REPORT

TO: Council

FOR: Council Meeting – 13 March 2024

FROM: Tim Harris – Executive Director Enabling Services

DATE: 4 March 2024

SUBJECT: UPPER SELWYN HUTS FUTURE OCCUPANCY STRATEGY

RECOMMENDATIONS

1. *That Council acknowledges:*

   a) *That climate change over the next 100 years means that sea level rise that will result in changes to the environment around Te Waihora / Lake Ellesmere specifically resulting in the lake not being able to be opened to the sea as easily or possibly as often, thus resulting in the lake area increasing in volume and area and the water table lifting. This includes the area of Upper Selwyn Huts (USH).*

   b) *Green Park Huts, managed by Ngai Tahu is subject to a management plan that sees its closure by June 2024*

   c) *Lower Selwyn Huts are administered by the Department of Conservation (DOC). DOC will shortly be inviting residents to make applications for a final, 10-year, transition concession. This concession may include conditions limiting the transfer of leases and building extensions.*

   d) *On 8 May 2019, the Council unanimously determined that 'Hut licences and subsequent renewals are short term and ultimately for a finite period' [1].*

   e) *That Council has a legislative obligation to protect the welfare and interests of hut owners and residents.*

2. *The Council agrees that a Deed of Licence (DOL) be issued for a period of five years from 30 June 2024. With the conditional opportunity to renew that licence for two further periods of five years up to a maximum total of 15 years from 30 Jun 2024. No occupancy will be permitted after 30 June 2039.*

3. *That Council agrees that the following significant changes are made to the DOL from 30 June 2024:*

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[1] *Resolutions database 20190612_003 adopted 2019-06-12 (unanimous decision)*

a. Transfer of a DOL of USH will be considered as follows:

- *Up to 30 Jun 2034, to any person.*
- *After 30 Jun 2034, to identified family members, or significant persons only[2].*

b. A USH and associated lot inspection programme be undertaken by Council to establish the condition of USH lots in relation to relevant legislation and Council policy.

c. That Council establishes an USH Project Team to plan and manage the withdrawal of USH by 30 June 203 and the subsequent restoration of the site to a clear site for repurposing.

d. That Council agrees a remediation bond be introduced.

4. That Council agrees that the USH portion of the Pines Wastewater Treatment Plant (WWTP) pipeline connection will be 50% funded by the USH community.

1. PURPOSE

1.2 The purpose of this report is to seek agreement from Council on a proposed approach for the eventual removal of the USH. Secondly for Council to confirm the proposed cost recovery mechanism for the USH section of the Pines Wastewater Treatment Plant (WWTP) connection and to agree amendments to a new DOL.

2. SIGNIFICANCE ASSESSMENT/COMPLIANCE STATEMENT

2.1 This report is deemed to have a medium significance assessment for Council activity.

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[2] To de determined by the USH Project team once established.

3. HISTORY/BACKGROUND

3.1 The first fisherman's huts in the area were constructed in 1888. Fishermen's huts were accepted as being appropriate at that time and were generally only used by the owners for a limited numbers of days per year. Today a number of huts are similarly used on a temporary basis but many of the huts are now used as a permanent place of residence. The reasons for permanent occupancy are varied including the unique living environment which attracts a number of the residents. For many, the low cost of purchase is also attractive. There are 96 huts. Current records indicate,

Category	Number
Number of licences in total	96
Number of permanent residents	75 (estimate only)
Numbers of hut owners who have notified SDC they are letting the hut	3 officially. However, based on the addresses and owner details it is assumed that a total of 9 may be rented out (multiple huts owned by the same individual or company and in most cases one of these is owner occupied)
Number of huts used on an occasional basis (holiday home)	12 (estimate only)

3.2 By way of Gazette Notice in 2015 part of the Reserve (4.6899 ha) was classified as "recreation reserve" and part (3.4314ha) as "local purpose reserve for the purpose of a hut settlement" under the Reserves Act 1977. It is important to note that local purpose reserve is subject to section 61 of the Reserves Act 1977 which records that a lease shall not be for a term exceeding 33 years. Hut owners have a DOL with Selwyn District Council. The licensee owns the hut, the crown owns the land, and the council is the administering body for the land and is the licensor.

3.3 The current DOL at the USH expires on 30 June 2024.The consent for wastewater discharge to land and water for USH expired in 2020. An extension of the consent was applied for until June 2024, when the first season/stage of WWTP pipeline works was proposed to be completed. The proposed four years duration for the new consent was based on the Ellesmere to Pines WWTP pipeline installation. The extension of the consent has not been granted to date and is operating on a continuance of the previously granted consent. The expectation from Environment Canterbury (ECan) is that Council will continue its current proposed works and have the USH section of the WWTP complete by 30 June 2024.

3.4 On 15 November 2023 Council agreed to fund a wastewater pipeline option to connect USH to the Pines WWTP. This was planned to be completed by June 2024 nullifying the requirement to renew the Resource Consent for a wastewater treatment system. Information regarding the likely cost recovery sums for USH owners presented at this meeting has subsequently been revised and outlined at paragraph 4.8 of this report.

3.4.1 **17 December 2017 -** Council received legal advice in relation to the feasibility of refusing to renew the licences, the feasibility of renewing the licences for a lesser term (or renewing conditional upon obtaining an extended resource consent term) and the feasibility of withdrawing wastewater services to the huts altogether. This information was subsequently considered by Council with a report from the Property and Commercial Manager, with the following resolution passed:

That in regard to the USH licences that the following occurs:

(a) That the Council appoints a Committee of Ward Councillors, the Mayor, and Chief Executive, to engage with the USH community to develop a plan regarding the future residential occupancy of the USH reserve.

(b) That the plan be prepared in conjunction with Environment Canterbury, Department of Conservation, Taumutu Rūnanga and Ngai Tahu to ensure consistency with arrangements that those authorities are obliged to undertake related to the Lake Ellesmere environment.

(c) That the Chief Executive is authorised to obtain from the appropriate authority an extension to the USH wastewater consent that is consistent with the licence expiry for the Lower Selwyn Huts.

(d) That these decisions are communicated to the USH community.

3.4.2 **February 2018 -** To fulfil the resolution above, Council appointed consultants, Development Matters, to undertake the work necessary, including consultation, to develop a future strategy plan. It provided a comprehensive report on the issues that needed to be addressed, at the time, for the issuing of a USH future DOL.

3.4.3 **6 November 2018 -** The committee referred to in 3.4.1 (a) above met to consider the report and proposed a maximum 30-year DOL extension in conjunction with an appropriate wastewater resource consent application.

3.4.4 **28 November 2018 -** At a portfolio briefing Council decided that they did not support the recommendations of the Committee and asked staff to reconsider options.

3.4.5 Subsequently Council issued a DOL to occupy which expired on 30 June 2020, this was reviewed in 2021. Council did not progress consultation or consideration of long-term licences as the future of wastewater management was uncertain. During this period of uncertainty licence extensions were offered in the form of letters.

3.4.6 **6 October 2022 -** Council issued its last letter extending the licence to occupy to 30 June 2024. (Appendix 1.)

4 DISCUSSION

4.1 This section discusses the factors which will influence the length of DOL issue and significant proposed changes to the current DOL. A draft DOL is attached. (Appendix 2).

Climate Change Science

4.2 Coastal communities across New Zealand have become increasingly aware of the impact climate change will have on their environments. For those around the edge of Lake Ellesmere/Te Waihora, the increase in the sea level of a forecast approximately 0.9m by 2100 means that the water table also lifts. Science supporting this is wide ranging with the most recent presented to Council in October 2023 from Aqualinc (Appendix 3). Other evidence regarding Sea Level rise can be found at (Appendix 4)

4.3 Currently rises in the lake level are countered by mechanically opening a channel between the lake and the sea. The decision to open the lake is made jointly by Te Rūnanga o Ngāi Tahu and Environment Canterbury. The decision-makers are required by the consent conditions to consider different values including protection of outstanding habitats, values associated with tikanga Māori, mahinga kai, summer lake levels, managing land inundation, tuna/eel migration and effects on drainage infrastructure.

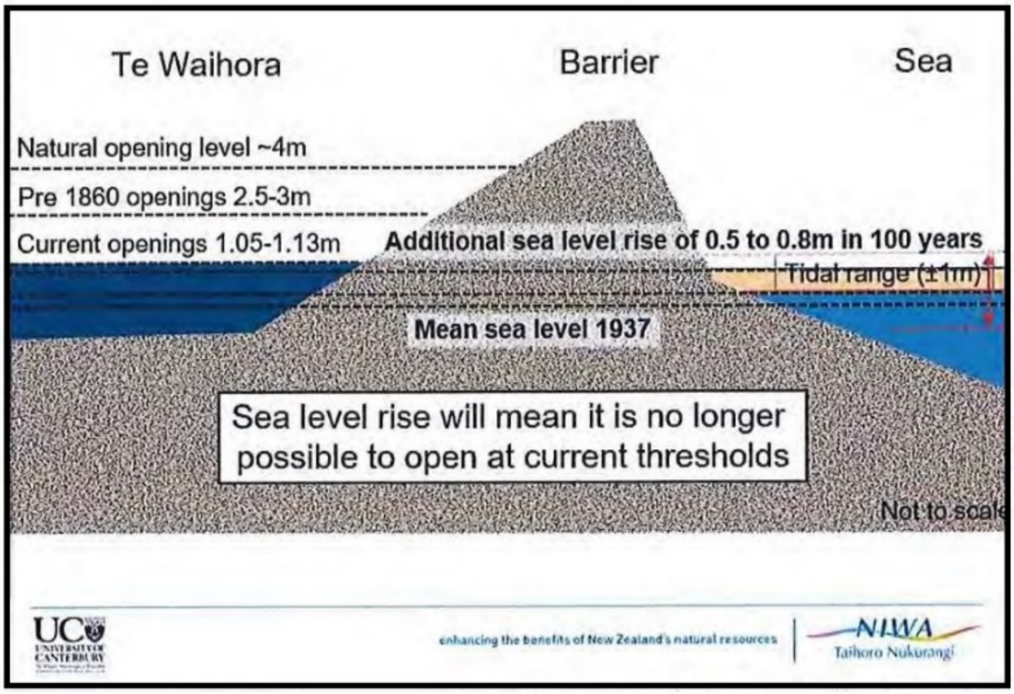

Diagram courtesy of Brett Painter (Environment Canterbury)

The Sea level rise over the next 100 years means that the lake will need to reach a higher capacity before it can be opened. The direct impact will be local inundation around the lake environs.

Other Lake Ellesmere/Te Waihora Communities

4.4 Two other lakeside communities exist. Lower Selwyn Huts managed by DOC and Greenpark Huts managed by Ngāi Tahu. Both communities are smaller than the USH community. Collaborative work with these organisations resulted in the date of 30 June 2024 established as a key point in time for the future of all three communities.

4.4.1 **Greenpark Huts** - These Huts are included within the Ngāi Tahu Claims Settlement Act 1998 (Settlement Act). Under section 125 of the Settlement Act, the Greenpark Huts ceased to be part of the conservation area managed by the Department of Conservation and became vested in fee simple title to Te Rūnanga. In late 2019 Te Rūnanga o Ngai Tahu determined that the water supply and wastewater infrastructure for the Greenpark Huts was inadequate. Additionally, the effects of climate change and rising water levels in the area presented an unacceptable risk to Te Waihora/Lake Ellesmere, a significant mahinga kai area and home to taonga species. Due to these factors, Te Rūnanga o Ngai Tahu decided not to renew the leases when they expire in June 2024.

4.4.2 **Lower Selwyn Huts** – Lower Selwyn Huts are administered by the Department of Conservation (DOC). DOC and the Lower Selwyn Huts Residents Association have met. DOC will shortly be inviting residents to make applications for a final, 10-year, transition concession. This proposal has also been discussed with Te Rūnanga o Ngāi Tahu and Te Taumutu Rūnanga. This concession may include conditions limiting the transfer of leases and building extensions. The evidence of the effects of climate change and rising water levels is far more compelling as Lower Selwyn Huts sit at the end of a peninsular below the level of USH.

4.5 With a view to collectively protecting the welfare and safety of all lakeside communities and supporting the wellbeing of Te Waihora/Lake Ellesmere it is deemed appropriate that a collaborative and consistent approach is adopted regarding all three lakeside community hut sites. Each administrative entity will be working towards similar goals for their respective communities. Entities will be able to learn lessons from each other's strategies and implementation and avoid unfavourable comparisons of intention. It is accepted while the end state for each site may be similar, the timelines to achieve respective end states can, and will, differ.

Major Stakeholders

4.6 There are many USH stakeholders however a summary of the most significant and their aspirations follows:

4.6.1 **Hut owners and residents** – Hut owners and residents would prefer that licences to occupy are issued in perpetuity or at the very least for 30 years and that Council and ECan explore and invest in solutions to allow continued hut occupation. It is important to note that allowing a DOL to run in perpetuity would be inconsistent with the Reserves Act 1977.

4.6.2 **Environment Canterbury** - Consultation with Environment Canterbury (ECan) chair Peter Scott on 9 November 2023 confirmed that ECans desired end state for USH was for any new DOL to be finite.

4.6.3 **Te Taumutu Rūnanga** - Consultation with Chair Liz Brown on 9 November 2023 established that Te Taumutu Rūnanga continued to support Ngai Tahu with their decision to close Greenpark huts in June 2024 but outlined that this was a challenging decision as closure impacted Mana Whenua and the same issue would exist with USH. There was a consensus that the expectation for any future USH lease would be time limited.

Pines WWTP Pipeline Connection

4.7 Council resolved on 8 May 2019[3] that any wastewater solution will be fully funded by the USH Community. On 15 November 2023, Council agreed, in a Public Excluded meeting, to approve additional funding of $10.94M towards the completion of the Ellesmere to Pines WWTP Pipeline and USH branch line bringing the total budget value of $35.56M. The recoverable portion for the USH component has since been confirmed as $4.046M.

4.8 Recovery of the $4.046M from USH owners could be recovered in full over any period of licence issue in accordance with the table below:

USH WWTP component total recovery estimates		
Shortfall Management	Term (Years)	Cost Implication (approximate) at an interest rate of 6.5% *
Increased Huts License	5	$10,143
Increased Huts License	10	$5,863
Increased Huts License	15	$4,483
Increased Huts License	20	$3,825
Increased Huts License	30	$3,228

* Noting existing sewerage component of the licence fee is $556/year and the cost implication is to be added

The lifespan of the pipeline is approximately 50+ years. If Councillors agree on a finite DOL period, it is likely that the pipeline will be used for many years after the USH are removed. The pipeline will support subsequent future use options. Councillors may consider it inappropriate to recover the full cost of the USH component of the pipeline from USH owners. This would leave a cost recovery

[3] *Resolutions database 20190612_003 adopted 2019-06-12 (unanimous decision)*

shortfall requiring attention in the forthcoming LTP. The table below outlines the cost implications of reducing the percentage of capital expenditure recovered form USH owners. Including the option of paying interest only.

Based on the cost of the USH component being recovered over a 15-year DOL period			
Percentage of the total cost recovered from USH owners.	Total cost to USH owners	Project deficit	Cost to USH owners' individual owners
Interest only			*$1,673*
25 %	$1,011,584	$3,034,753	*$702*
50 %	$2,023,169	$2,023,168	*$1,405*
75%	$3,034,753	$1,011,584	*$2,107*
100%	$4,060,000	$0	*$4,483*

4.9 Currently USH owners pay a licence fee of $1,389. Council has previously decided, and regularly confirmed, via Long Term Plan and Annual Plan consultation process that the USH community will not be included within the district wide rating systems for water or sewerage. During the draft annual plan preparation for 2019/2020 Councillors reconfirmed that decision. Should Councillors reverse this decision USH owners would pay for the following annual water and wastewater district targeted rates

Sewage $610
Water $308 and .80c per cubic meter of water used

In principle if USH owners commence paying annual water and wastewater district targeted rates the cost of the USH component of the Pines WWTP pipe could be covered in total by that rate.

4.10 It is possible to transport wastewater from USH to Pines WWTP. It is estimated this will cost $61k/month or $730k/ year with approximately 55 truck movements/ month or 660/ year (truck all waste) on average after June 2024. The cost to build the pipeline will be approximately equal 6 to 7 years of trucking.

4.11 Work to build the WWTP pipe has yet to start due to complications with resource consenting. Council is engaging with both ECan and Mahaanui Kurataiao Ltd (MKT)[4] with a view to establishing a revised work programme timeline. This work is ongoing and a fully operational date for the WWTP pipe has yet to be confirmed.

4.12 Options for delivering an USH wastewater solution beyond 30 June 2024 are:

4.12.1 **Option 1** - From 1 July 2024 or a date as enforced by ECan transport the USH wastewater to Pines WWTP by vehicle **- Not recommended.**

[4] Mahaanui Kurataiao is a charitable, resource and environmental management, advisory company established in 2007 by the six Papatipu Rūnanga of Te Tai o Mahaanui assisting Council with resource consenting for the Pines WWTP pipe project.

Advantages – This only provides an advantage if the DOL is agreed for a finite period of for less than 7 years.

Disadvantages – This requires a limited DOL period which is in contradiction of the recommended 15 years finite period.

4.12.2 **Option 2 -** Instal the USH component of the Pines WWTP pipe ASAP. Vary the resolution that USH owners pay the full cost of the USH WWTP pipeline requiring USH owners to pay only 50% of the costs of the pipe. **Recommended**

Advantages – For USH owners this reduces the amount payable reducing the risks and issues associated with a significant increase in annual charges.

Disadvantages – Any portion of the WWTP pipe cost that are not funded by the USH owners will need to be recovered in another way.

4.12.3 **Option 3** - USH owners share the full cost of the USH WWTP pipeline. **- Not Recommended**

Advantages – The USH portion of the WWTP pipe is delivered in accordance with the existing resolution and at zero cost to council.

Disadvantages – The full cost to USH owner may present financial challenges for some USH owners and residents resulting in financial hardship.

4.12.4 **Option 4 -** Include USH owners on the district wide rating systems for water or sewerage and fully fund the cost of the WWTP pipe from district rates. – **Not Recommended**

Advantages – The USH owners would not be required to fund the cost of their portion of the WWTP pipe. Removing the risks and issues associated with a significant increase in annual charges.

Disadvantages – The full cost of the WWTP pipe would fall to Council.

