINITION

In the South Dunedin Future Strategy, a case for change is identified, namely:

- South Dunedin is subject to flooding and other natural hazards, which present risk to people, places and assets. Some of these risks are expected to increase due to climate change, though uncertainty remains about timing and severity of impacts, which makes planning more difficult for councils, affected communities, and other stakeholders.
- This uncertainty means that current investment by public and private sectors is likely not adequately accounting for current or future flood risk. The consequences could include maladaptation and potentially higher costs for communities, councils and central government in the long term, including through disaster response, recovery and rebuild or a reduction in the expected operational life of assets and critical infrastructure.
- Downstream risks of systemic shocks and market failures are increasing (e.g. major flood event, finance or insurance withdrawal, property market decline), potentially leading to sudden and significant disruption or damage to social and economic wellbeing, particularly for affected communities in South Dunedin.

This case for change provides an underlying rationale for the South Dunedin Future Strategy programme and identifies the need for a climate change adaptation plan for the area. The risk that flooding and other natural hazards pose to South Dunedin is such that, if not managed, the risk of systemic shocks and market failures may become unacceptable. This section seeks to "define the problem" or rather the root causes of this issue that requires management.

Adapting a dense urban and industrial area requires an integrated, staged plan that stays in front of the expected changes. A business case approach provides a standard methodology to frame and assess options to promote outcomes and secure funding (methodology further discussed in Section 4). As such, elements of business case approaches will be incorporated into the adaptation

---

<sup>13</sup> See the South Dunedin Future Risk Identification Report for further detail on hazards.

option and adaptation strategy development. Clear, concise problem definition is a key component of a business case to describe the issue or opportunity that the project or programme will address. It specificity allows for articulating what is included in the scope of the problem to be addressed. Without a clear problem definition, the solutions may lack focus or ultimately not be suitable. With a clear problem definition, opportunities can be readily identified.

Importantly, a problem definition exercise does not attempt to simply identify problems (e.g. “climate change is a problem for South Dunedin”) but rather to identify the root causes of the problem by untangling key drivers (“South Dunedin is low lying”) or trying to understand why the problem is a problem (“People live in South Dunedin and the infrastructure isn’t built for these changing hazards”).

While a full investment logic mapping exercise<sup>14</sup> was not completed for SDF, the kick-off workshop with representatives from DCC, ORC, Aukaha and the South Dunedin Community Network included a session to define the problem. The problems identified by groups were then sorted into six themes (socio-economic, infrastructure, cultural, community and equity, uncertainty, other) and then distilled to the problem definition below which link with the strategic objectives (provided in Section 6.2):

- Historically, South Dunedin was a wetland, and the legacy practice of draining and reclamation has erased culturally significant landscapes and resources for Kai Tahu and Te Rūnanga o Ōtākou. Tangaroa (the sea) continues to shape and reshape te taiao (the environment).
- The water infrastructure in South Dunedin was largely constructed more than 50 years ago (96% of the network before 1980 and 46% of the pipe network constructed before 1940). This infrastructure is aging and is vulnerable to failure during extreme events.
- South Dunedin is a highly developed, dense, hazard prone area that provides homes for roughly 10% of Dunedin’s population. It particularly provides affordable housing for some communities that are already socio-economically disadvantaged.
- The communities and businesses in the area have significant exposure to, and as a result are less able to recover from flood events that will occur with increasing frequency and severity over time.
- Following the 2015 flood, communities in South Dunedin have reported feeling anxious when it rains and uncertain about the future.

To build a vision for South Dunedin, while engaging on the long list of generic adaptation approaches the problem statements can be investigated to identify opportunities, e.g. “if we solve this, then...?”. These opportunities are then – together with communities – used to define a vision for the future of South Dunedin guiding changes to the future urban form as adaptation options are implemented.

---

<sup>14</sup> Investment Logic Mapping (ILM) is a structured approach used to develop a clear and comprehensive understanding of the drivers, objectives, and expected outcomes of an investment project or program (in this case, adaptation options). It helps stakeholders define the problem, identify potential solutions, and make informed decisions regarding resource allocation and investment prioritisation. ILM involves a visual mapping process that captures and communicates the logic behind an investment. It helps to clarify the underlying assumptions, dependencies, risks, and benefits associated with the investment.

## 3.2 HAZARD MANAGEMENT FOCUS

There are a number of natural hazards affecting South Dunedin, as identified in the South Dunedin Future Risk Identification Report (2023). These are identified in the table below.

Table 1: Summary of direct climate and natural hazard risks to South Dunedin. Tick-marks indicate that a risk is identified. Black outline indicates the risk is identified in the Otago or National climate change risk assessment† (Source: South Dunedin Risk Identification Report)

| ELEMENT AT RISK                              | RAIN-FALL                                     | COASTAL HAZARDS            |                 | GROUNDWATER† †† | SEISMIC HAZARDS |           |              |
|----------------------------------------------|-----------------------------------------------|----------------------------|-----------------|-----------------|-----------------|-----------|--------------|
|                                              | EXTREME RAINFALL AND FLOODING† †              | SLR AND COASTAL INUNDATION | COASTAL EROSION |                 | EARTHQUAKE      | LANDSLIDE | LIQUEFACTION |
| Natural environment                          | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Buildings and open spaces                    | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Marae and other culturally significant sites | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Roads                                        | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Rail infrastructure                          | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Ports                                        | No port in South Dunedin                      |                            |                 |                 |                 |           |              |
| Water supply infrastructure                  | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Wastewater infrastructure                    | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Stormwater infrastructure                    | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Airports                                     | No airport in South Dunedin                   |                            |                 |                 |                 |           |              |
| Flood defences                               | Flood defences included in stormwater element |                            |                 |                 |                 |           |              |
| Solid waste and contaminated sites           | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Communications                               | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |
| Electricity transmission and distribution    | ✓.                                            | ✓.                         | ✓.              | ✓.              | ✓.              | ✓.        | ✓.           |

†Risks outlined in black are identified as highly rated risks in the Otago Climate Change Risk Assessment

††including wind and storm events

†††including in relation to rainfall and salinity stress

Rainfall, coastal, groundwater and seismic natural hazards facing South Dunedin have been screened against elements at risk (people, places, assets) within South Dunedin to identify direct physical risks within the area. Table 1 presents this screening, where tick-marks indicate the element is at risk due to a particular hazard. This shows that all elements are at risk from all hazards. Tsunami hazards are also relevant to the area but have a generally low frequency of occurrence.

Rainfall, coastal, groundwater and seismic hazards were the primary hazards evaluated in the Risk Identification Report given the risk they pose on the South Dunedin community. South Dunedin has a history of flooding during high intensity rainfall events (including 1923, 1929, 1968, 2015 and 2018). The frequency of these types of events will increase over time as sea levels drive higher groundwater levels and rainfall intensity increases due to climate change.<sup>15</sup> Large portions of the project area are exposed to coastal flooding due to sea level rise and storm surges within the 100 year planning time horizon of the South Dunedin Future programme. Groundwater within the South Dunedin area is typically shallow, and as climate change continues, the risk of emergent groundwater or groundwater ponding will increase, potentially affecting large portions of the project area. Seismic hazards such as liquefaction are also a risk to be considered in the South Dunedin Future Programme considering prior history of these impacts in Aotearoa New Zealand, including retreat as a result of impacts.

The above hazards pose significant risks that intersect and amplify one another. Climate change has the potential to exacerbate existing hazards and introduce new ones, leading to complex interactions and compounding effects. For example, sea level rise can combine with storm surge events and therefore heighten the risk of coastal flooding. Understanding these compounding and cascading effects is crucial for effective adaptation planning.

---

<sup>15</sup> ORC (2016) The Natural Hazards of South Dunedin.

## 4 ADAPTATION PLANNING METHODOLOGICAL APPROACH

To develop a regenerative climate change adaptation strategy for South Dunedin, a combination of three approaches will be used to support decision making within the context of assessing environmental, social and cultural outcomes. These include:

- **Dynamic Adaptive Planning Pathways (DAPP)** as recommended by the Ministry for the Environment in the 2017 Coastal Hazards and Climate Change Guidance for Local Government as well as the forthcoming Ministry for the Environment guidance on climate change adaptation.

DAPP, and adaptation pathways more broadly, provides a way to plan for uncertainty, taking action in the short term, and developing a series of actions to respond to change over time. This approach recognises the increasing hazards and need for a staged approach to implementation while allowing for flexibility in future decision making if conditions do not change as expected.