Community Wastewater Reticulation

4.13 The new WWTP pipe will take wastewater from the USH site. However, the existing earthenware pipes from individual huts to the WWTP pipe collection point (reticulation) installed in 1927 are generally accepted to be at the end of life. Implications of this are that groundwater can infiltrate into the reticulation increasing the flow into the new pipeline. A mid-range estimate of reticulation replacement is $1.5M. In anticipation of a finite licence period the decision was made to prioritise construction of the pipeline to Pines WWTP and defer renewal of the wastewater network within the community. The cost benefit of being able to reduce trunk main size by reducing infiltration by renewing the network, was not expected to be achieved over the anticipated remaining duration of the USH DOL period. Without a full engineering survey, it is not possible to confirm the condition of the existing reticulation. Once the Pines WWTP pipeline is operational this can be reviewed, and some sections of the existing reticulation may be renewed in the future. The consensus is that the existing reticulation is likely to last for a period up to 15 years before a complete replacement is required. As USH owners pay a sewerage component of their licence fee this cost will fall to Council.

4.14 Considering all the above factors options for a DOL term are:

4.14.1 **Option 1**. **Less than 10 years – Not recommended**

While this option dovetails with Ngāi Tahu plans to close Green Park huts it is considered too short a time to plan and manage USH drawdown and maintain the best interests of such a large community. This may put USH and Lower Selwyn Hut owners in competition for alternative housing solutions and government agency support at the same time. This option also requires the highest cost recovery factor for the Pines WWTP wastewater pipeline. Complete reticulation replacement will not be required.

4.14.2 **Option 2. 15 years – Recommended**

This option allows sufficient time to plan and manage USH drawdown and maintain the best interests of such a large community. This option will provide separation of competing housing interests between Lower Selwyn Huts and USH as they will close with five years apart. The Pines WWTP pipeline cost recovery factor is less onerous. The timeline is close enough to encourage community engagement towards a solution. Existing community wastewater reticulation could be maintained up to this point without complete replacement.

4.14.3 **Option 3. 20 years - Not recommended**

While this option provides more time for a drawdown project team to help owners make long term investment plans towards alternative solutions it will be difficult to engage owners so far away from an end date. There is a greater risk that climate related weather events will start to pose a health and safety risk which may require remediation costs. It is unlikely that the existing community wastewater reticulation could be maintained up to this point without complete replacement. This cost would fall to Council.

4.14.4 **Option 4. 30 years - Not recommended**

The existing community wastewater reticulation will require complete replacement. This cost would fall to Council. While this option provides significant time for a project team to help owners make long term investment plans towards alternative solutions it will be difficult to engage owners so far away from an end date. There is an increased likelihood that climate related weather events will pose a health and safety risk. Remediation cost may be prohibitive and prevent ongoing occupation. Complete reticulation replacement will be required.

4.14.5 **Option 5. In perpetuity – Not recommended**

Council decided in 2019 that any new DOL should be for a finite period. A grant of a Licence in perpetuity would be inconsistent with the principles of the Reserves Act 1977.

Transfer of Deed of Licence

4.15 Currently owners can sell their hut and apply for a transfer of DOL to a new owner. Considering the long-term future of the site it might be prudent to restrict the ability to transfer a DOL to create a 'sinking lid' on the number of huts at USH over time. The ability to restrict licence transfer could be initiated from 30 June 2024 or at a point in time in the future. Legal advice has advised that Council can restrict the ability to transfer licences as part of the new terms for the DOL.

4.16 Options are for DOL transfer are:

4.16.1 **Option 1.** Allow DOL transfers to any person for 15 years **– Not Recommended.**

Disadvantages - This perpetuates occupation until June 2039 and will result in a cliff edge moment which will present management challenges and leaves occupants competing for alternative accommodation options at the same time. Site remediation will not be able to commence until all huts have been removed. It is possible that a number of hut owners will abandon huts at the same time presenting considerable legal and remediation costs.

Advantages – Maintaining full occupancy retains a positive social aspect that would be lost with a dwindling population. Owners that decide to sell could do so and recover their capital value at any time. This option maintains a consistent number of hut owners who can contribute towards cost recovery for the new Pines WWTP pipeline. Owners can pass on a DOL to members for their family should they pass away.

4.16.2 **OPTION 2.** Prohibit DOL transfers from 30 Jun 24 **– Not Recommended**

Disadvantages - The value of huts will reduce significantly impacting on the financial situation of hut owners as they will be unable to recover their capital expenditure as any hut sold must be removed. This could potentially lead to huts being abandoned. An unknown sinking lid on hut numbers does not allow budgeting for cost recovery of the cost for the new Pines WWTP pipeline.

Advantages – The gradual removal of huts over time will avoid a 'cliff edge' moment and the associated challenges of all huts being removed at the same time. Council will learn from each individual hut removal and be able to apply lessons to the advantage of itself and hut owners.

4.16.3 **OPTION 3**. Phased transfers. It is proposed that up to June 2034 a DOL can be transferred to any person. After June 2034 until June 2039 DOL can only be transferred to an identified family member or significant person. – **Recommended**

Disadvantages - This perpetuates occupation until June 2034 and may result in surge of hut vacations at that point with the potential for hut owners to abandon huts at the same time presenting considerable legal and remediation costs. It will be challenging to establish the criteria for identified family members or significant persons. Cost recovery capacity for the WWTP will be reduced from 2034 as huts are vacated.

Advantages – Hut owners have 10 years to sell their huts on the open market should owners wish to do so. This will support occupancy and a fuller community which retains a positive social aspect that would be lost with a dwindling population. Avoids a cliff edge moment in Jun 2039 with all DOL ending at the same time. Affords stronger occupancy up to 2034 to support WWTP capital cost recovery. Supports a gradual drawdown of USH DOL in the last 5 years of the occupancy period if agreed at 15 years.

Current and residual hut value

4.17 The improvement value for a hut based on the current information held in the rates system ranges from $15,000 to $116,000 with an average of $50,000. This is not the value that a hut would sell for, it is the value assigned by Quotable Value either as part of the triennial revaluation or if revalued as a result of notified improvements. As soon as a finite lifespan for the USH is determined the market value of huts will be affected by the term of the licence granted. While some huts can be relocated, it may not be an economically viable option for all the huts

5. COMPLIANCE

5.1 Each hut is licenced to occupy 202 m^2 but it is important to remember that a licenced area does not mean that there is a legally surveyed area as each hut does not have a title. Permanent occupancy was never contemplated when the huts were initially allowed. Accordingly, the small amount of land area each hut was allocated, was of no concern.

5.2 The closeness of huts when permanent occupation occurs, causes issues specifically when the land area is only just adequate for the hut with limited spare space for a car or any type of storage. These physical conditions have required specific terms to be included in the licence to occupy which support good neighbour relations, from dog ownership, which is not permitted, to piling or storing materials that create a nuisance

Liability

5.3 On 22 February 2024 Council received legally privileged advice from Buddle Findley which outlined the risks associated with the Council not fulfilling its duty of care under the DOL. This advice covered issues associated with the following legislation:

Building Act 2004
Resource Management Act 1991
Reserves Act 1977
Property Law Act 2007
Health and Safety at Work Act 2015

The advice urged Council to continue to enforce the relevant provisions of the Hut owner's DOL in to protect its interests and limit lability. With regard to the RMA regulatory risks, it reinforced the importance of the Council continuing to take reasonable care to enforce relevant provisions of the DOL if the Council becomes aware that relevant consents and/or permissions have not been obtained in relation to the RMA.

5.4 Council has taken a consistent solutions-based approach where possible before considering more formal enforcement options when a breach of legislation has been discovered. A meeting on 24 November 2023 chaired by Head of Regulatory established that the main reason compliance was so challenging to enforce was due to the absence of a baseline condition report of each lot to fully understand which compliance issues exist. Initial conversations indicate a number of lots and structures fall short of the required standards, along with many of the requirements of the DOL. Council needs to ensure that it fulfils its responsibilities under the DOL and not rely on enforcement from Regulatory and Building teams as a default.

5.5 Currently compliance officers and environmental health officers visit USH on a reactive basis and work with individuals whose lots or structures are non-compliant to achieve a mutually satisfactory outcome. This work is exhaustive, time consuming and costly and frequently involves Council involving other agencies to support individuals whose lots are non-compliant.

Challenges

5.6 Compliance and other issues that present challenges for Council are:

5.6.1 Dangerous, affected and/or insanitary buildings – people who use the building can do so safely without endangering their health and can escape from the building if it is on fire.

5.6.2 Unauthorised building work - alterations and additions without approval under the DOL and/or building consent.

5.6.3 Lack of routine maintenance – Upkeep of the existing hut in good order.

5.6.4 Hoarding – Inside and outside creating conditions that contribute to an insanitary building or obstruct the public, create a nuisance, or constitute a 'fire hazard.'

5.6.5 Dogs - Keeping dogs on the reserve is not permitted.

5.6.6 Arrears - Most licence holders meet their financial obligations under the licence, some do not. There are a number of hut owners/residents who are in arrears with rates (3) and annual licence fees (13). Council has a process which it follows for debt recovery, however due to individual circumstances a number (6) individuals are in arears with licence fees between $2-5K. An important point to note is that an USH DOL does not provide the same security for arrears recovery that the Council would normally have when a rate is levied. There is no ability to place a charge on the land and remember that the Council owns the land. Claiming a hut and selling the hut is obviously an option but there would be a limited market for recovering costs. Council will need to exercise caution taking this issue forward in particular with vulnerable residents.

5.6.7 Potential fire risk - The risk of fire and its ability to spread quickly through the huts has been of concern to FENZ and Council for a long time. Ongoing monitoring of the reserve needs to be implemented to address issues as they occur (e.g., lawns mowed, no hoarding/buildup of combustible materials around huts). The risk being higher in the dry summer months particularly in La Niña periods with the east coast experiencing warmer than average air and sea temperatures and reduced rainfall.

5.6.8 Natural disaster risk – the risk of a significant flood or other natural disaster occurring within the next 15 years and how this will be responded to must be a consideration. Where a significant event occurs reoccupation and remedial work may be deemed inappropriate bringing the DOL to an end earlier.

5.7 Any occurrences in contravention to the licence can initiate a process that could result in a termination of a licence to occupy. However, the preferred option is to collaborate with owners to reach a solution. To date no licences have been terminated.

5.8 Council will need to carefully consider the related issues of non-compliance and the ability of owners to fund non-compliance or arrears issues. Owners may also be reluctant to invest in addressing non-compliance issues if they know that their licence is finite.

5.9 **It is recommended** that an inspection of each hut and surrounding lot be undertaken to understand the current condition of each. This will then form a baseline from which Council can consider a way forward. This has been included as a proposed term in the new Licence.

5.10 Council should be aware that any inspection may discover issues that require formal compliance action by staff. If owners do not make good, identified issues this could result in termination of a licence to occupy. Failure to take appropriate action to resolve issues of non-compliance will mean that the significant costs incurred inspecting the lots will have been wasted. If there is no will tackle non-compliance the inspection should not be conducted.

5.11 Considering the demographics of the USH population and potential costs involved in remedial work, Council may decide to allow a period of grace after the inspection to allow residents and owners time to rectify issues that do not pose an immediate threat to safety. It is recommended that compliance issues and the limited numbers of arrears cases are resolved with sympathetic deadlines. But all such issues should all be resolved as a condition of future DOL issue. However, it is accepted that in some instances immediate action may be required to allow continued occupation if serious safety issues are identified.

6. FUNDING IMPLICATIONS

Depending on Council decisions that are several short and long-term funding implications:

6.1. The Council has previously decided, and regularly confirmed, via Long Term Plan and Annual Plan consultation processes that the Selwyn Huts community will not be included within the district wide rating system for water or sewerage and during the draft annual plan preparation for 2019/2020, Councillors reconfirmed that decision. Reversing this decision will impact on current LTP planning.

6.2 There is a considerable cost associated with a complete inspection of USH and associated lots, this is in the region of a minimum of $41,500.00 in staff time to conduct the inspection and write up a basic report. Any non-compliances to be dealt with would require additional staff time on top of that and would require further support agencies involvement.

6.3 Conflicting interests and the complex history of the huts has incurred extensive legal costs over time resolving issues. In adopting a finite licence approach and a robust approach to resolve non-compliance issues it is highly likely that these costs will escalate.

6.4 If hut owners decide to leave USH their share of repayments towards the Pines WWTP connection will stop and fall to Council.

6.5 Faced with new financial responsibilities that make a hut owners continued occupation impossible they may abandon their hut. Pursuing former hut occupants for demolition or hut removal costs might not be economical. Council may consider it appropriate to include a 'bond' element with the future licences. This was proposed in April 2022 ($383 per year over 15 years to raise $5750). However, feedback from residents resulted in this proposal being withdrawn. While demolition, removal and remediation costs are likely to be greater than $5000 per site **it is recommended** that this sum is recovered for consistency of approach. This sum will need to be recovered over any agreed DOL period.

6.6 Any USH Project Team will investigate long term solutions to accommodate the best interests of USH owners. The Hurunui Council are pursuing a similar outcome for a beach community under threat of inundation by proposing a managed retreat and relocation option. The Hurunui Council are considering how funding tools can be used to support this managed retreat investing in this proposal. Summary information here

6.7 A summary of potential future costs is below based on the assumption that a DOL is granted for a maximum of 15 years.:

Issue	Approximate costs	Remarks
Initial inspection of huts and sites	$41,500	Remediation of subsequent issues will require funding by USH owners.
Legal costs	$50,000	Responding to challenges and ongoing support with DOL preparation
Communications	$10,000	Public engagement and paid for communications

Deficit offset if Council decides to only change a portion of the cost of the WWTP pipeline to USH owners.	$1M – 4.06M	Subject to Council decision
Project team costs over 15 years	Subject to Council Decision on duration of DOL	Ngah Tahu has a considerable administrative team engaged in the work to close Green Park huts

7 SUMMARY OF POTENTIAL HUT OWNER FEE INCREASES

7.1 The table below indicates a summary of all potential costs to USH owners at varying DOL durations for the recommended 50% recover of WWTP pipe costs.

Table 1 - Potential Annual USH costs based on Hut valued at $50K
50% of Wastewater Pipeline cost recovered.

Licence term	**Current costs**		**Potential costs**		Total payable
	Current Licence cost per annum (note 1)	Rates for 2024/25 applied draft LTP uplift. Not inflated for future years (note 2)	Pipeline recovery proposal (approx. interest of 6.5%) Per annum (note 3)	Demolition bond (see paragraph 6.5) Per annum	
5	$ 1389	$1,538	$5,071	$1,150	$9,149
10	$1,389	$1,538	$2,931	$575	$6,434
15	$1,389	$1,538	$2,241	$383	$5,552
20	$1,389	$1,538	$1,911	$288	$5,129
30	$1,389	$1,538	$1,403	$192	$4,944

Notes
1 & 2 Currently no incremental annual increase, this will need to be considered.

7.2 For comparison the table below indicates a summary of all potential costs to USH owners at varying DOL durations if 100% of WWTP pipe costs were recovered.

Table 2 - Potential Annual USH costs based on Hut valued at $50K **<u>100%</u> of Wastewater Pipeline cost recovered.**					
Licence term	**Current costs**		**Potential costs**		Total payable per annum
	Current Licence cost per annum (note 1)	Rates for 2024/25 applied draft LTP uplift. Not inflated for future years (note 2)	Pipeline recovery proposal (approx. interest of 6.5%) Per annum (note 3)	Demolition bond (see paragraph 6.5) Per annum	
5	$ 1389	$1,538	$10,143	$1,150	$14,220
10	$1,389	$1,538	$5,863	$575	$9,365
15	$1,389	$1,538	$4,483	$383	$7,793
20	$1,389	$1,538	$3,822	$288	$7,040
30	$1,389	$1,538	$2,807	$192	$6,347
Notes 1 & 2 Currently no incremental annual increase, this will need to be considered.					

REPUTATIONAL ISSUES & COMMUNICATION

8.1 The USH community has been strongly opposed to the closure of the huts. It is likely there will be resistance to proposals and that members of the community will seek wider public support.

8.2. It is imperative that impacted and wider Selwyn communities are well informed and understand the reasons for the proposals and that impacted owners and residents feel:

The process is transparent
They are well informed
They are supported
They have engagement with the process and feel involved

8.3 It is intended that an evolving and agile communications plan will seek to keep target audiences engaged and that information is readily available and clearly identified points of contact established. The demographics of the target audience will influence the channels though which information is exchanged.

8.4 The USH and other lake communities have been the focus of media attention for a long time. Elevated levels of media attention is anticipated at key decision points.

Tim Harris
EXECUTIVE DIRECTOR ENABLING SERVICES

Appendix 1 Letter extending licence to occupy to 30 June 2024

6 October 2022

All Hut Owners – Upper Selwyn Huts

Dear Sir/Madam

UPPER SELWYN HUTS – DEED OF LICENCE EXTENSION

As you know, the existing deed of licence for the Upper Selwyn Huts (**Huts**) expired on 30 June 2020.

Council staff reviewed the terms and conditions of the existing form of licence in 2021 but did not progress consultation with licensees as the future of wastewater management at the Huts was uncertain. In the meantime, the Council has permitted licensees to continue exercising their entitlements as licensee of the Huts pending the resolution of wastewater issues.

As noted in our update of 23 May 2022, the Council has agreed to connect the Ellesmere Wastewater Treatment Plant to the Pines Wastewater Treatment Plant in Rolleston via a pipeline along Leeston Road. Planning, design, costing and contract tendering is underway, and construction is expected during 2023/2024. This development means that the Huts could be connected to reticulated wastewater. This solution is anticipated to be more economic than a replacement onsite wastewater treatment option but the capital cost would still need to be recovered from the Huts community over time.

Notwithstanding Council's recent progress, it is aware that the Government's Three Waters Reform Programme will affect the future ownership and funding of water and wastewater infrastructure within the Huts community. Considering these uncertainties, the Council has not progressed renewed licence documentation for the Huts.

Once the above matters are resolved, the Council will be in a better position to confirm the tenure and terms and conditions of the Council's proposed new form of licence for the Huts. In the meantime, the Council appreciates that licensees require certainty about the future of the Huts community.

Accordingly, the Council has decided to extend the expiry date for all deeds of licence which were due to expire on 30 June 2020 until **30 June 2024.**

Please do not hesitate to contact me if you wish to discuss the issues covered in this letter.

Yours faithfully

Murray Washington
GROUP MANAGER – INFRASTRUCTURE AND PROPERTY

Appendix 2 Draft DOL

Dated 2024

DEED OF LICENCE
Upper Selwyn Huts

SELWYN DISTRICT COUNCIL
(Licensor)

THE PERSON(S) NAMED IN SCHEDULE 1 OF THIS LICENCE
(Licensee)

CONTENTS

DATED **2024**

PARTIES

1. **SELWYN DISTRICT COUNCIL** (**Licensor**)

2. **THE PERSON(S) NAMED IN SCHEDULE 1** (**Licensee**)

BACKGROUND

A. The Licensor manages the Reserve.

B. The Licensee's Previous Licence has expired and the Licensee is holding over and will come to an end on 30 June 2024.

C. The Licensee seeks a new licence to occupy for the Lot on the Reserve which the Licensor is prepared to grant subject to the terms and conditions of this Licence.

D. Climate change in the future means that the sea level will rise causing changes to the environment around Lake Ellesmere/ Te Waihora specifically resulting in the lake not being able to be opened to the sea as easily or possibly as often, thus resulting in the lake area likely increasing in volume and area and the water table lifting. This will effect the Upper Selwyn Huts community and Reserve.

E. The resource consent for the wastewater system that currently serves the Upper Selwyn Huts community expired in 2020, an extension of the consent was applied for until June 2024The extension of the consent ______has not been granted to date and is operating on a continuance of the previously ________granted consent. It is not feasible to renew this resource consent.

F. By decision of a full committee of Council on 8 May 2019, the Licensor resolved that any wastewater solution will be funded by the Licensees of the Upper Selwyn Huts community.

G. The Licensor's 2021/2031 long term plan provided:

> [The Council proposes to] [c]*connect the Upper Selwyn Huts settlement to the new pipeline from Ellesmere Wastewater Treatment Plant to Pines Wastewater Treatment Plant (as outlined above). This will have the additional benefit of allowing the Coes and Chamberlains Ford camping areas to connect, and will remove wastewater treatment facilities from near the Selwyn River. The connection is to be funded through the licence fee.*[1]

H. By decision of a full committee of Council on 15 November 2023, the Licensor resolved to approve additional funding towards the completion of the Ellesmere to Pines Waste Water Treatment Plant Pipeline and the Upper Selwyn Huts branch line. Council has determined that the cost of completing the section of the pipeline that services the Upper Selwyn Huts shall be recovered from each of the Licensees of the Upper Selwyn Huts community by way of a Wastewater Connection Contribution Payment.

I. [Wastewater details to be included]

[1] Page 27, Selwyn District Council Long Term Plan 2021-2031.

J. The Licensor considers that the connection to the Upper Selwyn Huts community to the Pines Wastewater Treatment Plant means that the Upper Selwyn Huts community may remain viable for the short term. On this basis, it is prepared to grant a further licence to the Licensee provided:

- The Licensee accepts the terms and conditions of this Licence;
- Due to the effects of climate change, the Licensee acknowledges and agrees that no further Licence will be granted beyond 30 June 2039;
- All regulatory requirements in relation to such licence, including but not limited to the Resource Management Act 1991, Building Act 2004 and any successor legislation, can feasibly and economically be complied with; and
- The Licensee bears its share of the costs for the connection of the Upper Selwyn Huts community to the Pines Wastewater Treatment Plant through a Wastewater Connection Contribution Payment.

TERMS AND CONDITIONS

1. DEFINITIONS AND INTERPRETATION

1.1 **Definitions**: In this Licence, unless the context otherwise requires:

(a) **Bond** means the bond to be paid, held and disbursed in accordance with clause 7. The Bond will be used to make good the condition of the Lot should a Licensee not meet their obligations pursuant to clause 28;

(b) **Commencement Date** means the date specified in Schedule 1;

(c) **Default Interest Rate** means the interest rate specified in Schedule 1;

(d) **Final Expiry Date** means the date specified in Schedule 1;

(e) **Law** includes all statutes, bylaws, regulations, orders, district and regional plans, other subordinate legislation of any type, and all common law, in force in New Zealand;

(f) **Licence** means this Deed of Licence;

(g) **Licence Fee Instalments** means the instalments specified in Schedule 1;

(h) **Licence Fee** means the amount specified in Schedule 1 and includes any variation in that amount following a Licence Fee Review;

(i) **Licence Fee Payment Dates** means the dates specified in Schedule 1;

(j) **Licence Fee Review** means a review of the Licence Fee determined in accordance with clause 9 of this Licence;

(k) **Licence Fee Review Date** means the date specified in Schedule 1;

(l) **Lot** means the area of land described in Schedule 1;

(m) **Other Charges** means the charges listed in clause 6 and this Licence;

(n) **Previous Licence** means the previous Deed of Licence for the Lot which comes to an end on 30 June 2024.

(o) **Reserve** means the reserve described in Schedule 1;

(p) **Renewal Dates** means the dates specified in Schedule 1;

(q) **Renewal Term** means the terms specified in Schedule 1;

(r) **Resident** means the Licensee specified in Schedule 1;

(s) **Residents Code of Conduct** means the Code of Conduct set out in Schedule 2;

(t) **Term** means the period of time specified in Schedule 1 and includes, where relevant, any period of renewal of the Term; and

(u) **Wastewater Connection Contribution Payment** means the amount specified in Schedule 1.

(v) **Working Day** means a working day as defined by the Local Government Act 2002.

1.2 **Interpretation**: In this Licence, unless the context otherwise requires:

(a) a reference to a party is a reference to a party to this Licence and includes that party's successors;

(b) schedules and annexures form part of this Licence and have effect accordingly;

(c) a provision of this Licence to be performed by two or more persons binds those persons jointly and severally;

(d) words in a singular number include the plural and vice versa;

(e) words importing a gender include all other genders;

(f) any reference to any Law includes any Law which amends or replaces it, as well as any subordinate Law made under it;

(g) where the Licensor's consent or approval is expressly required under a provision of this Licence, the Licensee must seek the consent or approval of the Licensor for each separate occasion it is required notwithstanding that the Licensor has granted consent or approval for a like purpose on a prior occasion;

(h) the word "including" and other similar words in this Licence do not imply any limitation; and

(i) words used in the Background to this Licence have the same meaning given to them in clause 1.1.

2. GRANT OF LICENCE

2.1 **Grant**: Pursuant to section 61 of the Reserves Act 1977, the Licensor grants, and the Licensee accepts, a licence to occupy the Lot subject to the terms and conditions contained in this Licence.

3. TERM

3.1 **Term**: The Licence commences on the Commencement Date and continues for the Term unless terminated early in accordance with the terms of this Licence.

4. LICENCE FEE

4.1 **Licence Fee**: The Licensee must pay:

(a) the Licence Fee to the Licensor in advance in the Licence Fee Instalments on the Licence Fee Payment Dates;

(b) any accrued Other Charges on their due date or otherwise invoiced by the Licensor upon demand; and

(c) any sums payable in accordance with clause 7.

5. RIGHTS OF RENEWAL:

5.1 **Preconditions**: On the expiry of the Term, and provided:

(a) The Licensee has complied with the obligations in clause 12;

(b) the Licensee has observed the terms and conditions contained in this Licence;

(c) the Licensor is satisfied, at its sole discretion, that the Licensee and his or her family and associates have the right to occupy no more than one lot on the Reserve;

(d) the Licensor considers in its sole discretion that the climate change effects to the Reserve and surrounding environment around Lake() Ellesmere / Te Waihora are such that that the grant of a further term of the Licence would not have any detrimental effect to Council's wider climate change considerations;

(e) the Licensee has given to the Licensor written notice of the Licensee's desire to continue to occupy the Lot beyond the Term at least three (3) months before the end of the Term; and

(f) the Licensor considers in its sole discretion that it is both feasible and desirable in all the circumstances as they exist at the time for occupation of the Reserve and the Lot to continue,

the Licensor may elect to renew this Licence on the Renewal Dates for the Renewal Term beginning on the day following the Termination Date of the then term.

5.2 **Extent of Renewals**: In no case may the Licensee obtain a renewal of this Licence for a period expiring later than the Final Expiry Date.

5.3 **Deed of Renewal**: The parties will enter into a deed of renewal recording the terms of the renewal prior to the Renewal Date.

5.4 **Review of Licence Fee on Renewal**: If this Licence is renewed under this clause 5, then

(a) **Determined as if Licence Fee Review**: the Licence Fee payable during that period will be determined using the terms of clause 9 as if the commencement date of the relevant Renewal Term were a Licence Fee Review Date; and

(b) **Further Reviews**: the Licence Fee payable during each Renewal Term will be subject to review on the Licence Fee Review Date(s); and

(c) **Ratchet**: The Licence Fee so determined must never be less than the Licence Fee payable immediately before the start of the relevant Renewal Term.

6. OTHER CHARGES AND PINES WASTEWATER CONNECTION CONTRIBUTION

6.1 In addition to the Licence Fee and any other charges or payments required to be made pursuant to this Licence, the Licensee must pay quarterly on the Licence Fee Payment Date during the Term (and any Renewed Term) of this Licence the Licensee’s Wastewater Connection Contribution Payment.

6.2 In addition to the Licence Fee, the Wastewater Connection Contribution and any other charges or payments required to be made pursuant to this Licence the Licensee must pay:

(a) all rates, levies, taxes, duties, assessments, charges and other outgoings which may be charged, levied or reasonably assessed or which may become payable by virtue of the Licensee’s occupation of the Lot; and

(b) all costs in relation to the supply/disposal of water, sewage, drainage and rubbish which are reasonably attributable to the Licensee's occupation of the Lot and are not otherwise included in any charges or assessments made by any authority or by the Licensor,

(c) on the 20th of the month following receipt of invoice.

6.3 The Licensee must pay all charges for electric power, water supply, telephone rental and other utilities supplied to the Lot. The Licensor will not be liable for any cost incurred in re-establishing the supply of any of these utilities if any of them become unavailable for any reason.

7. BOND

7.1 In addition to the Licence Fee, the Wastewater Connection Contribution Payment and Other Charges payable under this Licence, the Licensee must contribute towards the establishment of a Bond for the Lot.. The Licensee must pay:

(a) a sum on account of the Bond to be held by the Licensor at the amounts and intervals, and to the maximum limit, specified in Schedule 1, to be administered as follows:

(i) the Licensor may deduct any amount payable by the Licensee pursuant to clause 28 from the Bond and apply such sum towards the cost of completing such works and operations (and the Licensee shall, for the avoidance of doubt, remain liable to the Licensor for the cost of completing such works and operations if, and to the extent that, the Bond held by the Licensor is insufficient for these purposes);

(ii) any balance of the Bond held by the Licensor following deduction by the Licensor under clause 7.1(a)(i) shall be refunded to the Licensee within 20 Working Days of the completion of the works required pursuant to clause 28; and

(iii) this clause 7 shall not in any way limit, or prejudice the enforcement by the Licensor of, any obligation of the Licensee under this Licence.

7.2 The Licensor within 20 Working Days of receipt of a written request by the Licensee, but no more than annually, will provide the Licensee with a statement showing the Bond held and any deductions made by the Licensor.

8. PAYMENT

8.1 If the Licensee defaults in payment of the Licence Fee or other moneys payable under this Licence for:

(a) 10 Working Days after the due date for that payment; or

(b) the date of the Licensor's demand;

then the Licensee shall pay on demand:

(c) interest at the Default Interest Rate on the moneys unpaid from the due date for payment until the date of payment; and

(d) Any administrative, legal or other costs, charges or expenses incurred by or for which the Licensor becomes liable as a result of the Licensee's breach of the Licence terms.

8.2 The Licence Fee and all other moneys payable under this Licence shall be paid by way of direct debit or by any other manner directed by the Licensor and without any deductions or set-off.

9. LICENCE FEE REVIEW

9.1 The Licensor may review the Licence Fee on the Licence Fee Review Dates in the following manner:

(a) the Licensor will commence the review not earlier than 3 months before a Licence Fee Review Date and no later than 9 months following the Licence Fee Review Date by giving written notice to the Licensee;

(b) subject to clause 9.1(e), the notice must specify the Licence Fee which the Licensor considers to be the market value for the licence of the Lot as at the Licence Fee Review Date;

(c) if, within 20 Working Days of receipt of the Licensor's notice, the Licensee gives written notice to the Licensor that the Licensee disputes the proposed new Licence Fee the new Licence Fee is to be determined in accordance with clause 9.3;

(d) if the Licensee does not give notice to the Licensor under clause 9.1(c) the Licensee will be deemed to have accepted the Licence Fee specified in the Licensor's notice; and

(e) notwithstanding clause 9.1(b), the new Licence Fee so determined or accepted must not be less than the Licence Fee payable during the year preceding the particular Licence Fee Review Date and will be the Licence Fee payable by the Licensee from the Licence Fee Review Date.

9.2 Until determination of the new Licence Fee, the Licence Fee payable by the Licensee from the Licence Fee Review Date is to be the Licence Fee specified in the Licensor's notice. On determination of the new Licence Fee an adjustment is to be made and paid, either by the Licensor or by the Licensee, whichever is applicable.

9.3 Immediately the Licensee gives notice to the Licensor under clause 9.1(c), the parties will endeavour to agree on a new Licence Fee. If the parties are unable to reach agreement within 20

Working Days the new Licence Fee is to be determined as follows by registered valuers acting as experts and not as arbitrators as follows:

(a) each party will appoint a valuer and give written notice of the appointment to the other party within 10 Working Days of the parties agreeing to determine the new Licence Fee by this means;

(b) if the party receiving a notice does not appoint a valuer within the 10 Working Days period the valuer appointed by the other party is to determine the new Licence Fee and that valuer's determination will be binding on both parties;

(c) before commencing their determination the respective valuers must appoint an umpire who need not be a registered valuer;

(d) the valuers are to determine the new Licence Fee which they consider to be the market value for the licence of the Lot as at the Licence Fee Review Date but in no case is the new Licence Fee to be less than the Licence Fee payable during the year preceding the particular Licence Fee Review Date;

(e) if the valuers fail to agree, the Licence Fee is to be determined by the umpire and that determination will be binding on both parties;

(f) each party is to be given the opportunity to make written or verbal representations or submissions to the valuers or the umpire subject to such reasonable time and other limits as the valuers or the umpire may prescribe;

(g) the valuers or the umpire must have regard to any such representations but will not be bound by them; and

(h) the valuers or umpire must give written notice to the parties once they have determined the new Licence Fee and such notice is to provide how the costs of the determination are to be borne and is to be binding on the parties.

10. BUILDING WORKS

10.1 The Licensee must not carry out any alterations, additions, or erect a fence or other structure on the Lot without the prior written consent of the Licensor.

10.2 The Licensee must, upon request by the Licensor, submit written building plans and other details to the Licensor for approval before commencing any works.

10.3 In giving approval under clause 10.1, the Licensor may, in the Licensor’s sole and absolute discretion, impose any reasonable terms and conditions as the Licensor considers appropriate.

10.4 The Licensee must pay all costs (including any cost reasonably incurred by the Licensor) associated with applications for consent and approval to carry out works under this clause.

10.5 When undertaking any building works, the Licensee must comply with all statutory requirements including obtaining building consents and code compliance certificates as required under the Building Act 2004.

10.6 If the Licensee removes any improvements from the Lot the Licensee will, unless the Licensor approves otherwise in writing, repair and make good at the Licensee's own expense all damage which may have been done by the removal and will leave the Lot in a clean and tidy condition. For the avoidance of doubt, this obligation includes (but is not limited to):

(a) Removal of any foundations; and

(b) In ground services capped appropriately.

10.7 Should the Licensee fail to comply with clause 10.6, the Licensor may undertake whatever works and operations are necessary to effect the same and all costs and expenses incurred in doing so shall be payable by the Licensee to the Licensor upon demand.

11. EXISTING HUT AND STRUCTURES

11.1 The Licensee shall maintain the existing hut and any improvements together with any fences, gates or other structures now existing or which may be erected on the Lot in good order and repair, in a neat, tidy, and sanitary condition and complies in all respects with the Building Code and any By-Law, Policy or otherwise of the Licensor, to the satisfaction of the Licensor.

11.2 Subject to the Licensor providing to the Licensee reasonable notice, the Licensor and the Licensor's employees and agents may, at all reasonable times, enter the Lot to view its condition and the condition of the hut and any improvements.

12. LICENSOR INSPECTION PROGRAMME

12.1 The Licensee acknowledges and agrees that within twelve (12)months of the Commencement Date of this Licence the Licensor will complete a full building and maintenance inspection of the existing hut and any other structures on the Lot to determine compliance with the Building Act 2004.

12.2 Subject to the Licensor providing to the Licensee reasonable notice, the Licensor and the Licensor's employees and agents may, at all reasonable times, enter the Lot for the purposes of completing this inspection and any follow up inspections required.

12.3 Following completion of the inspection, the Licensor will provide a written report to the Licensee of any remedial works required (if any) to the existing Hut and other structures on the Lot to ensure compliance with all relevant legislation.

12.4 The Licensee agrees to, at its cost, to complete all remedial works required within the timeframe advised by the Licensor and Licensee as part of the inspection programme.

12.5 If the Licensee does not complete the remedial works required within the agreed timeframe, the Licensor may at its sole discretion terminate this Licence by giving no less than twenty (20) working days notice to the Licensee.

13. LICENSEE'S FURTHER OBLIGATIONS

13.1 The Licensee must at the Licensee’s expense:

(a) take all steps necessary to control any pest, insect or rodent infestation occurring in or emanating from the Lot, and if required by the Licensor, engage a pest exterminator approved by the Licensor;

(b) hold and maintain all approvals, authorities and consents required to occupy and use the Lot including, where required, any discharge consents; and

(c) comply with all requirements of the Licensor, any competent authority and with all Laws applicable to the occupation and use of the Lot, including all bylaws and fire safety requirements.

13.2 The Licensee may use the Lot for residential occupation only. No business may be operated from the Lot.

13.3 The Licensee must at all times comply with the Residents Code of Conduct set out in Schedule 2 of this Licence and any amendment thereto.

13.4 The keeping of dogs on the Lot is strictly prohibited, in accordance with the Selwyn District Dog Control Bylaw 2012.

13.5 The Licensee must ensure that it or its invitees do not carry out any acts prohibited under this Licence.

14. PROTECTION OF THE ENVIRONMENT

14.1 Except as approved in writing by the Licensor, the Licensee will not, whether by act or omission:

(a) interfere with, remove, damage, or endanger the natural features, animals, plants, or historic resources on the Reserve;

(b) deposit on the Reserve debris, rubbish or other dangerous or unsightly matter, or contaminate the Reserve or any water body in or under the Reserve;

(c) pile or store materials in any place on the Reserve where it may obstruct the public or create a nuisance;

(d) conduct any noxious, noisome, dangerous, illegal or offensive activity on the Reserve, and generally the Licensee shall utilise its rights under this Licence in a clean, quiet and orderly manner free from damage, nuisance, disturbance or annoyance to any persons; or

(e) carry out any business occupation on the Reserve.

14.2 The Licensee shall dispose of all refuse and recycling material in the receptacles provided or otherwise in accordance with the directions of the Licensor.