In Aotearoa, DAPPs are typically developed using the MfE 10-step cycle as shown in Figure 5. Future option evaluation under the SDF programme will be structured following this process. Option evaluation can be done in a variety of ways, and the approach is presented below.

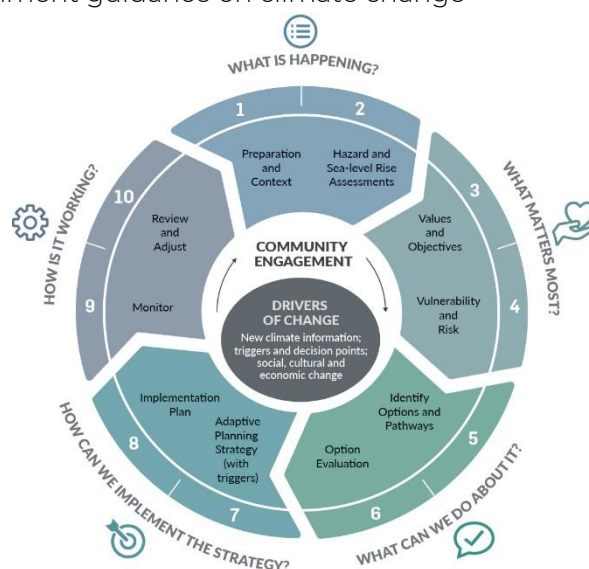


Figure 5: MfE 10-step Adaptation Planning

- **Better Business Case** as recommended by Treasury New Zealand to provide a transparent, consistent, objective analysis of options to streamline funding applications. This will be used to inform decision making within a DAPP style process.

The Better Business Case approach includes:

- Strategic Case to evaluate how options or projects align with the strategic intent of the programme
- Economic Case to assess value for money including consideration of wider social and environmental effects
- Commercial case to evaluate viability of procurement and opportunities for public-private partnership
- Financial case to demonstrate affordability and funding sources
- Management case to describe implementation requirements.



Figure 6: Better Business Case Approach

This approach will be tailored and adjusted to provide sufficient flexibility to incorporate the dynamic long-term changes associated with climate-related risks as well as the impacts of variability in planning horizons on processes and outcomes.

- **Multi Criteria Assessment** consistent with Waka Kotahi's 2020 guidance in alignment with the Better Business Case process, supported by **additional economic and circular economy assessments** (more detail to be provided in Stage 3 of the Adaptation workstream). This will inform our use of a DAPP style process., taking into account the importance of social, cultural, and environmental outcomes.

# 5 LONG LIST OF GENERIC ADAPTATION APPROACHES

---

The first step (for the adaptation workstream) in developing an adaptation strategy is to identify a long list of generic approaches to manage risk. A range of approaches are presented that could be incorporated to manage risk and provide regeneration opportunities over time. At this early stage, the approaches are non-spatial while still considering the South Dunedin context.

South Dunedin is a low-lying coastal area vulnerable to flooding, particularly due to intensifying rain events, rising sea levels and groundwater as the climate changes. These factors have resulted in the development of multiple long list adaptation approaches that carefully consider South Dunedin's unique characteristics. By considering the region's susceptibility to flooding and other related challenges, these non-spatial approaches aim to address key issues while laying the groundwork for future stages of adaptation planning.

Long-list adaptation approaches have been categorised against the PARA (Protect, Accommodate, Retreat & Avoid) framework to develop a range of approaches.<sup>16</sup> These PARA approaches can be applied to elements at risk as identified in the South Dunedin Future Risk Identification Report (2023). Each provides a different way to manage risk and adapt to climate change as outlined below:

- *Protect*: building physical protection measures in place, thereby changing the extent of hazards.
- *Accommodate*: staying in place and making changes to buildings and infrastructure to improve resilience, thereby not changing exposure to hazard extents but reducing vulnerability.
- *Retreat*: managed retreat or managed relocation refers to purposefully moving away from areas where the risk is too high, noting that retreat is not a 'do nothing' approach but can be an opportunity for regeneration and that these opportunities need to be proactively identified. Reactive retreat refers to moving away from areas after a climate event has occurred that has made the area unsafe/uninhabitable. Retreat includes the re-purposing of land (land use change).
- *Avoid*: minimising exposure by staying away from areas where the risk is too high.

These approaches are not mutually exclusive, with a combination of approaches likely required to respond to specific context and challenges over time.