15. PROTECTION FROM FIRE

15.1 The Licensee must:

(a) Install and maintain in any Hut or other structure on their Lot an operational fire / smoke alarm;

(b) use best endeavours to ensure no fire hazards arise from its occupation or use or from any act or neglect of its invitees;

(c) not light or permit to be lit any fire on the Reserve without the written permission of the Licensor; and

(d) not store or permit to be stored fuels or other combustible materials on the Reserve without the written permission of the Licensor. In that event storage of fuels and combustible materials is approved it must be in accordance with the provisions of all Laws including the Hazardous Substances and New Organisms Act 1996. For the avoidance of doubt, the Licensee may keep firewood on the Lot provided that the firewood is stored in a manner to mitigate any fire risk to the Lot and Reserve.

16. WATER, SEWER AND SANITARY

[Draft – subject to final instructions being received]

16.1 The Licensee shall:

(a) meet the Licensor's costs of, or incidental to, approving any application or undertaking any works on behalf of the Licensee;

(b) undertake any works affecting the lateral pipelines in accordance with required consents or conditions of consent including any building consents;

(c) keep any lateral pipelines which service the Lot in a state of good order and repair, free of any infiltration and obstructions; and

(d) ensure that storm water is not discharged from the Lot into the waste water system.

16.2 The costs of resolving any problems relating to a lateral pipeline shall be:

(a) shared equally between licence holders where the issue relates to a shared section of lateral pipeline from the common junction to the main pipeline; and

(b) individually the responsibility of the licence holder where the issue relates to a licence holder's section of lateral pipeline above the common junction.

16.3 For the avoidance of doubt, all reticulated water and sewage systems servicing the Reserve and the Lot, are and shall remain, the sole and unencumbered property of the Licensor, irrespective of the grant of, or the payment of any amount required under, this Licence.

17. TREES AND SHRUBS

17.1 Any trees, shrubs or hedge plants which have the potential to shade adjoining lots shall not be allowed to grow beyond a height of 2.2 metres.

17.2 The planting of willow, poplar and cabbage trees is strictly prohibited.

17.3 Any new plantings must be low flammability species only as determined by Fire and Emergency New Zealand from time to time. A list of approved low flammability species can be obtained from Fire and Emergency New Zealand’s website (Flammability of Plant Species | Fire and Emergency New Zealand)/.

18. ADVERTISING

18.1 The Licensee must not erect or display any signs or advertising on the Lot or Reserve

19. COMPLIANCE WITH LEGISLATION

19.1 The Licensee shall abide by all relevant statutory and common law obligations of the Licensor, and shall not of itself do, nor shall it permit or suffer to be done, any act that comprises a breach of such obligations. The Licensee shall comply with all relevant legislation and regulations directly or indirectly relating to or touching upon its use or occupation of the Lot and Reserve, including without derogating from the generality of the foregoing compliance with the provisions of the relevant District Plan, the Building Act 2004, Health Act 1956, Litter Act 1979, and the Health and Safety at Work Act 2015 (HSW Act), including any consequent amendments and enactments passed in substitution.

19.2 The Licensee will do all things necessary as the occupier of the Lot to comply with the HSW Act, including any consequent amendments and enactments passed in substitution thereof, including but not limited to:

(a) take all steps reasonably practicable to ensure that any person in or on the Lot or the Reserve is not harmed by any Hazard arising in or on the Premises. “Hazard” shall have the same meaning as in the HSW Act;

(b) take all reasonable steps to protect the safety of all persons present on the Lot and the Reserve; and

(c) take all reasonable steps to eliminate any dangers to the public and must clearly and permanently mark any that remain and of which the Licensee is aware.

19.3 The Licensee must as soon as reasonably possible notify the Licensor of anything on the Reserve or the surrounding area which may endanger the public or the environment.

20. VEHICLES, BOATS AND TRAILERS

20.1 There are to be no more than two motor vehicles parked on the Lot at any time. This excludes the motor vehicles belonging to any visiting invitees of the Licensee.

20.2 All motor vehicles brought onto the Lot are to have a current warrant of fitness and vehicle registration, unless an exemption through NZTA has been issued.

20.3 Any caravans, buses, boats or trailers brought onto the Lot are to have a current electrical certificate, current warrant of fitness and registration.

20.4 The subleasing or hiring of motor vehicles, caravans and buses on the Lot is strictly prohibited.

21. TEMPORARY SUSPENSION

21.1 Without prejudice to any other rights or remedies under this Licence, the Licensor may temporarily suspend this Licence if, in the reasonable opinion of the Licensor:

(a) there is a temporary risk to public safety or the safety of the Licensee or any other licence holders whether arising from natural events such as earthquake or flood or whether arising in any other way including the activities of the Licensee or its invitees;

(b) there is a serious breach of clauses 11, 12, 13, 14 and/or 19 such that the hut and/or the Lot should not be occupied; or

(c) the activities of the Licensee or its invitees in breach of clause 14.1(d) unreasonably interfere with the quiet enjoyment of other licence holders.

21.2 The Licensor may suspend this Licence while the Licensor investigates any of the circumstances contemplated in clauses 21.1 and also where reasonably required while the Licensor investigates any potential breach by the Licensee or its invitees of which the Licensor has become aware.

21.3 During any period of temporary suspension:

(a) the Licensee shall vacate the Lot and not re-enter the Lot unless and until directed to do so by the Licensor;

(b) except where the temporary suspension is due to acts or omissions of the Licensee or its invitees, the Licence Fee payable by the Licensee is to abate in fair proportion to the loss of use by the Licensee; and

(c) Other Charges and amounts payable in accordance with clauses 6 and 7 shall in all cases continue to be payable unless and to the extent the Licensor decides otherwise in its reasonable discretion.

21.4 The Licensor is not to be liable to the Licensee for any loss sustained by the Licensee by reason of the suspension of the Licence under this clause 21.

22. CONSENT TO OCCUPATION OR TRANSFER

22.1 From the Commencement Date to 30 June 2034, the Licensee is not to transfer, sublicence, rent or hire out, assign, mortgage or otherwise dispose of the Licensee's interest under this Licence or any part of it without the prior written consent of the Licensor, which shall only be available in respect of a transfer or occupation and in accordance with the requirements of this clause 22.

22.2 From 1July 2034 to 30 June 2039, the Licensee is not to transfer, sublicence, rent or hire out, assign, mortgage or otherwise dispose of the Licensee’s interest under this Licence or any part of it without the prior written consent of the Licensor, which shall only be available in respect of a transfer or occupation of the Lot where the intended occupant is a family member of the Licensee, and in accordance with the requirements of this clause 22.

22.3 The consent of the Licensor to the occupation of the Lot by a person other than the Licensee will only be available where the Licensor is satisfied in its sole discretion that:

(a) the number of persons occupying the Lot will remain appropriate;

(b) the transferee or assignee (together with their family members and associates) will not, following the transfer or assignment, occupy or have the right to occupy more than one lot on the Reserve;

(c) the occupant provides evidence to the satisfaction of the Licensor that they can ~~is likely to be able to~~ comply with all obligations of the Licensee under this Licence;

(d) the transferee or assignee is not an Overseas Person as defined by the Overseas Investment Act 2005; and

(e) the occupant has, where required by the Licensor, enters into a document required by the Licensor under which it agrees to be bound by all obligations of the Licensee under this Licence.

22.4 The Licensee shall ensure that any occupant of the Lot complies at all times with all obligations of the Licensee under this Licence. For the avoidance of doubt, any obligations owed by an occupant directly to the Licensor are additional to, and not in substitution for, the obligations of the Licensee under this License, and the Licensor may accordingly enforce any breach by an occupant against the Licensee, the occupant, or both.

22.5 The consent of the Licensor to a transfer by the Licensee of the Licensee's interest under this Licence will only be available where the Licensor is satisfied, in its sole discretion, that the intended transferee is ~~likely to be~~ able to comply with all obligations of the Licensee under this Licence, and has entered into a new licence with the Licensor for the balance of the current Term, such new licence to otherwise be on the same terms and conditions as this Licence.

22.6 In addition to the other requirements of this clause 22, the Licensor may, in considering whether to grant consent, require such inspection(s) of the hut and/or the Lot as it sees fit to establish whether the hut and/or the Lot are compliant with this Licence, with particular regard to clauses 11, 12, 13 and 14. Where the hut and/or the Lot are not compliant, the Licensor may, for the avoidance of doubt, require that such non-compliances are rectified as a condition of the consent.

22.7 The Licensee must pay any consent fee prescribed by the Licensor and any costs reasonably incurred by the Licensor in relation to any consent under this clause 22.

23. DAMAGE OR DESTRUCTION

23.1 If the Hut or any portion of the Hut is destroyed or so damaged that the Hut cannot be used, then either party may terminate this Licence by twenty (20) Working Days written notice to the other party. Any termination of this licence under this clause will not affect the parties' respective rights, obligations and liabilities which subsist or have accrued on the date of termination under this clause. Any repair or rebuild/reinstatement in accordance with clause 23.1 shall be undertaken by the Licensee in accordance with clause 9.3(h).

24. TERMINATION

24.1 If:

(a) the Licence Fee under this Licence is unpaid and remains unpaid for 10 Working Days after service on the Licensee of a written notice pursuant to section 245 of the Property Law Act 2007;

(b) the Licensee has not complied with the Licensee's obligations in this Licence after service on the Licensee of a written notice pursuant to section 246 of the Property Law Act 2007 specifying the default and requiring the default to be remedied within a period which the Licensor considers to be reasonable in the circumstances; or

(c) the Licensor determines that it is no longer:

(i) economically feasible; or

(ii) lawful,

to provide water, wastewater or other infrastructure services to the Lot,

then the Licensor may by notice in writing cancel this Licence and re-enter the Lot. The Term shall terminate upon the cancellation but without prejudice to the rights of either party against the other.

25. LICENSOR MAY REMEDY LICENSEE'S DEFAULT

25.1 The Licensor may elect to remedy at any time without notice any default by the Licensee under this Licence at the Licensee's cost provided that where it is able and safe to do so in the circumstances, the Licensor shall first endeavour to give the Licensee notice of such election.

25.2 The Licensee must pay to the Licensor forthwith on demand all reasonable costs and expenses incurred by the Licensor, including legal costs and expenses as between solicitor and client, in remedying such default.

26. QUIET ENJOYMENT

26.1 The Licensee, while paying the Licence Fee, Wastewater Connection Contribution Payment, Bond, Other Charges and all other payments and charges due under this Licence, and performing and observing the terms and conditions of this Licence, is entitled peaceably to hold and enjoy the Lot without hindrance or interruption by Licensor or by any person or persons claiming under the Licensor until the expiry or termination of this Licence.

27. INDEMNITY

27.1 The Licensee will indemnify and keep indemnified the Licensor against all claims made by any person in respect of any injury, loss, or damage, including fire, caused or suffered as a result of or arising out of any acts or omissions of the Licensee or its invitees or otherwise caused as a consequence of its occupation of the Lot.

28. EXPIRY OF LICENCE

28.1 At the expiry or termination of the Term, the Licensee must quietly yield up the hut and any improvements on the Lot in the same good and substantial repair and condition as they were in at the Commencement Date, fair wear and tear excepted.

28.2 The Licensor may direct that the hut and any improvements remaining on the Lot at the expiry or termination of this Licence, be removed by the Licensee at the Licensee's cost. The Licensee will in complying with such direction repair and make good at the Licensee's cost all damage which may have been done by the removal and will leave the Lot in a clean and tidy condition.

28.3 Where the Licensor does not make a direction under clause 28.2, the hut and any improvements remaining on the Lot at the expiry or termination of this Licence will be deemed to be fixtures and property in them will vest absolutely in the Licensor and the Licensor will not be liable to pay compensation to the Licensee for the hut and improvements.

28.4 Where the Licensee fails to comply with a direction under clause 28.2, the Licensor may undertake whatever works and operations are necessary to effect the same and all costs and expenses in doing so shall be deducted from the Bond held and any balance payable by the Licensee to the Licensor upon demand.

29. SURVIVAL

29.1 Following expiry or termination of this Licence, clauses 7, 8, 27 and 28 together with other provisions that are by their nature intended to survive, will remain in effect.

30. FORCE MAJEURE

30.1 Neither party will be liable to the other party for any delay in performance, of or failure to perform, its obligations (other than a payment of money) under this Licence as a result of any cause beyond its reasonable control.

31. NO WARRANTY BY LICENSOR AND OWN RISK

31.1 The Licensor does not warrant that the Lot is or will remain suitable or adequate for the Licensee's purposes. All warranties as to suitability and adequacy implied by law are expressly negatived to the full extent permitted by law.

31.2 The Licensee enters into this Licence on the understanding that because of its proximity to Te Waihora (Lake Ellesmere), the Reserve and the Lot may be subject to flooding from time to time.

31.3 The Licensee acknowledges and accepts all risks, and occupies the Lot at their own risk. The Licensor expressly excludes to the greatest extent permissible by Law all liability, for any loss, damage or injury of any kind caused howsoever in relation to the occupation and use of the Reserve or the Lot by the Licensee or their invitees.

32. NOTICES

32.1 All notices including requests, demands and other communications under this Licence, to be given by a party to any other party must be in writing and:

(a) signed by the party itself or on its behalf by its solicitor or (in the case of the Licensor) other authorised person; and

(b) given or served:

(i) in the manner provided in the Property Law Act 2007 where that Act applies; or

(ii) in all other cases, by personal delivery, receipted courier pack or email to the recipient's address for service or as otherwise directed by the relevant party, or (in the case of a notice from the Licensor to the Licensee) by being prominently affixed to the hut or other structure or vehicle on the Lot.

32.2 Any notices under clause 32.1(b)(ii) will be deemed given, served and received:

(a) when personally delivered or affixed; or

(b) in the case of email, when acknowledged by the addressee except that return emails generated automatically shall not constitute an acknowledgement.

32.3 Unless and until changed under this clause, the addresses for service of the parties are as set out in Schedule 1. A party may, by notice to the other, change its address for service.

33. COSTS

33.1 The Licensee must pay on demand all costs and fees (including Council staff and contractor's costs, solicitors' costs on a solicitor/client basis and/or the fees of debt collecting agencies engaged by the Licensor) arising out of and associated with steps taken by the Licensor:

(a) to enforce or attempt to enforce the Licensor's rights and powers under this Licence; and/or

(b) to recover outstanding money owed to the Licensor under this Licence.

34. WAIVER

34.1 No failure by a party to exercise, or delay in exercising (in whole or in part) any right, power or remedy under, or in connection with, this Licence shall not operate as a waiver of that right, power or remedy. A waiver of any breach of any provision of this Licence shall not be effective unless that waiver is in writing and signed by the party against whom that waiver is claimed. A waiver of any breach shall not be, or be deemed to be, a waiver of any other or subsequent breach.

35. SEVERABILITY

35.1 Any illegality, or invalidity or unenforceability of any provision in this Licence is not to affect the legality, validity or enforceability of any other provisions.

36. ENTIRE UNDERSTANDING AND NO REPRESENTATIONS

36.1 Except as provided by Law, this Licence and any written variation agreed by the parties contain the entire understanding between the parties with reference to the subject matter of this Licence and there is no other agreement, representation or warranty whether it is expressed or implied which in any way extends, defines or otherwise relates to the provisions of this Licence.

36.2 The Licensee acknowledges that it has not relied on any statement or representation by the Licensor.

37. THE LICENSOR ACTING AS TERRITORIAL AUTHORITY

37.1 The Licensee acknowledges that:

(a) The Licensor, in its capacity as territorial authority (the **Council**), is required to carry out its statutory consent functions under the Reserves Act 1977, Resource Management Act 1991, the Building Act 2004 and the Conservation Act 1987 in accordance with the provisions of those and other Laws.

(b) The granting by the Council of any consent or approval by the Council as territorial authority under those Acts or any other Laws, will not of itself be deemed to be a consent or approval by the Licensor under this Licence.

(c) The Council is bound by statutory obligations to exercise its powers, including discretionary powers and duties under those Acts or any other Laws without regard to any relationship it may have with the Licensee under this Licence.

38. DISPUTE RESOLUTION

38.1 If there is a dispute between the parties in relation to this Licence, either party may give the other party notice specifying the matter in dispute.

38.2 **Good Faith:** Within 10 Working Days of receipt of the notice of dispute, each party must nominate one person who will have authority to settle the dispute. The nominated persons must try in good faith to resolve the dispute within 20 Working Days of their nomination.

38.3 **Mediation**: If the dispute is not resolved within 30 Working Days of receipt of the notice of dispute, either party may by notice to the other party refer the dispute to mediation. The mediation will be in Christchurch and conducted under the Arbitrators' and Mediators' Institute of New Zealand Incorporated (**AMINZ**) standard mediation protocol. If the parties do not agree on a mediator or the mediator's fees within 5 Working Days of receipt of the notice of mediation, the mediator shall be appointed or the fees set by the President of AMINZ (or his/her nominee) at the request of either party.

38.4 While any dispute remains unresolved each party shall continue to perform this Licence to the extent practicable, but without prejudice to their respective rights and remedies.

38.5 Nothing in this clause 38 will preclude a party from seeking urgent interlocutory relief before a court, or preclude the Licensor from taking proceedings for the recovery of any Licence Fee or other monies payable under this Licence which remain unpaid or from exercising the rights and remedies under clauses 21 or 24 .

39. LICENCE NOT REGISTRABLE

39.1 The Licensee acknowledges and agrees that this Licence is not registrable. The Licensee must not require registration of this Licence.

40. NO CAVEAT

40.1 The Licensee must not register or cause to be registered a caveat over the title(s) to the Reserve relating to the Licensee's interest under this Licence.

EXECUTION

THE COMMON SEAL of)
SELWYN DISTRICT COUNCIL was)
hereto affixed in the presence of:)

____________________________ Mayor / Councillor

____________________________ Councillor / Authorised Officer

SIGNED by)
the **LICENSEE**)
in the presence of)

____
Signature

____
Witness signature

____
Print Licensee's Name

____
Full Name

____
Address

____
Occupation

SCHEDULE 1

1. **Licensee:**

2. **Reserve:** Sections 1 and 2 Survey Office Plan 457605being approximately 3.4 hectares in area. The definition of *the Reserve* shall for the purposes of clauses 14 and 15 extend to include all adjoining or nearby land of the Licensor.

3. **Lot:** of the Reserve as shown on the **attached** plan having valuation number .

4. **Previous Licence:** Licence of the Lot dated which expired on .

5. **Commencement Date:** 1 July 2024.

6. **Term:** five (5) years commencing on the Commencement Date.

7. **Renewal Dates:** 1 July 2029 and 1 July 2034

8. **Renewal Terms**: two (2) rights of renewal of five (5) years each

9. **Final Expiry Date**: 30 June 2039

10. **Licence Fee:** $ per annum payable quarterly in advance payable on 1 July, 1 October, 1 January and 1 April in each year of the Term including any Renewed Term.