## 5.1 DEVELOPMENT METHODOLOGY

The generic long list methodology recognises the work to date to understand South Dunedin risks and hazards as well as existing infrastructure performance in the South Dunedin Future Risk Identification Report (2023). Possible approaches were collated to create an initial "long long" list from national and international case studies and previous reports specific to South Dunedin (listed in Appendix A-2) alongside further nominations received from subject matter experts within the consultant team and community crowdsourcing.

---

<sup>16</sup> See *Glossary* for a definition of PARA.

The domestic and international case studies report (in Appendix A-3) examines raising buildings in Australia and New Zealand, Copenhagen's Cloudburst Management Plan (which uses a range of conveyance and storage options to manage intense rainfall), retreat following the Christchurch earthquakes, and the Long Bay development in Auckland which incorporated water sensitive and nature-based solutions to manage flood hazards. These case studies not only present an overview of types of options that might be useful but also how they were developed and implemented, including funding and consenting mechanisms to encourage participation of the private sector.

Community crowd-sourced options were received through engagement events during September-October 2023, including:

- Otago like Polyfest 2023: A popular youth event celebrating Māori and Pasifika cultures.
- Meet the Scientists Night: An SDF programme event exploring underlying science topics of relevance to the impacts of climate change on South Dunedin.
- Street meet and sausage sizzle: An SDF programme public event on South Dunedin's main street that sought community feedback on views, values and ideas for adaptation.
- 'What can we do about it?': An SDF programme event that explored adaptation experiences in New Zealand and the Netherlands, sought comments on existing approaches and asked for ideas for new approaches from the community.

Additional 'crowd-sourced' adaptation ideas were also received via an online survey, through direct approaches from community members, and from analysis of community ideas captured during the many SDF programme engagement events over the past four years. Table 2 shows the themes, number of people and example feedback gained from crowd sourcing events. All options that related to adaptation approaches were taken forward into the generic long list, with the only options not included at this stage being those that were not adaptation focused, e.g. a children's theme park.

Table 2: 2023 Engagement block feedback themes

| Themes                       | Number | Percentage of total responses |
|------------------------------|--------|-------------------------------|
| Stormwater infrastructure    | 46     | 20%                           |
| Nature-based solutions       | 41     | 18%                           |
| Managed retreats and buyouts | 18     | 8%                            |
| Forbury Park                 | 16     | 7%                            |
| Recreation and amenities     | 14     | 6%                            |
| Transport                    | 11     | 5%                            |
| Economic                     | 9      | 4%                            |
| Coastal                      | 9      | 4%                            |
| Don't lift that rock!        | 9      | 4%                            |
| Building controls            | 8      | 3%                            |
| Chemtrails etc.              | 7      | 3%                            |
| Wellbeing                    | 7      | 3%                            |

| Themes        | Number     | Percentage of total responses |
|---------------|------------|-------------------------------|
| Civil Defence | 5          | 2%                            |
| Accessibility | 5          | 2%                            |
| Engagement    | 5          | 2%                            |
| Seismic       | 4          | 2%                            |
| Māori/Pacific | 4          | 2%                            |
| Miscellaneous | 13         | 6%                            |
| <b>Total</b>  | <b>231</b> | <b>100%</b>                   |

The “long long-list” was consolidated, removing duplicates and combining approaches where appropriate, to avoid too much overlap in assessing approaches (e.g. ponds and wetlands being included as examples of dedicated water storage) to create a generic long list. All risk management options identified in community engagement sessions have been included in the generic long list but have been integrated or combined where appropriate.<sup>17</sup> Where appropriate, when individual suggestions have been combined the specific details have been maintained through sub-approaches provided within the approach. The generic long list, presented below, has been reviewed, discussed, and confirmed by the Kia Rōpine Challenge Team. The Kia Rōpine team consists of WSP, Tonkin and Taylor and Beca specialists in climate change and resilience, Climate Change Risk Assessments, adaptation and communications and community engagement.

## 5.2 LONG LIST OF GENERIC ADAPTATION APPROACHES

An overview of the long list of generic adaptation approaches is provided above in Table 1. Sub-approaches under more general solution types (such as increasing permeability) have been included for greater process transparency and understanding of the approaches. As the evaluation process continues beyond the generic long list these sub-approaches may be split out and assessed individually as appropriate. The approaches suggested during public engagement events have been identified with the use of asterisks.