11. **Wastewater Connection Contribution Payment**: [Drafting Note – instructions required]

12. **Licence Fee Review Date:** [Drafting note – instructions required]

13. **Bond:** $ per quarter on account of the Bond payable in accordance with clause 7.1(a) until the

14. **Default Interest Rate:** 10% per annum

15. **Address for Notices:**

    Licensor:

    Selwyn District Council
    2 Norman Kirk Drive
    Rolleston 7614

    Licensee:

16. **Additional Agreed Terms:** The following terms (if any) are specific to this Licence:

SCHEDULE 2 – RESIDENTS CODE OF CONDUCT

These Rules are designed to ensure that the community life at Upper Selwyn Huts and the Reserve is maintained and that an environment exists that is conducive for everyone to have quiet enjoyment of their Lot and to have positive social experiences in the Reserve. The underlying principle is consideration for others. These Rules are formulated with a view to the safety and welfare of all Upper Selwyn Huts Residents, consideration for the needs of others, and the protection of property and the Reserve. The rules are intended to benefit all Residents.

The expectations of Residents outlined in the Rules should not be seen as an exhaustive list. By entering into this Licence, you become a member of the Upper Selwyn Huts residential community and accept the responsibilities and obligations of being a good neighbour and citizen, whether or not they are detailed in the Rules.

If you fail to comply with these Rules and any updated or variation of them, it will constitute a failure by you to comply with the provisions of your Licence and may lead to termination of your Licence to Occupy.

General Behavioural Rules

All Residents of the Upper Selwyn Huts community, agree to behave in such a way that makes the community safe, inclusive and equitable for all.

- You must not act in an insulting or threatening manner towards any resident or visitor at the Reserve.
- You are expected to respect the rights of others in the community and to act in a supportive, responsible manner.
- You may not enter another Licensee’s Lot without their express prior permission.
- If you are party to any offence under these Rules committed by another resident or guest, you shall be deemed to have committed the breach. For the purpose of these Rules, ‘party’ includes any Licensee who in any way aids, assists, counsels, procures, or encourages another to commit an offence under these Rules.
- You are responsible not only for your behaviour but that of your partner, children, and guests. This includes any actions which may threaten the safety and wellbeing of residents, their guests, Council staff members, and/or the property, which may result in the termination of your Licence.
- Criminal acts will be reported to the Police.

Bully, Harassment, Harmful Sexual Behaviour and Discrimination

Bullying is any repeated unreasonable behaviour that is directed towards a person, or group of people, that can lead to physical or psychological harm. This includes cyberbullying.

Harassment is unreasonable or unwelcome conduct that is offensive, humiliating or intimidating to any other person and is either repeated, or of such significant nature that it has a detrimental effect on the person, their performance or their work and study environment. It includes gender-based, racial, and sexual harassment.

Discrimination can occur when a person is treated less favourably than another person, in the same or similar circumstances, because of a prohibited ground such as their sex, colour, religious belief, race, marital status, ethnic or national origins, family status, ethical belief, sexual orientation, political opinion, age, employment status or disability.

Harmful sexual behaviour including sexual harassment, sexual assault, and bullying of any kind, undermines safety and respect, and may be a breach of this Licence.

Bullying, harassment of any kind and discrimination have no place within the Upper Selwyn Huts community.

- You must not behave towards other residents in any way that may constitute harassment, bullying or discrimination.
- Any serious incidents of harassment, bullying or discrimination will be reported to the Police.
- Any serious incidents of harassment, bullying or discrimination may lead to the immediate termination of your Licence, at the Licensor’s sole discretion.

Noise

- Out of consideration to your fellow residents, you may not make excessive or disruptive noise at any time.
- You must exercise extra restraint between 10.00pm and 7.00am when most other residents are likely to be sleeping. This includes weekends and public holidays.
- You are also expected to take some responsibility for the noise around you, by asking others to be quiet when they are being unreasonably noisy or unintentionally disruptive.
- You must lower your noise level when asked to by other residents.
- Residents should consider using alternative external venues if they wish to have several guests at one time as the amount of noise generated by more than one guest generally exceeds acceptable noise levels.
- If you experience problems with the volume of noise that you cannot solve, contact Council's Noise Control service as outlined in Schedule 3.

Drugs

Any potential drug related matters will immediately be referred to the Police.

- Non-prescribed or illegal drugs are strictly forbidden on the Reserve and on your Lot at all times.
- You may not possess, cultivate, manufacture, use and/or distribute any non-prescribed or illegal drugs.
- You may not distribute prescribed drugs.
- Any paraphernalia which assists in the inhalation or consumption of drugs is prohibited.
- If you are discovered possessing, using or selling such substances your Licence may be terminated on 24 hours and you may face possible criminal prosecution.

Smoking

- Smoking is not permitted on the Reserve.
- Any person is entitled to request courteously that smoking on the Reserve cease.
- Any person who receives a request not to smoke is expected to respond cooperatively and courteously, and to comply with the request.

Safety and Security

- You must ensure that you have a working fire alarm / smoke detector installed in your Hut at all times.
- You must behave in a responsible manner and ensure your actions do not put yourself or others at risk.
- You may not have or use fireworks in and around your Lot or on the Reserve. All fireworks are strictly forbidden at all times.

Changes to Rules

The Licensor reserves the right to amend or add to these Rules at any time.

All current Licensee will be notified of any amendment or addition to Rules before they come into force.

At the Licensor's sole discretion, residents will be consulted on rules changes in advance but there is no obligation for the Licensor to do so.

SCHEDULE 3 – WHO TO CONTACT AND WHERE TO GO FOR HELP

The purpose of this Schedule is to provide all Residents with guidance on where they may be able to seek help for specific matters, if needed. The list below is a non-exhaustive list and is intended to be of a guidance nature only and should not substitute a Resident seeking specialist advice.

IF IT IS AN EMERGENCY – DIAL 111

MATTER	WHO TO CONTACT
Non urgent Police matters	Call: 105 Report online at www.police.govt.nz/use-105
No urgent medical matters	Call your Doctor or Phone Healthline for free advice on 0800 611 116
Mental Health Helplines	There are several helplines that you can call: **1737, need to talk?** If you feel anxious, down, a bit overwhelmed, or just need someone to talk to, call or txt 24 hours a day, 7 days a week. 1737 is staffed by a team of paid counsellors who can talk to you if you have mental health or addiction problems. • Call: 0800 1737 1737 • Text: 1737 • 1737 — Need to Talk?(external link)↗ **Depression helpline** The Depression Helpline is a free helpline that you can call or txt 24 hours a day, 7 days a week. It has trained counsellors who can talk you through your problems and suggest help in your area. • Depression helpline(external link)↗ • Call: 0800 111 757 • Text: 4202 **Youthline** Any young person in New Zealand, or anyone supporting a young person, can call Youthline for help 24 hours a day, 7 days a week. You can txt between 8am and midnight. You can chat online with a counsellor from 5pm to 9pm through the Youthline website. You can also email any time. • Youthline(external link)↗ • Call: 0800 376 633 • Text: 234 **The Lowdown** The Lowdown team are an experienced group of counsellors. They are available 24 hours a day, 7 days a week. You can contact them any time by txt or by email from their website.

	• The Lowdown(external link)↗ • Text: 5626 **General alcohol drug helpline** • Alcohol drug helpline(external link)↗ • Call: 0800 787 797 • Text: 868
Ombudsman New Zealand	Call: 0800 802 602 Email: info@ombudsman.parliament.nz
Hut Licence Fee enquiries	Email: accounts.receivables@selwyn.govt.nz
Rates Enquiries	Email: revenue@selwyn.govt.nz
Reserve Maintenance / Public Toilets	reserves@selwyn.govt.nz or contactus@selwyn.govt.nz
Compliance (Vehicles / parking)	parking@selwyn.govt.nz
Compliance (Building)	Building.compliance@sewlyn.govt.nz
Building Enquiries (General)	Building.technical@selwyn.govt.nz
Water / Wastewater / Stormwater (Repairs and Maintenance)	Water.services@selwyn.govt.nz
Noise Control	Call: 0800 SELWYN (735 996)
Stopbank / River Issues	Environment Canterbury Call: 0800 324 636 Email: ecinfo@ecan.govt.nz
Dogs	
Clause 19 Health & Safety notifications	

SCHEDULE 4 - PLAN

Appendix 3 Aqualinc Report - Impact of Climate cycles and trends on Council Assets 2023 Update

aqualinc

water & soil intelligence

REPORT

IMPACT OF CLIMATE CYCLES AND TRENDS ON COUNCIL ASSETS 2023 Update

PREPARED FOR

Selwyn District Council

WL23041

07/09/2023

PREPARED BY

Nick Dudley Ward

Ayaka Kashima

Ross Hector

Greg Hatley

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aqualinc.com

Quality Control

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DOCUMENT CONTROL

Version Number	Date	Name
1	30 June 2023	Draft for SDC comment
2	7 September 2023	Final

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Aqualinc has produced two previous reports for Selwyn District Council on the impact of climate cycles and trends on water infrastructure: *Impacts of Climate Cycles and Trends on Selwyn District Water Assets*. The first report was completed in 2016, and an update was completed in 2020.

These previous reports compared future climate projections to 2050 with historical data, which aligned with the timeframe for SDC's Long Term Plan (LTP). Furthermore, they focused solely on SDC's Five Waters assets (water supply, wastewater, stormwater, land drainage and water races).

This report is an update of the previous two reports, with historical climate data extended to 2023. It differs from the previous reports in the following significant ways:

- expansion of the range of SDC assets considered to include roading, facilities and open spaces,
- consideration of risks from non-SDC assets,
- extension of the analysis timeframe for climate future projections to 2100, and
- places greater focus on climate projections than historic data.

Since the 2020 report, several important international and national reports have been published, with the most notable being Assessment Report 6 (AR6) which is the most detailed synthesis of climate change science. While broadly consistent with AR5 (published in 2013/2014), its conclusions are expressed with significantly greater confidence and sense of urgency. The main message from this report is that climate futures are highly dependent on emissions scenarios, and therefore highly uncertain. Under all scenarios, climate change means more volatility in weather patterns with a greater incidence of extreme events.

Assessments of climate impacts and their associated risks on SDC assets are summarised in Table 1 and Table 2. There levels of risk have been assigned ('low', 'medium' and 'high'). There is inevitably a high degree of subjectivity in the assignment of risk level, which has been carried out in consultation with SDC staff. Most environmental factors assessed as high risk relate to the occurrence of extreme events like extreme rainfall, drought, or high wind. Of substantially greater importance than the assignment of absolute risk is the relative risk between different asset classes and different environmental factors.

This assessment should be compared with Tonkin and Taylor's *Canterbury Climate Change Risk Assessment.* This report differs substantially from the T+T report for several reasons including:

- difference of spatial scale – the T+T report covers all of Canterbury and includes all stakeholder and asset owner interests. This report is focused solely on the Selwyn District and the council's assets.
- granularity – Selwyn district is partitioned into three zones (high country, plains and low plains/coastal) and an assessment of risks to assets has been given for each zone.

The T+T report has four risk levels ('low', 'moderate', 'high' and 'extreme') instead of three. As an example of the difference between the current report and the T+T report, risk to groundwater availability due to sea level rise is assessed as 'extreme' for all climate futures in the T+T report whereas we have assessed it to be low / medium (but with substantial uncertainties). Sea level rise (SLR) poses a significant risk to shallow coastal groundwater systems but since SDC groundwater is sourced from relatively deep bores our assessment is that (moderate) SLR will not significantly impact SDC's potable water supply, projecting to 2050.

Zone	Environmental factor	Water	Wastewater	Stormwater	Land drainage	Water races
All zones	Temperature (excl. ET impacts)	Medium	Medium	Medium	Medium	High
	Annual rainfall	Low	Low	Low	Low	Low
	Drought	High	Low	Low	Low	Medium
	Evapotranspiration (ET)	Medium	Low	Low	Low	Low
	Wind (excluding ET impacts)	Medium	Medium	Low	Low	Low
	Alpine river flows	Medium	Low	Low	Low	High
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	High	High	High	High
	Foothills-sourced river flows	High	Low	Low	Low	High
	Snow levels and ice	Low	Low	Low	Low	Low
Plains	Extreme rainfall events (Plains)	Low	High	High	High	High
	Snow levels and ice	Low	Low	Low	Low	Low
	Ground water levels (upper /mid plains)	Medium	Low	Low	Low	Low
Coastal and lower plains	Sea Level rise	Low	Medium	Medium	High	Low
	Extreme rainfall events (Coastal)	High	High	High	High	Medium
	Groundwater levels (Lower Plains)	Low	Low	low	Medium	Low

Table 1. Summary risk assessment of climate change impacts on SDC water assets projecting to 2050.

Zone	Environmental factor	Transportation	Community facilities	Developed open spaces	Natural open spaces
All zones	Temperature (excl. ET impacts)	High	High	High	Medium
	Annual rainfall	Low	Low	Low	Low
	Drought	Low	Low	High	Medium
	Evapotranspiration (ET)	Low	Low	Medium	Low
	Wind (excluding ET impacts)	Low	High	High	High
	Alpine river flows	Medium	Low	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	High	High	High
	Foothills-sourced river flows	High	High	High	Medium
	Snow levels and ice	Low	Low	Low	Low
Plains	Extreme rainfall events (Plains)	High	High	High	High
	Snow levels and ice	Low	Low	Low	Low
	Ground water levels (upper /mid plains)	Low	Low	Low	Low
Coastal and lower plains	Sea Level rise	Medium	Medium	High	Medium
	Extreme rainfall events (Coastal)	High	High	High	High
	Groundwater levels (Lower Plains)	Low	Low	Medium	Low

Table 2. Summary risk assessment of climate change impacts on SDC transportation, community, and open space assets projecting to 2050.

The key messages of this report are summarised below:

Temperature

- Over the last 100 years New Zealand has warmed by an average of 1°C.
- Future annual average warming in Canterbury spans a wide range: 0.5-1.5 °C by 2040, and 0.5-3.5°C by 2090, depending on the greenhouse gas emission scenario.
- By 2040, seasonal mean temperatures across much of Canterbury are projected to increase by 0.5-1.5°C under RCP4.5. By 2090 they are projected to increase by 1.5-3.0°C under RCP8.5, with increases of 3.0-4.0°C for westernmost pasts of Canterbury.

- The number of hot days is projected to increase by 10-20 days by 2040 for the Selwyn District under both RCP4.5 and 8.5. By 2090 the number of hot days is projected to increase by 10-60 days.
- The number of frost days is projected to decrease by 10-30 frost days per year for inland parts of the region. By 2090 the number of frost days is projected to decrease by 20-50 days for inland areas of Canterbury.

Evapotranspiration

- By 2040, both RCP4.5 and RCP8.5 project an accumulated potential evapotranspiration deficit (PED) of 50-100 per year for most eastern parts of Canterbury.
- By 2090 under RCP8.5 5, PED is projected to increase by 100-200 mm per year for many inland areas of the Selwyn District.
- Historical PET records suggest that rates have not changed significantly over the period 1960-2023.

Annual rainfall

- Annual rainfall is projected to change by between ±5% for most of Canterbury by 2040 and 2090.
- Winter rainfall is projected to increase considerably by 2090 under RCP8.5 in many eastern, western and southern parts, with 15-40% more rainfall projected.

Dry days

- By 2040, under RCP4.5 the annual number of dry days is projected to decrease by up to 5 days for eastern parts of the District and the Plains, while increasing by a smiliar amount elsewhere.
- By 2090, under RCP8.5 this is projected to change by up to ±15 days.

Extreme rainfall

- Extreme rainfall events are expected to increase everywhere in New Zealand.
- With 2°C warming, projections of the increase in 50-year Rx1 day and Rx5 day events for New Zealand are inconsistent.
- With 4°C warming, models project a median increase in the intensity and frequency of heavy precipitation of more than 15% in the 50-year Rx1 day and Rx5 day events compared to the 1°C warming level.

Snow and windspeed

- The number of snow days is projected to decrease throughout the district, with the largest reductions of the order of 10-25 days in higher elevation areas.
- Annual mean wind speed is projected to increase 2-10% for much of the district under RCP8.5.

Groundwater

- Groundwater levels in bores drilled into deeper aquifers are projected to decrease, with a greater frequency of lower water levels.
- Groundwater levels in shallow coastal bores are projected to increase slightly due to sea level rise (SLR).
- SLR will lead to a greater risk of saline intrusion near the coast, but the extent and magnitude has a high degree of uncertainty.

River flows

- Historical river flow data in the Selwyn District does not indicate any long-term trends.
- Mean annual flows in the alpine rivers (Waimakariri and Rakaia) are projected to increase by 3% by the 2040’s, as a result of increased alpine precipitation. The greatest increases are likely to occur in winter.
- Foothill river flows may slightly decrease over the next 30 years, due to a small increase in evapotranspiration.
- Towards 2100, the annual cycle of river flows may be significantly modified and is highly dependent on climate future.

Sea level rise

- In the last 60 years, sea levels have risen by 2.44 mm per year (0.14 m total). If global emissions remain high, sea levels will increase by a further 0.21 m by 2040 and 0.67 m by 2090 (MfE, 2020).
- Sea levels are projected to rise by up to 0.90 m by 2100 under RCP8.5.
- ESL (extreme sea level) events that are historically rare will become common by 2100 under all emissions scenarios.
- With SLR, saltwater intrusion into coastal and surface waters and soils is expected to be more frequent and enter farther inwards.
- Sea level rise (SLR) may result in Te Waihora / Lake Ellesmere needing to be opened more often or managed under a new operating range. If global emissions remain high, and without any change in lake management, lake levels are projected to rise by 0.21 m by 2040 and 0.67 m by 2090.

Risk assessment of SDC assets

Summary tables of risk assessments for SDC assets are given in Tables 1 and 2. The following comments apply to all asset classes:

- Projecting to 2050, environmental factors assessed as high risk of impacting SDC assets relate to the occurrence of more extreme weather events.
- Projecting to 2100, climate change impacts on SDC assets are highly dependent on emissions scenario.
- In all emissions scenarios, the occurrence of extreme weather events is likely to increase.

Comments specific to asset classes are given below:

Potable water supply

- Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.

Wastewater

- Higher alpine rainfall and flood flows will likely result in an increase of stormwater inflows for the Arthurs Pass, Castle Hill and Lake Coleridge wastewater systems.
- An increase in sea level rise of ~0.21 m may impact Upper Selwyn Huts and Rakaia Huts wastewater systems.
- Projecting to 2100, climate change impacts on SDC wastewater assets are highly dependent on emissions scenario.

Stormwater

- Higher alpine rainfall and extreme rainfall events may result in an increase in occurrence of surface flooding at Arthurs Pass, Castle Hill and Lake Coleridge.
- An increase in sea level rise of ~0.21 m may impact the efficacy of the stormwater system during coastal storm events at Rakaia Huts.