These approaches are further presented in high-level fact sheets provided in Appendix A-1. Each fact sheet includes a visualization and description of the approach; an evaluation of approach characteristics grouped into pros, cons and neutral factors; and a high-level assessment of the approach against strategic objectives (presented in the next section) to facilitate comparison.

It is important to note that due to the lack of space in South Dunedin caused by the existing land use and infrastructure, many of the adaptation approaches require significant disruption, demolition or temporary modification to existing buildings and assets. The specific requirements of the approaches will be looked at in more detail in the next phase.

---

<sup>17</sup> For example, consolidation occurred for feedback received on ‘drain it better’ and ‘stormwater network improvements’ into ‘conveyance improvements’, and similarly for ‘wetlands’ and ‘ponds’ into ‘dedicated storage’ to allocate them to the correct level of approaches and sub approaches.

While this assessment is occurring at an individual approach level, the final 'solution' will require a combination of multiple adaptation approaches over time to respond to the changing risk profile of South Dunedin.

Table 1: Generic Long List of approaches

| GENERIC LONG LIST OF APPROACHES |                                                             | Description                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Protect                         | Ground reinforcements                                       | Ground reinforcement is a preventative method to stabilise soils and reduce potential of seismic impacts including liquefaction and landslides.                                                                                                                                                                                                                                                   |
|                                 | Groundwater lowering / drainage / dewatering wells          | Process of reducing the water table or groundwater levels in an aquifer.                                                                                                                                                                                                                                                                                                                          |
|                                 | Land grading                                                | A flood risk management strategy that involved physically raising the ground level above the floodplain.                                                                                                                                                                                                                                                                                          |
|                                 | **Conveyance improvements                                   | The enhancement or modification of existing new drainage systems. This might involve combinations of installing larger pumps and pipes to increase water flow, intercepting and diverting flows upstream, creating engineered channels or canals, and/or enhancing stormwater conveyance capacity both overland and through piped networks.                                                       |
|                                 | **Remove wastewater network overflows and cross connections | Includes measures such as fixing cracked pipes or manholes (that may have been caused by ground movement, deterioration of aged pipes or tree roots).                                                                                                                                                                                                                                             |
|                                 | Dedicated water storage                                     | Include detention basins, ponds, and wetlands and they be located at the coast or inland.                                                                                                                                                                                                                                                                                                         |
|                                 | *Floodable infrastructure                                   | Floodable infrastructure refers to open spaces, green spaces (e.g., parks, reserves), carparks, and roads being transformed into intentional temporary flood storage zones or overland flow paths to protect other areas from flooding.                                                                                                                                                           |
|                                 | Increase permeability of ground surface                     | Increasing permeability of the ground surface improves the receiving environment's ability to absorb and/or manage excess rainwater, reducing the volume and rate of runoff that would otherwise go through to the stormwater network.                                                                                                                                                            |
|                                 | Coastal protection                                          | Coastal risk management comprises various tactics aimed at safeguarding coastal areas and can include 'hard' engineering options and 'soft engineering' options to manage erosion, flooding and/or tsunamis.                                                                                                                                                                                      |
| Accommodate                     | **Behavioural / societal changes                            | Resilience strategies that aim to reduce the impacts of hazards by emphasizing prevention and preparedness. Potential options to increase community resilience and understanding of climate hazards include: <ul style="list-style-type: none"> <li>o *Mental health support</li> <li>o *Climate hazard safety education and awareness</li> <li>o Financial incentives / disincentives</li> </ul> |