Land drainage

- Higher alpine rainfall and extreme rainfall events may result in an increase in occurrence of surface flooding in the Arthurs Pass land drainage (flood protection) systems.
- An increase in sea level rise of ~0.21 m will impact Te Waihora /Lake Ellesmere levels and parts of the land drainage network.

Water races

- An increase in alpine flood flows could result in an increase in flood damage to intakes. Conversely, higher alpine flows would improve reliability of water supply.
- A potential minor reduction in flows in the Kowai River may impact supply reliability.

Transportation assets

- Under all emissions scenarios, the incidence of extreme events is expected to increase resulting in more frequent road closures.
- Flood events previously categorised as 1 in 100 year events may become 1 in 10 year events

Facilities and open spaces

- Under all emissions scenarios, the incidence of extreme events is expected to increase resulting in more frequent inundation of areas.
- More frequent occurrence of extreme events will impact on building envelopes and systems, and the accessibility and usability of facilities that are required as part of emergency response.

Recommendations and limitations

This report reviewed many information and data sources. Projected climate futures were used to assess risks to SDC assets as defined in the scope of this report. The aim of this exercise is to help SDC asset managers and planners prioritise resilience planning. This report provides a high-level assessment of climate change impacts that is meant as a guide for this moment in time. Projected climate futures may not be how the future climate eventuates, and recent collective global experience suggests that impacts may be accelerating. We therefore recommend a review and rescoping of this work within two years, with a significant focus on adaptation.

Projecting even into the near future, the biggest uncertainty is groundwater. This is because groundwater systems are hidden from sight, and it is difficult to monitor effects.

The impact of sea level rise on (especially) shallow coastal groundwater systems is a very significant uncertainty. Given that large-scale saline contamination and soil degradation through salination is likely to be effectively irreversible, we recommend further investigation on the Selwyn District's coastal groundwater and sea level rise. The purpose of this is to provide recommendations to better monitor the state of shallow coastal groundwater systems, to enable early warning of severe impacts and more robust decision-making in the future.

1 INTRODUCTION

This section provides summaries of:

- **Previous reports and revised scope for present report,**
- **Recent national and international reports on Climate Change,**
- **Risk assessments of SDC assets, and**
- **Document structure.**

Aqualinc has produced two previous reports for Selwyn District Council on the impact of climate cycles and trends on water infrastructure: *Impacts of Climate Cycles and Trends on Selwyn District Water Assets*. The first report was completed in 2016 while an update was completed in 2020.

These reports compared future climate projections to 2050 with historical data, which aligned with the timeframe for SDC's Long Term Plan (LTP). Furthermore, they focused solely on SDC's Five Waters assets (water supply, wastewater, stormwater, land drainage and water races).

This report is an update of the previous two reports, with historical climate data extended to 2023. It differs from them in the following significant ways:

- expansion of the range of SDC assets considered to include roading, facilities and open spaces,
- consideration of risks from non-SDC assets,
- extension of the analysis timeframe for future projections to 2100,
- and places greater focus on climate projections than historic data.

Since the 2020 report, several important international and national reports have been published:

- In 2021-2023 the International Panel on Climate Change (IPCC) published Assessment Report 6 (AR6) which is the most detailed synthesis of climate change science. While broadly consistent with AR5 (published in 2013/2014), its conclusions are expressed with significantly greater confidence and sense of urgency, as will be discussed in the next section.
- Furthermore, the Ministry for the Environment published *National Climate Change Risk Assessment for New Zealand* (MfE, 2020) which is an important point of reference for the current report**.**
- Given that downscaled climate change projections for New Zealand using AR6 have not yet been made available, the MfE has also issued *Aotearoa New Zealand climate change projections guidance* (MfE, 2022), which provides a distilled summary and interpretation of the AR6 findings that are relevant to New Zealand. This report states that *'overall future regional projections using CMIP6 [Coupled Model Intercomparison Project Phase 6] global projections over New Zealand, excluding extremes, are expected to be similar to previous versions, but perhaps with areas of improved confidence and clarity'*. This report uses a combination of information from assessment reports based on AR5 and AR6.
- We also reference extensively NIWA's 2020 report *Climate change projections for the Canterbury Region,* based on a downscaling of AR5.

While it is important to understand climate change impacts in the context of historical climate, the planet is undergoing unprecedented and rapid climate and environmental changes that are not reflected in the last 100 years of historical data. So, while a particular extreme weather event may be comparable in magnitude to previous observed events, extreme weather events are projected to become more frequent. For example, events which were regarded as 1 in 100-year events will, in time, become closer to 1 in 10-year events. This important uncertainty ('in time') is a critical factor in risk management. Table 3 and Table 4 provide an overall risk assessment for SDC water, transportation, community facility and open space assets, categorised by zone (hills and high country, plains and coastal) and environmental factor. Most factors assessed as high risk relate to the (projected) increased occurrence of extreme weather events and to sea level rise.

Zone	Environmental factor	Water	Wastewater	Stormwater	Land drainage	Water races
All zones	Temperature (excl. ET impacts)	Medium	Medium	Medium	Medium	High
	Annual rainfall	Low	Low	Low	Low	Low
	Drought	High	Low	Low	Low	Medium
	Evapotranspiration (ET)	Medium	Low	Low	Low	Low
	Wind (excluding ET impacts)	Medium	Medium	Low	Low	Low
	Alpine river flows	Medium	Low	Low	Low	High
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	High	High	High	High
	Foothills-sourced river flows	High	Low	Low	Low	High
	Snow levels and ice	Low	Low	Low	Low	Low
Plains	Extreme rainfall events (Plains)	Low	High	High	High	High
	Snow levels and ice	Low	Low	Low	Low	Low
	Ground water levels (upper /mid plains)	Medium	Low	Low	Low	Low
Coastal and lower plains	Sea Level rise	Low	Medium	Medium	High	Low
	Extreme rainfall events (Coastal)	High	High	High	High	Medium
	Groundwater levels (Lower Plains)	Low	Low	low	Medium	Low

Table 3. Summary risk assessment of climate change impacts on SDC water assets projecting to 2050.

Zone	Environmental factor	Transportation	Community facilities	Developed open spaces	Natural open spaces
All zones	Temperature (excl. ET impacts)	High	High	High	Medium
	Annual rainfall	Low	Low	Low	Low
	Drought	Low	Low	High	Medium
	Evapotranspiration (ET)	Low	Low	Medium	Low
	Wind (excluding ET impacts)	Low	High	High	High
	Alpine river flows	Medium	Low	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	High	High	High
	Foothills-sourced river flows	High	High	High	Medium
	Snow levels and ice	Low	Low	Low	Low
Plains	Extreme rainfall events (Plains)	High	High	High	High
	Snow levels and ice	Low	Low	Low	Low
	Ground water levels (upper /mid plains)	Low	Low	Low	Low
Coastal and lower plains	Sea Level rise	Medium	Medium	High	Medium
	Extreme rainfall events (Coastal)	High	High	High	High
	Groundwater levels (Lower Plains)	Low	Low	Medium	Low

Table 4. Summary risk assessment of climate change impacts on SDC transportation, community, and open space assets projecting to 2050.

An overview of the document structure is given in Table 5. Each section begins with a short summary or key messages with sections being largely self-contained.

Report Section No.	Topic	Purpose
1	Introduction	Previous reports, purpose, summary risk matrices.
2	Climate Change Science and AR6	Overview of AR6 and related reports.
3	Climate Cycles and Variability	Overview of climate patterns.
4	Historical Data	Sources of historical data.
5	Temperature	Summaries of historical data and projected climate futures.
6	Evapotranspiration	
7	Rainfall	
8	Other Climate Variables	
9	Groundwater	Modelled groundwater system responses to climate change futures and irrigation.
10	River Flows	Summaries of historical data and projected climate futures.
11	Sea Level Rise	Sea level rise (SLR) and secondary impacts.
12	Te Waihora/Lake Ellesmere	
13	Rakaia Mouth	
14	Rakaia Huts	
15	Groundwater and Sea Level	
16	Potable Water Supply	Projected impacts of climate change on SDC assets and risk assessments.
17	Wastewater	
18	Stormwater	
19	Land Drainage	
20	Water Races	
21	Transportation Assets	
22	Facilities and Open Spaces	
23	Non-SDC assets	
24	Recommendations and limitations	
25	References	
	Appendix A	IrriCalc model.
	Appendix B	Groundwater model calibration.

Table 5. Report structure.

2 CLIMATE CHANGE SCIENCE AND AR6

2.1 International and national reports

The basis of the 2020 *Impacts of Climate Cycles and Trends* report was the International Panel on Climate Change (IPCC) assessment report AR5 (2013/2014) and a Ministry for Environment report *Climate Change Projections for New Zealand* (2016) based on AR5.

In 2021-2023 the IPCC published updated AR6 synthesis reports. The overall conclusions of AR5 and AR6 remain the same: the world is warming with human activities being the primary cause, but at a rate faster than previously estimated and with a higher incidence of extreme events. However, conclusions are expressed with significantly greater confidence in AR6, with many conclusions strengthened. Additionally, projections and estimates of temperature increase are slightly higher than in AR5. For example, AR6 concludes that the world has already warmed by 1.1°C since pre-industrial times, compared to 0.85°C in AR5.

AR6 states that *'it is unequivocal that human influence has warmed the atmosphere, ocean, and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred*'. Notably, AR6 observes that each of the last four decades has been successively warmer than any decade that preceded it since 1850.

The biggest driver of climate change is the increase in atmospheric concentrations of greenhouse gases, primarily carbon dioxide (CO_2), that result from human activities, such as burning fossil fuels for energy (coal, oil, and natural gas), deforestation, and industrial processes. These greenhouse gases trap heat in the atmosphere, causing the Earth's temperature to rise and leading to a range of impacts including sea level rise, more frequent and intense heatwaves, more severe storms, and changes in precipitation patterns.

To estimate impacts of Climate Change in the future, AR5 used four Representative Concentration Pathways (RCPs). These are standardised scenarios which model different trajectories of greenhouse gas emissions and their potential impacts on the climate system:

- **RCP2.6**: This is the most optimistic scenario, in which greenhouse gas emissions peak around the year 2020 and then decline rapidly, leading to a world in which global warming is limited to below 2°C above pre-industrial levels by the end of the century.
- **RCP4.5**: This scenario assumes that greenhouse gas emissions continue to rise until around mid-century, and then gradually decline due to a combination of technological change, policy measures, and behavioural changes. It assumes that the world will warm by about 2°C above pre-industrial levels by the end of the century, but that this warming will be limited to below 2°C if additional measures are taken.
- **RCP6.0**: This scenario assumes a more moderate level of greenhouse gas emissions, with emissions continuing to rise until around mid-century and then declining more slowly than in RCP4.5. It assumes that the world will warm by about 3°C above pre-industrial levels by the end of the century, but that this warming could be limited to below 2°C if aggressive mitigation measures are taken.
- **RCP8.5**: This is the most pessimistic scenario, in which greenhouse gas emissions continue to rise throughout the 21st century, largely driven by a reliance on fossil fuels and limited mitigation efforts. It assumes that the world will warm by about 4°C above pre-industrial levels by the end of the century, with significant impacts on ecosystems, food production, and human health.

RCP4.5 and RCP8.5 were considered in the 2020 report. In 2020 the RCPs were replaced by Shared Socioeconomic Pathways (SSPs) and include five scenarios: SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. The principal difference is that the SSPs consider broader socioeconomic and political trends that could affect the trajectory of emissions, for example, future demographic trends, economic development, energy use, land use, and technological change. Broadly speaking the conclusions drawn from the SSPs are consistent with those from AR5.

The 2022 Ministry for the Environment report *Aotearoa New Zealand climate change projections guidance* provides a summary and interpretation of AR6 relevant to New Zealand. Table 6 shows the difference between projected global mean warming between AR5 and AR6. Note that the 'envelopes of uncertainty' in brackets are slightly smaller in AR6 than in AR5, while the level of confidence expressed has also increased in AR6 ('likely range' to 'very likely range'). Table 7 shows projected changes in New Zealand temperatures for mid-century and end of century under a range of SSPs. The report notes that *'New Zealand regional air temperature* *is projected to increase slightly less than the global mean, reflecting the large oceanic influence on New Zealand climate*'.

Table 6. Projected global mean warming in 2081-2100, relative to 1850-1900, in AR5 and AR6. The AR5 values are originally relative to the mean temperature of 1986-2005. Following AR5, 0.6°C has been added to represent warming between 1850-1900 and 1986-2005. 'SPM' refers to the WG1 Summary for Policymakers reports for AR5 and AR6. (Table 1 from MfE, 2022).

End-of-century nominal radiative forcing (W m^{-2})	Warming in 2081-2100 (°C) under RCP scenarios (likely range; AR5 table SPM.2)	Warming in 2081-2100 (°C) under SSP scenarios (very likely range; AR6 table SPM table B.1.2)
1.9		1.4 (1.0-1.8)
2.6	1.6 (0.9-2.3)	1.8 (1.3-2.4)
4.5	2.4 (1.7-3.2)	2.7 (2.1-3.5)
7.0		3.6 (2.8-4.6)
8.5	4.3 (3.2-5.4)	4.4 (3.3-5.7)

Table 7: Projected New Zealand region annual mean air temperature change (over land and sea) relative to 1995-2014 average. Values in parentheses indicate the 10-90 percentile range spanned by the ensemble of CMIP6 models. (Table 2 from MfE, 2022).

NZ region	Mid century	End of century
SSP1-2.6	+0.75°C (0.39 to 1.06°C)	+0.8°C (0.47 to 1.46°C)
SSP2-4.5	+1.0°C (0.60 to 1.32°C)	+1.6°C (1.03 to 2.26°C)
SSP5-8.5	+1.3°C (0.91 to 1.66°C)	+3.1°C (2.20 to 4.05°C)

2.2 Regional reports

In their 2020 report *Climate change projections for the Canterbury Region*, the National Institute of Water & Atmospheric Research (NIWA) presented future climate predictions for Canterbury at a 5 km x 5 km resolution, based on downscaling global climate model simulations using representative RCPs from AR5. The general picture is of a shift upwards of daily temperatures, along with an increase in the range of likely temperatures, leading to a higher incidence of extreme events: more heat waves, coastal flooding and changing seasonality (MfE, 2020).

Some of the most noteworthy conclusions of the NIWA report are:

- Diurnal temperature range (the difference between minimum and maximum daily temperatures) is expected to increase over time with increasing greenhouse gas concentrations.
- The average number of hot days (≥25°C) is projected to increase over time and emission scenario. The number of hot days in some inland areas of Canterbury are projected to increase by 60-85 days per year by 2090 under the most extreme scenario RCP8.5, while the number of frost days (<0°C) are expected to decrease, with largest decreases in inland areas.
- Projected changes to rainfall show considerable variability across the region with small changes of ±5% in annual rainfall projected by 2040 and 2090. The largest changes are expected during winter with 15-40% more rainfall projected in many eastern, western and southern parts by 2090 under RCP8.5.
- Projected increase in potential evapotranspiration deficit (PED) leading to increased drought potential.
- Floods are expected to become larger for many parts of Canterbury.

Tonkin + Taylor published *Canterbury Climate Change Risk Assessment* in 2022. This was the result of extensive consultation and assessed a very broad range of risks for all stakeholder and asset owner interests. This risk assessment differs from ours in terms of scope and detail. The T+T report is global in terms of stakeholders and risks. The current report focuses entirely on SDC assets and our assessment of risk is relative to these assets and consequently differs from the T+T assessment. For further details we refer to section 15.

3 CLIMATE CYCLES AND VARIABILITY

3.1 Climate and weather patterns

The terms 'climate' and 'weather' are often used interchangeably but differ significantly in their scope and duration. Weather refers to atmospheric conditions in a particular place at a specific time and includes short-term variations (on a daily or hourly timescale) in precipitation, humidity, wind speed, cloud cover and atmospheric pressure.

Climate, on the other hand, refers to long-term patterns and variability of atmospheric conditions observed over a significant a period, typically 30 years or more.

While much of the variation in New Zealand's climate is random and lasts only for short periods, our climate is heavily influenced by three large-scale oscillations:

- El Niño-Southern Oscillation (ENSO),
- Interdecadal Pacific Oscillation (IPO), and
- Southern Annular Mode (SAM)

These processes have substantial quasi-cyclic impacts on our climate and weather patterns. The year-to-year climate of New Zealand will continue to be impacted by this natural variability in the future. Consequently, those engaged in planning and managing climate-sensitive infrastructure and activities in the Canterbury region will have to manage and adapt to the combined effects of both human-induced changes and natural variability. It is therefore helpful to review historical data in combination with projected climate futures.

3.2 Climate change

Climate change refers to long-term shifts in global or regional climate patterns, primarily caused by human activities such as the burning of fossil fuels, deforestation, and industrial processes which has resulted in observed global warming since pre-industrial times. As a result of global warming, temperature, precipitation, and wind patterns, as well as other aspects of the Earth's climate system have changed and continue to change.

While climate models and standardised scenarios (like the RCPs or SSPs) provide valuable information on climate futures, there remains considerable uncertainty especially when projecting to the end of the 21st century. This is shown, for instance, by the envelopes of uncertainty of mean annual temperatures shown in Table 6 and Table 7. There is compounding uncertainty about the higher incidence and magnitude of extreme events like floods and droughts which are associated with global warming. This makes assessing the impact of climate futures 30 years and 70 years ahead in the Selwyn District and the management of assets very challenging.

Although an increasing trend in annual mean temperature is observed in the Canterbury region, and New Zealand generally, since the start of records, the natural variability of climate variables like temperature, together with the problem of extrapolation into the future, make it impossible to attribute individual recent extreme events to climate change using current data. Furthermore, climate change is about a change in the statistical distribution of events and while, on a global and national scale, we are observing more extreme events like floods and droughts, there is considerable uncertainty about the likely distribution of extreme events for climate futures in 2050, and even more in 2100. For these climate futures we need to rely on climate model projections and, while downscaled projections for New Zealand based on AR6 have not yet been released, it has already been noted above that the conclusions of AR5 and AR6 are broadly consistent. In the following sections we will therefore refer extensively to the NIWA report *Climate change projections for the Canterbury Region* which, as mentioned above, is based on AR5.

A useful way to visualise the impacts of climate change is shown in Figure 1. The blue curve represents the distribution of current daily temperatures, while the red curve represents the distribution for a climate future in which the planet is warmer by, say, 1.5°C. The most important thing to note is that along with the shift towards hotter temperatures, the red curve has been stretched out. Thus, there is a bigger range of temperatures - more hot days and fewer cold days. In short, we can expect more volatility in weather patterns.

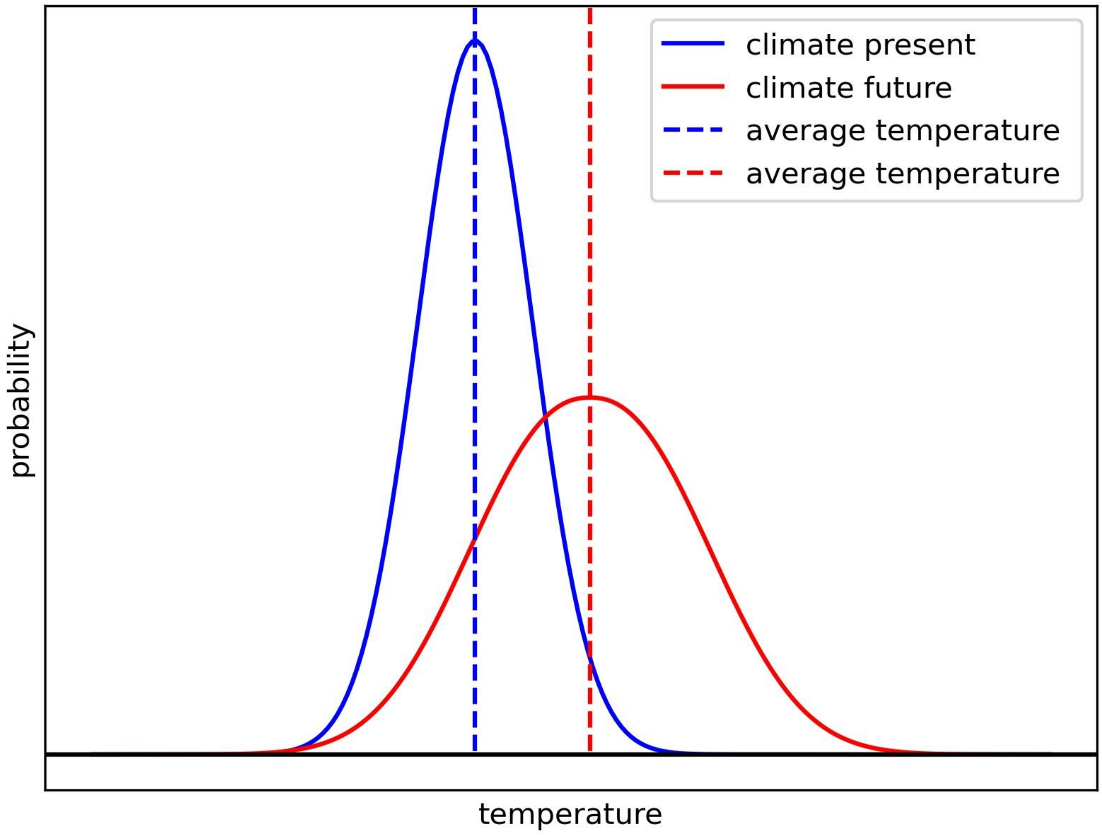


Figure 1. Climate change in a nutshell (From: N. Dudley Ward, Water Sketches: Climate Challenges, Calamities and Adaptations.).

4 HISTORICAL DATA

This section gives a summary of

- **Historical time series data sources, and**
- **Data extension methodologies.**

Historical data sources are shown in Table 8.

Table 8. Summary of data and sources.

Data type	Source	Frequency
Rainfall	cliflo.niwa.co.nz	Daily
Maximum temperature	cliflo.niwa.co.nz	Daily
Minimum temperature	cliflo.niwa.co.nz	Daily
Potential evapotranspiration (Penman)	cliflo.niwa.co.nz	Daily
Ground water levels	data.ecan.govt.nz	Daily
River flows	data.ecan.govt.nz, hydrowebportal.niwa.co.nz ECan (Tony Gray)	Daily
Sea level (at Lyttelton)	LINZ Data Service	Annual
Te Waihora Lake Ellesmere Water Level	ECan (Tony Gray)	Daily

Evapotranspiration is not directly measured, but may be estimated empirically from radiation, temperature, wind, and vapour pressure measurements, typically using the Penman-Monteith method.

The source data in Table 8 was processed to generate extended time-series for the period 1910-2023. Aqualinc's Climate Time Series Extension (CTSE) software was used to gap fill and extend daily time-series for rain, temperature and potential evapotranspiration (PET). CTSE identifies weather observation data for sites that are highly correlated, and fills gaps based on the correlation. An outline of the CTSE software is provided in Brown *et al*. (2016).

A daily time-series of PET for the 1910-2023 period was generated using the McGuiness-Bordne method, which estimates PET as a function of daily mean temperatures and latitude (Guo *et al*. 2016). This method was used due to a lack of radiation records (which are required by the Penman-Monteith method) prior to 1960. These estimates were then compared to the 1960 - 2023 extended PET data estimated using the Penman-Monteith method and were found to be broadly consistent.

Groundwater level time-series for the climate futures considered in this report were obtained by simulating groundwater movement using extended rainfall and PET time series as inputs (see Section 9). Rainfall and PET were used to estimate daily land surface recharge and water demand using Aqualinc's IrriCalc model (Bright 2009).

Table 9. Data extension processes

Data type	Process	Period
Rainfall	Extended and gap filled with CTSE software	1892-2023
Minimum and maximum temperature	Extended and gap filled with CTSE software	1905-2023
Potential evapotranspiration (Penman-Monteith)	Extended and gap filled with CTSE software	1960-2023
Potential Evapotranspiration (McGuiness-Bordne)	Generated from temperature data	1910-2023
Groundwater level	Modelled using rainfall and potential evapotranspiration input and calibrated to post-earthquake observed groundwater levels.	1910-2023

5 TEMPERATURE

The key messages for this section are:

- **Over the last 100 years New Zealand has warmed by an average of 1°C.**
- **Future annual average warming in Canterbury spans a wide range: 0.5-1.5 °C by 2040 and 0.5-3.5°C by 2090 depending on the greenhouse gas emission scenario.**
- **By 2040, seasonal mean temperatures across much of Canterbury are projected to increase by 0.5-1.5°C under RCP4.5. By 2090 they are projected to increase by 1.5-3.0°C under RCP8.5, with increases of 3.0-4.0°C for westernmost pasts of Canterbury.**
- **The number of hot days is projected to increase by 10-20 days by 2040 for Selwyn District under both RCP4.5 and 8.5. By 2090 the number of hot days is projected to increase by 10-60 days.**
- **The number of frost days is projected to decrease by 10-30 frost days per year for inland parts of the region. By 2090 the number of frost days is projected to decrease by 20-50 days for inland areas of Canterbury.**

According to the British Meteorological Office, global surface temperatures have warmed by about 1°C on average since the late 19th century. New Zealand has also warmed by this amount between 1908 and 2018 according to MfE (2020).

This section is largely based on the 2020 NIWA report *Climate change projections for the Canterbury Region.* Over the historic period 1986-2005 considered by NIWA, mean temperatures range between 10-14°C for most coastal and inland low-elevation locations of Canterbury, as shown in Figure 2. By 2040 annual mean temperature is projected to increase by 0.5-1.5°C by 2040 under RCP4.5 and RCP8.5, while by 2090 increases of the order of 0.5-2.0°C (RCP4.5) and 1.5-3.5°C (RCP8.5) are projected for most of the region, as shown in Figure 3. Greater temperature increases are projected for inland areas. This may be due to the moderating effect of the sea for coastal and plains areas.

The NIWA report also contains graphical representations of projections of changes in seasonal mean, maximum and minimum temperatures which, for the Selwyn District, are broadly consistent with Figure 3.

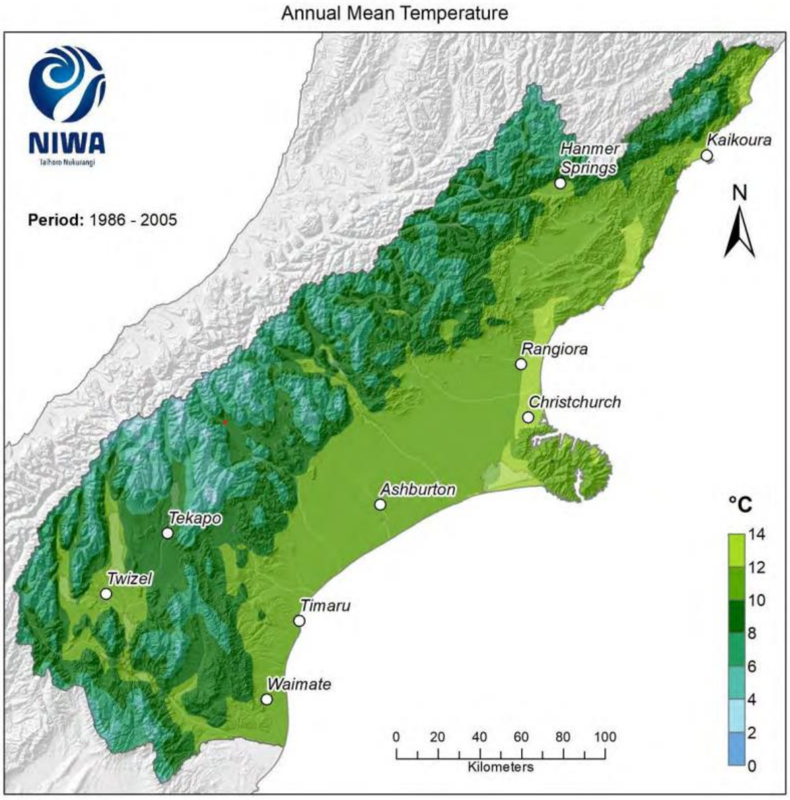


Figure 2. Modelled annual mean temperature, average over 1986-2005 (NIWA, 2020)

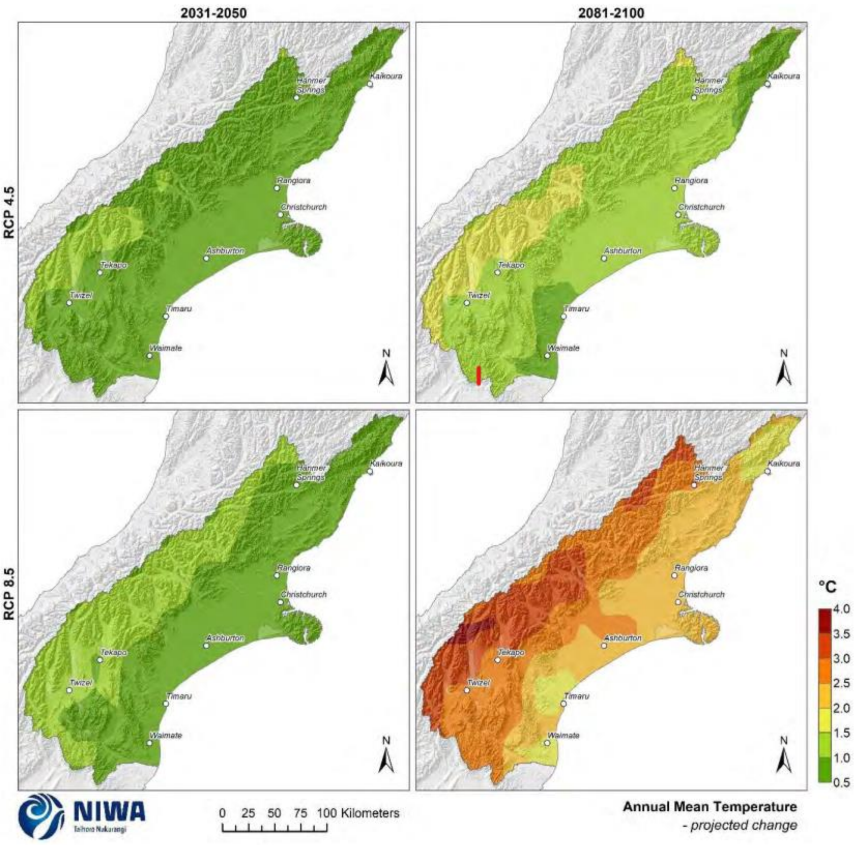


Figure 3. Projected annual mean temperature changes by 2040 and 2090, under RCP4.5 and RCP8.5, (NIWA, 2020).

The NIWA projections are based on taking the average of 6 dynamically downscaled climate models and therefore give one possible trajectory for a climate future: a kind of 'best estimate'. However, each climate model predicts a different climate future. While there is broad consistency between different model projections (all models project warming for RCPs 4.5 and 8.5, with higher greenhouse concentrations generally leading to more warming) the actual degree of warming is much less certain especially when projecting to 2090. This is reflected, for example, by the wide envelopes of uncertainty shown, for example, in Table 6. We refer also to Figure 4.9 in NIWA (2020), which shows the variability between different models.

Nevertheless, of far greater consequence to managers and decision-makers than the actual numerical values of annual and seasonal warming are projected physical consequences of warming; that is, changes to the patterns of seasonal and daily temperatures and impacts on the hydrological cycle, especially precipitation patterns and the incidence of hot days (≥25°C) and frost days (≤0°C). Broadly speaking, annual and seasonal minimum and maximum temperatures are projected to increase under all emission scenarios. However, projected increases in minimum temperatures are projected to be less than projected increases in maximum temperatures, leading to an increase in the diurnal temperature range.

5.1 Hot days

The number of hot days observed in Canterbury is projected to increase under all emissions scenarios. Currently Selwyn District experiences an average of 30-40 hot days per year, as shown in Figure 4. This is projected to increase by 10-20 days by 2040 for Selwyn District under both RCP4.5 and 8.5. By 2090 the annual number of hot days is projected to increase by 10-60 days, depending on the emissions scenario, as shown in Figure 5.

Historically, hot days occur most frequently during summer months, with 10-30 hot days observed in most low-elevation areas of Canterbury. With warming the increased frequency of hot days observed in summer months is projected to spill over into spring and autumn, lengthening the traditional summer season.

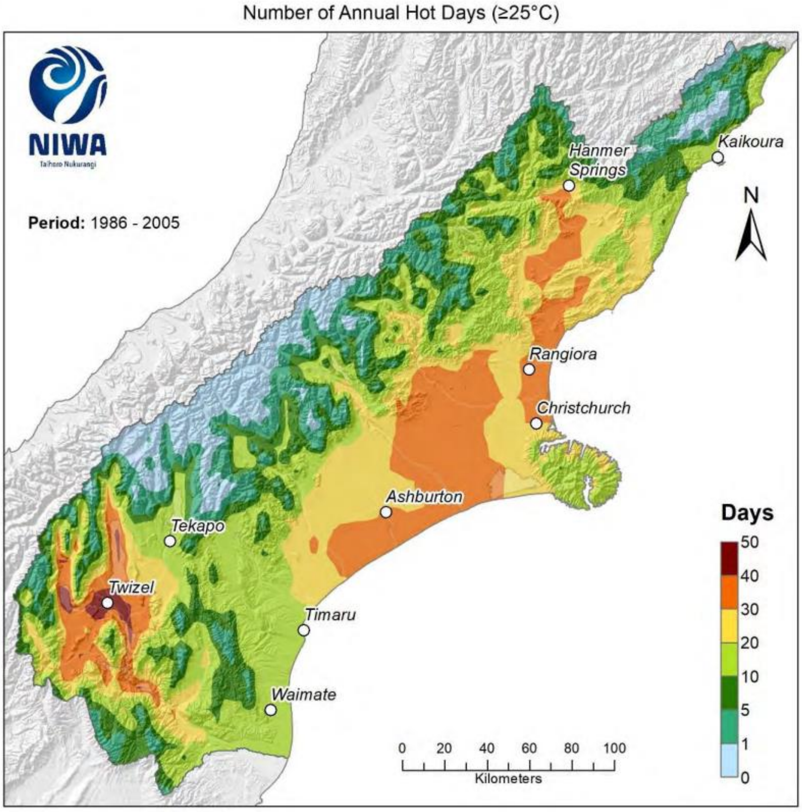


Figure 4. Modelled annual number of hot days (days with maximum temperature ≥25°C), average over 1986-2005, (NIWA 2020).

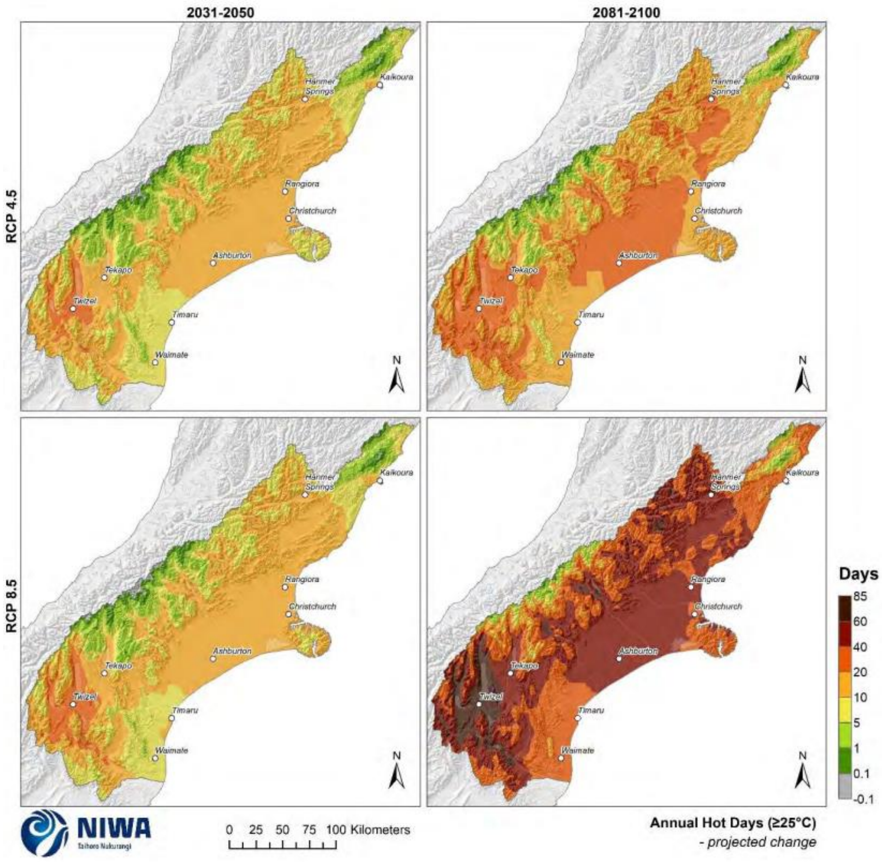


Figure 5. Projected annual hot day (days with maximum temperature ≥25°C) changes by 2040 and 2090, under RCP4.5 and RCP8.5 , (NIWA 2020).