| GENERIC LONG LIST OF APPROACHES |                                                                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | *Readiness and response                                                            | "Readiness" (also known as "Preparedness") and "Response" measures typically refer to the operational systems and capabilities that are put in place before an acute event occurs and immediately after (e.g. generally not slow onset hazards such as erosion or rising groundwater). Readiness and Response planning generally falls within the responsibilities of Civil Defence Emergency Management (CDEM). <sup>18</sup>                                                                                                                                               |
|                                 | Property level interventions                                                       | Property level interventions refer to adjustments or modifications that are made directly to individual properties to enhance their resilience against flooding. These could include raising homes, waterproofing first floors, raintanks, flood barriers, or other individual property level interventions.                                                                                                                                                                                                                                                                 |
| Retreat                         | *Managed retreat (proactive retreat)                                               | A strategic decision to withdraw, relocate or abandon private or public assets (including land and buildings) before significant damage occurs. This may include: <ul style="list-style-type: none"> <li>o Voluntary buyouts on open market</li> <li>o Buyouts with climate leases</li> <li>o Targeted retreat of built environment - buyouts for enabling works (e.g. detention)</li> <li>o Post-disaster buyouts or post-insurance withdrawal buyouts</li> <li>o Retreat of critical infrastructure from vulnerable sites</li> <li>o Whole community relocation</li> </ul> |
|                                 | Reactive retreat                                                                   | Reactive retreat is the withdrawal, relocation or abandonment of private or public assets in response to immediate threats or after damage has already occurred. It involves a more reactive approach where decisions are made in direct response to acute events like storms, flooding, tsunamis, earthquakes or rapid erosion.                                                                                                                                                                                                                                             |
| Avoid                           | More restrictive building/development standards                                    | Involves controls on development to reduce exposure and vulnerability to hazards such as earthquakes and coastal flooding. They may include more restrictive standards, development guides, regional and district plan rules, resource consent conditions, bylaws, urban development or growth strategies to mitigate the impact of a hazard.                                                                                                                                                                                                                                |
|                                 | *No new development / redevelopment or change of land use that may exacerbate risk | May involve permitting more development in areas of low risk (through intensification or traditional development including outside of South Dunedin), restricting new development, construction and land use changes in high-risk areas, changing land uses to prevent rebuilding, all of which could include district plan changes.                                                                                                                                                                                                                                         |

\*Approaches suggested by members of the communities during public engagement events

\*\* Approaches suggested multiple times by members of the communities during public engagement events during public engagement events

At this stage, the fact sheets do not include economic, commercial, financial or management cases, but as the approaches are further refined, additional cases will be incorporated into more detailed templates. Visualizations will also be refined with additional detail added in subsequent stages.

<sup>18</sup> While included under 'Accommodate' of the PARA Framework for completeness, it is worth noting that many Civil Defence measures should already be in place under existing emergency management practices and so this approach is focused on options outside of Civil Defence's remit.

As the South Dunedin Future programme continues, additional details will be added to each of the approaches if they are taken forward into the spatial long list. It will be critical that for approaches such as managed relocation (and all other approaches), there is clear information about how this process might occur including funding mechanisms (who pays, how much, when, etc.), relocation destinations (if land or property swaps are considered), and how social, economic and environmental outcomes are promoted in a changing urban setting. Consideration of cost, consentability (under both the current statutory system and potential future system) and funding will be included in the spatial long list phase.

## 6 APPROACH FRAMING

---

Within the business case framework, a multi criteria assessment is used to evaluate alignment of approaches with the strategic case. While at this generic long list phase, approaches are not scored, communicating the direction of the future assessment framework is key to allow time to build understanding of the relative merits of the range of approaches being considered. At this stage, approach characteristics are presented in the fact sheets as well as alignment with strategic objectives, both discussed below. As the approaches move into the spatial long list phase, assessment of approaches against critical success factors will be key to determine whether the approaches are or are not taken forward.

Importantly, approaches will be assessed in the future based on:

- Ability to achieve strategic objectives (discussed below) that include social, cultural, and environmental outcomes as well as economic
- Ability to be implemented and ability to effectively reduce risk (critical success factors, discussed below).

Because of the early stage of the programme, approach characteristics are also presented to begin to provide an understanding of benefits and trade-offs of the various approaches.

### 6.1 CHARACTERISTICS

The characteristics below help differentiate between adaptation approaches and begin to identify the relative merits or challenges of the various approaches. They are:

- Time (lead time to implement and design life)
- Cost (including whole of life)
- Emissions<sup>19</sup> (beyond solely carbon footprint), pollution, and material re-use<sup>19</sup>.
- Health of and connection to the natural environment
- Generational flexibility
- Technical feasibility (including ease of consenting and legal requirements)
- Technical efficacy
- Social co-benefits (such as economic potential, community ownership, wellbeing, housing affordability)
- Maintained sense of place / identity
- Interdependencies (e.g. when other approaches would be required or useful in combination as well as at a city-scale in terms of cascading impacts)

---

<sup>19</sup> As approaches progress through shortlisting, this will include considering the possible use of circular design principles. Circularity acknowledges that emissions encompass more than just carbon and considers other pollutant emissions, resource depletion, waste generation and overall lifecycle impacts among other sustainability outcomes.

These factors are used in the long list fact sheets presented in Appendix A-1 to identify high-level advantageous and disadvantageous characteristics of approaches. There is no selection or evaluation of approaches occurring at this stage. This will occur in the future stages of this workstream in conjunction with the community, stakeholders and partners. Criteria used in evaluating options as part of subsequent stages will be developed further with stakeholders ahead of the evaluation.

It is also noted that these characteristics are not intended to represent the strategic objectives and will be considered alongside the strategic objectives (Section 6.2) and critical success factors / fatal flaws (Section 6.3).

## 6.2 STRATEGIC OBJECTIVES

The identification of values and objectives for an adaptation strategy are key to providing a clear trajectory for the future to inform option assessment. The strategic objectives, which may be further refined or added to in order to incorporate Rūnaka values, draw on:

- *The South Dunedin context:* Available local information was considered including South Dunedin Future's Strategic Intent, responses from the previous community engagement efforts, and the outputs from the problem-definition session at the South Dunedin Future kick-off workshop.
- *City, regional and national context:* The local context was then grounded in regional and national strategic direction including:
  - Otago Regional Council Strategic Directions,
  - Dunedin City Council's Te Ao Tūroa (The Environment Strategy) and Social Wellbeing Strategy, and
  - Arotakenga Huringa Āhuarangi (New Zealand National Climate Change Risk Assessment Framework) which includes Treasury's Living Standards Framework (LSF) for wellbeing and the 'He Ara Waiora' framework.
  - Te Taki Haruru – Māori Strategic Framework which provides a framework to operationalise the Treaty of Waitangi partnership between mana whenua and council.
  - New Zealand Coastal Policy Statement (2010) which provides guidance relating to the development of strategic options and transition mechanisms for areas of existing development.
- *International practice:* Alignment with the UN Sustainable Development Goals to measure impact, increase project visibility and attract support was also considered.

The strategic objectives are provided in Table 2 and used in the Strategic Case section of the generic long list fact sheets presented in Appendix A-1. Outcomes will continue to be used, alongside other criteria, to evaluate options throughout the project. Assessing alignment with community objectives and Rūnaka values provides a measurement of how options do/do not move South Dunedin towards a preferred future state.

Table 2: Strategic objectives for South Dunedin Future

| STRATEGIC OBJECTIVE                                                                                                                                                              |                                                                                                                                    | ALIGNMENT WITH CENTRAL, REGIONAL, AND LOCAL STRATEGIES AND FRAMEWORKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainable urban development                                                                                                                                                    | Urban development accounts for the changing environment in South Dunedin, providing better spaces for people, water, and wildlife. | <ul style="list-style-type: none"> <li>• 'Waiora Wellbeing' in Treasury's LSF and He Ara Waiora framework</li> <li>• ORC mission: 'enriching life in a way that ensures positive relationships between environment, people and place, now and the future'</li> <li>• DCC Te Ao Tūroa vision: Dunedin is one of the world's great small cities with a thriving environment we look after, respect and enjoy</li> <li>• DCC Social Wellbeing Strategy vision: we are a city with connected people, cohesive communities and quality lifestyles for all</li> </ul> |
| Environmental and cultural restoration                                                                                                                                           | Restore and regenerate natural environment, renew urban spaces, and re-energise cultural connections to place.                     | <ul style="list-style-type: none"> <li>• 'Natural Capital' in Treasury's LSF and He Ara Waiora framework</li> <li>• ORC vision: 'An environment that supports healthy people and ecosystems'. 'Communities that connect with, and care for, Otago's environment'</li> <li>• DCC Te Ao Tūroa objectives: 'Plan for and adapt to climate change', 'manage natural resources sustainably', 'sustain ecosystem services', 'increase indigenous biodiversity',</li> </ul>                                                                                            |
| Just transition                                                                                                                                                                  | Respond to climate change in ways that empower communities and promote fairness and equity.                                        | <ul style="list-style-type: none"> <li>• 'Social Capital' in Treasury's LSF and He Ara Waiora framework</li> <li>• ORC vision: 'Communities that are resilient in the face of natural hazards, climate change and other risks'</li> <li>• DCC Social Wellbeing Strategy strategic directions: a reasonable standard of living for all, connected people</li> </ul>                                                                                                                                                                                              |
| Social and economic resilience                                                                                                                                                   | Strengthen communities and businesses so they are well-prepared for floods and other hazards, able to cope and bounce back.        | <ul style="list-style-type: none"> <li>• 'Financial / Physical Capital' in Treasury's LSF and He Ara Waiora framework</li> <li>• ORC vision: 'Communities that are resilient in the face of natural hazards, climate change and other risks'</li> <li>• DCC Te Ao Tūroa objectives: 'Plan for and adapt to climate change',</li> <li>• DCC Social Wellbeing Strategy strategic directions: vibrant and cohesive communities</li> </ul>                                                                                                                          |
| Promote community safety                                                                                                                                                         | Promote community safety in South Dunedin by reducing flood and other risks, despite increasing natural hazards.                   | <ul style="list-style-type: none"> <li>• 'Human Capital' in Treasury's LSF and He Ara Waiora framework</li> <li>• ORC vision: 'A sustainable way of life for everyone in Otago'</li> <li>• DCC Te Ao Tūroa objectives: 'enjoy, connect to, and celebrate the natural world', 'increase understanding of the natural world'</li> <li>• DCC Social Wellbeing Strategy strategic directions: Healthy and safe people</li> </ul>                                                                                                                                    |
| NOTE: These objectives have had input from Rūnaka through Te Taki Haruru and Aukaha but may be further refined or amended to align with Rūnaka values as the project progresses. |                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## 6.3 CRITICAL SUCCESS FACTORS AND FATAL FLAWS

As the long list of generic adaptation approaches begin to be evaluated spatially, certain 'critical success factors' must be met for approaches to continue to be considered. Critical success factors provide a starting point for identifying and agreeing on specific criteria that are required for implementation (e.g. "go / no-go" factors). They do not define what success looks like on a project. The approaches that proceed onto the spatial long list should be able to, as a minimum, achieve the critical success factors and not have 'fatal flaws'. Fatal flaws are characteristics that mean the approach cannot be achieved or would pose such significant risks or impacts that it is not worth further assessment. Matters relating to high cost (but affordable) or complexity can bring implementation challenges but are not considered fatal flaws. Initial thinking on what these screening factors might comprise are included below, noting that these will be refined and confirmed as part of the project's next steps (see Section 4.4):

- Technically unfeasible or impractical to implement in South Dunedin
- Inconsistent with the principles of the Treaty of Waitangi
- Results in higher health and safety risks than the 'do nothing' option
- Institutional/governance capability
- Unable to provide required level of service within an acceptable whole-of-life cost budget (to be defined)
- Unconsentable
- Results in risk to life or is unable to mitigate risk to life.

As the programme progresses, the approaches will be assessed against critical success factors and strategic objectives. The "do nothing" approach (which includes business as usual maintenance, etc.) should also be assessed to provide a base case for comparison of outcomes.

## 7 NEXT STEPS

---

The long list of generic adaptation approaches as identified above and in Appendix A-1 signify an early step in adaptation planning for South Dunedin. Immediate next steps include continuing engagement with Rūnaka and local communities on the long list of approaches. Concurrently, the Rūnaka are developing project-specific aspirations that will respond to the higher level Rūnaka values. The strategic objectives identified in this document will be used in future multi-criteria assessments of options (weightings, if any, are undetermined at this stage).

Following confirmation of methodology with Dunedin City Council, Otago Regional Council, Rūnaka as project partners, and the Kia Rōpine Challenge Team, this generic long-list will be developed into a spatial long list. How preferred approaches will eventually be selected should be determined in the coming months to allow transparent communication of the decision-making process to occur before the decision making begins. At a high level it is expected that this will involve:

- Confirming fatal flaws and critical success factors to be used to screen spatial approaches from the generic long list, as mentioned in Section 6.3;
- Identifying spatial cells by grouping similar hazard characteristics (e.g., areas with high groundwater, likely stormwater ponding, lower exposure to hazards etc.); and
- Developing spatial long list by removing approaches from the generic long list that do not meet the critical success factors or have fatal flaws for each spatial cell.

In the process of refinement from generic long-list to spatial long-list through to spatial short-list, the approaches presented in this report will become increasingly specific and targeted to the needs of South Dunedin, culminating at the end of the process in a recommended (preferred) adaptation options pathway.

# APPENDIX A-1

---

## Appendix A-1: Generic Long List Approach Fact Sheets