5.2 Frost days

The annual number of frost days is projected to decrease throughout the Canterbury region, with larger reductions further inland and at higher elevations. Currently much of Selwyn District experiences between 10-50 frost days a year, as shown in Figure 6, with most frost days occurring during winter months. With warming the duration of the 'frost season' is projected to decrease.

By 2090 much of Canterbury is projected to experience a reduction of between 5-20 days under RCP4.5 and 10-50 days under RCP8.5 as shown in Figure 7, with the greatest reduction experienced in the high-country areas. Note that while the projected reduction is the same as the current number of frost days, this does not imply that there will be no frosts in the Selwyn District under future climates.

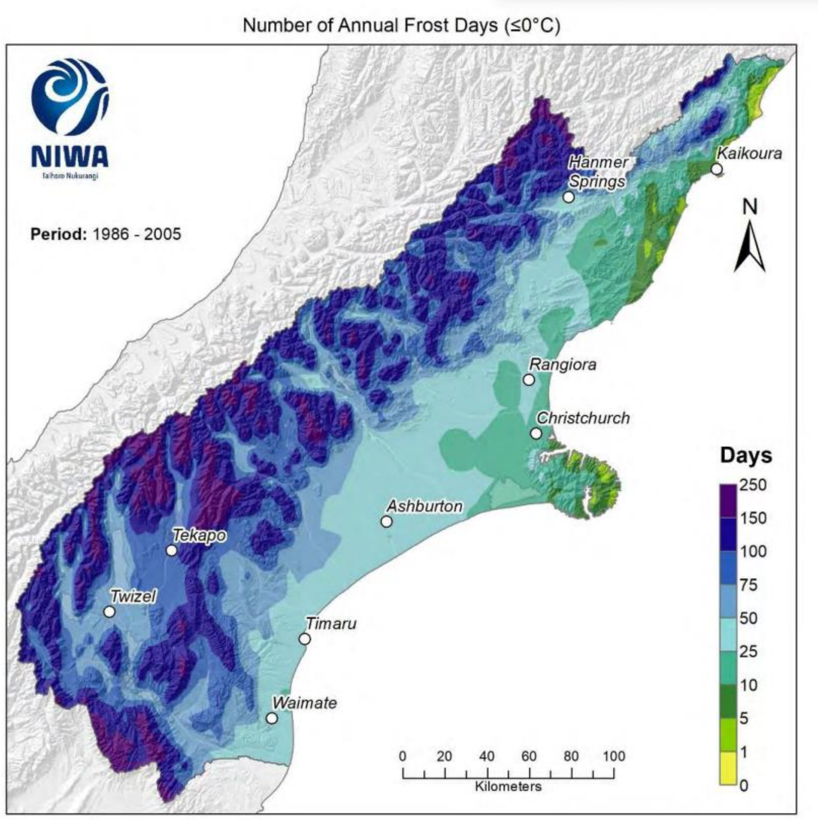


Figure 6. Modelled annual number of frost days (days with minimum temperature ≤0°C), average over 1986-2005.

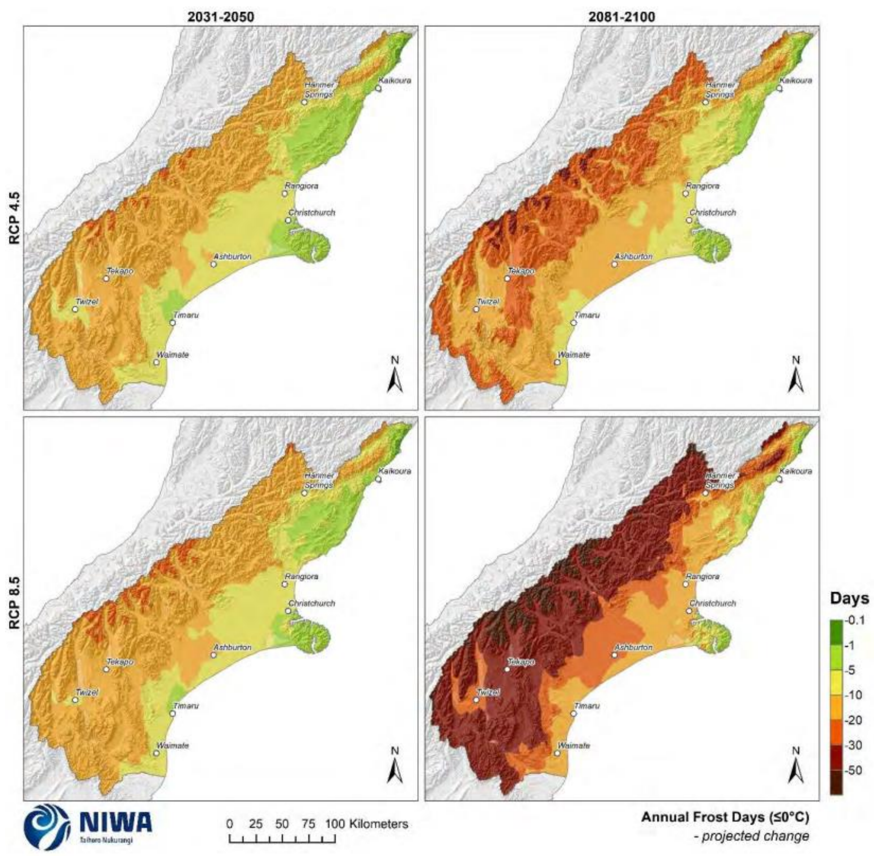


Figure 7. Projected annual frost day (days with minimum temperature ≤0°C) changes by 2040 and 2090, under RCP4.5 and RCP8.5.

5.3 Summary

The information in this section gives a broad and simplified summary of projected future temperatures for the Selwyn District. There are significant uncertainties about our climate future as shown by the envelopes of uncertainty quoted above and by the large disparities between projections based on RCP4.5 and RCP8.5. Although climate scientists are increasingly confident about the causes of global warming and climate change impacts, almost all statements in the IPCC reports are qualified with statements of uncertainty. Inevitably, envelopes of uncertainty increase significantly with distance into the future. Furthermore, the 2020 *National Climate Change Risk Assessment for New Zealand* cautions against the use of static measures like minimum flood levels, routinely used in planning. The report further states that '*failure to account for uncertainty in decision-making increases the likelihood that an action will be maladaptive*' and encourages flexible planning and design that consider the inevitable uncertainties associated with climate change. Perhaps the best picture of future changes to the Selwyn District's temperatures to keep in mind is Figure 1. This effectively summarises the contents of Section 5. Increasing temperature is the fundamental driver of climate change which influences all of the other climate variables considered in this report.

6 EVAPOTRANSPIRATION

The key messages for this section are:

- **By 2040, both RCP4.5 and RCP8.5 project an accumulated PED of 50-100 per year for most eastern parts of Canterbury.**
- **By 2090 under RCP8.5 5, PED is projected to increase by 100-200 mm per year for many inland areas of the Selwyn District.**
- **Historical PET records suggest that rates have not changed significantly over the period 1960-2023.**

Evapotranspiration is the process by which water is transferred from the Earth's surface to the atmosphere through a combination of direct evaporation and transpiration from plants. The 'potential evaporation' (PET) is the rate of evaporation that would occur if there were a sufficient water source available. As the growing season progresses, the rate of water loss through evapotranspiration usually surpasses the amount of rainfall received, leading to an increase in soil moisture deficit. This limits the availability of moisture for pasture production, and evapotranspiration becomes insufficient to meet the water demand from the atmosphere. This leads to 'potential evapotranspiration deficit' (PED), which is the difference between the atmospheric demand and the actual evapotranspiration. This deficit is the amount of water required by irrigation to maintain plant growth without being constrained by water scarcity.

The PED provides a measure of drought intensity and duration, with higher PED values corresponding to drier soils.

Figure 8 shows estimated PET between 1960 and 2023 for three long-term climate stations in the Selwyn District. While each station has a very small decreasing trend in PET, it is very small with respect to the year-to-year variability. The very low values of PET in recent years highlight short-term variability that will continue to be a factor of future climate.

By contrast, the 2020 NIWA report concludes that PED is projected to increase across much of Canterbury, increasing drought potential. Over the period 1986-2005 the Selwyn District experienced 200-400 mm PED per year. By 2040 under RCP 4.5 and 8.5, most eastern parts of the region are projected to experience an increase in PED of 50-100 mm per year, while by 2090 under RCP8.5 PED is projected to increase by 100- 200 mm per year for many inland areas of the Selwyn District.

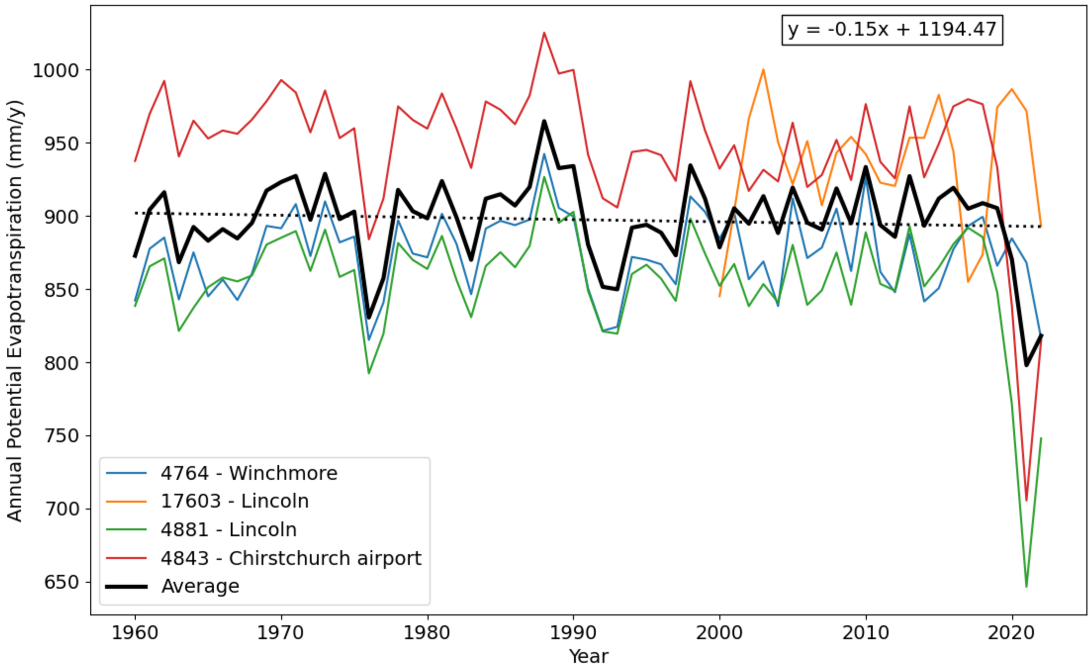


Figure 8. Measured PET from 1960 to 2023 for three locations in the Selwyn District.

7 RAINFALL

7.1 Annual Rainfall

The key messages of this section are:

- **Annual rainfall is projected to change by between ±5% for most of Canterbury by 2040 and 2090.**
- **Winter rainfall is projected to increase considerably by 2090 under RCP8.5 in many eastern, western and southern parts, with 15-40% more rainfall projected.**

Over the historic period 1986-2005, for eastern parts of Canterbury average rainfall ranges from 500-800 mm, as shown in Figure 9, with winter the driest season of the year. For much of the region under both RCP4.5 and RCP 8.5 annual rainfall is projected to change by up to ±5% for much of Canterbury, as shown in Figure 10. By 2090 the disparity between climate futures based on RCP4.5 and 8.5 on a seasonal scale is significantly greater with winter rainfall projected to increase significantly in many eastern, western and southern parts of Canterbury (including the Selwyn District), with 15-40% more rainfall projected.

It is interesting to compare climate future projections with historical data. Rainfall data from 6 sites across the Canterbury Plains is shown in Figure 11. Annual rainfall for the three long-term stations on the lower Central Canterbury Plains is shown in Figure 12, while Figure 13 shows annual rainfall for three long-term stations on the upper Central Canterbury Plains. There are no evident long-term trends in the measured data which is consistent with the small projected changes projecting to 2050.

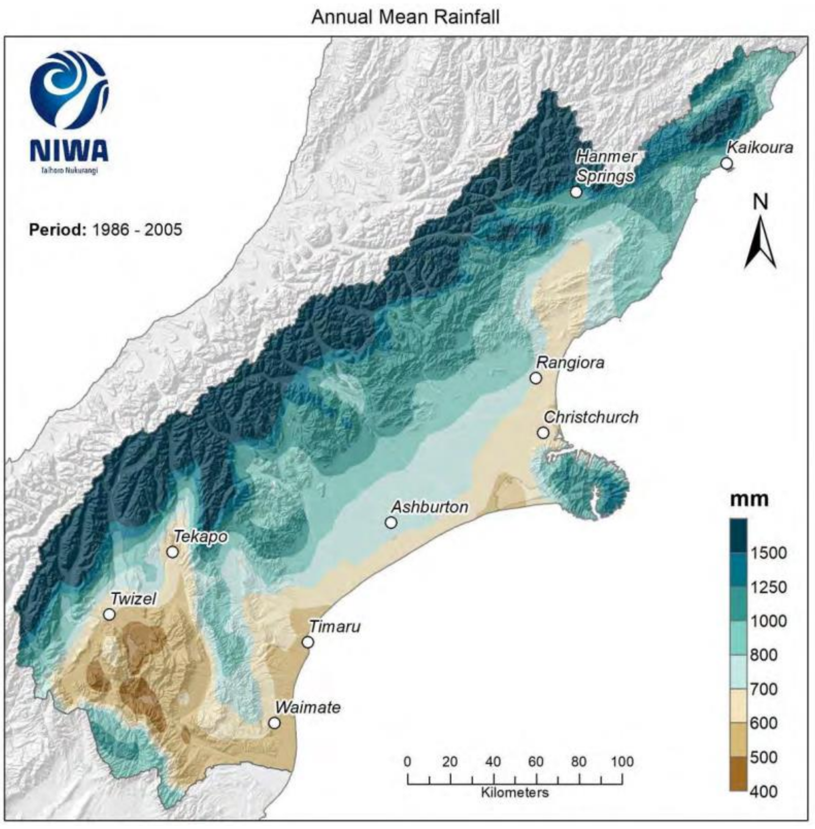


Figure 9. Modelled annual mean rainfall (mm), average over 1986-2005 (NIWA, 2020).

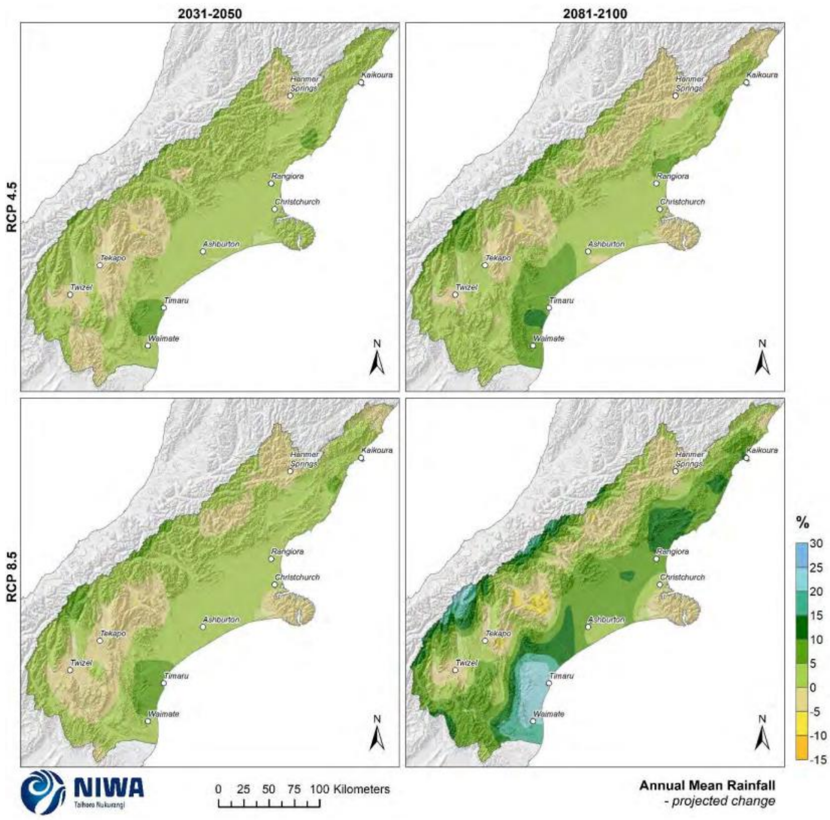


Figure 10. Projected annual mean rainfall changes by 2040 and 2090, under RCP4.5 and RCP8.5 (NIWA, 2020).

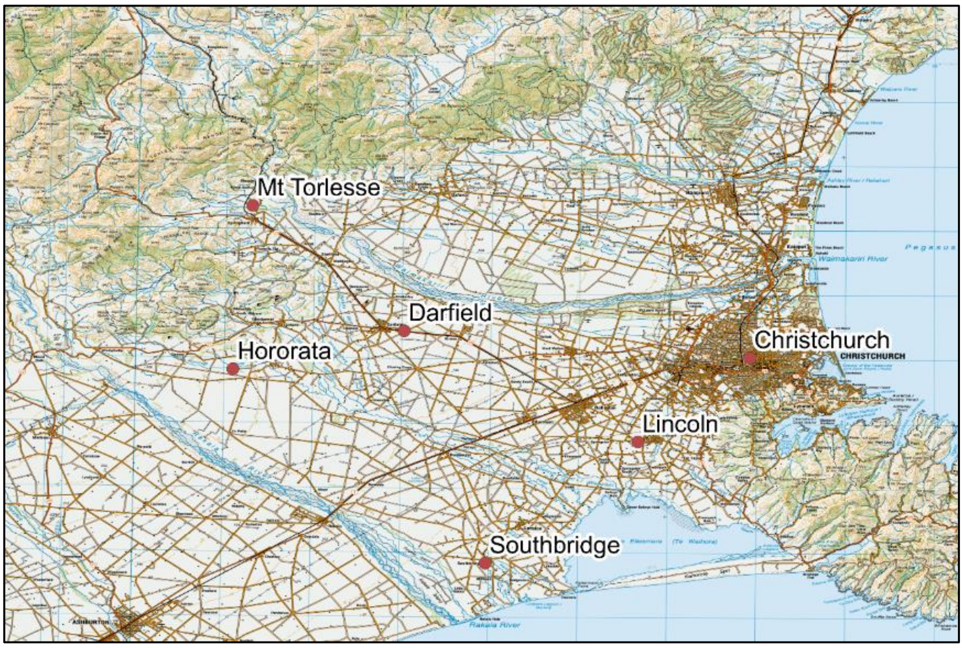


Figure 11. Locations of rainfall stations.

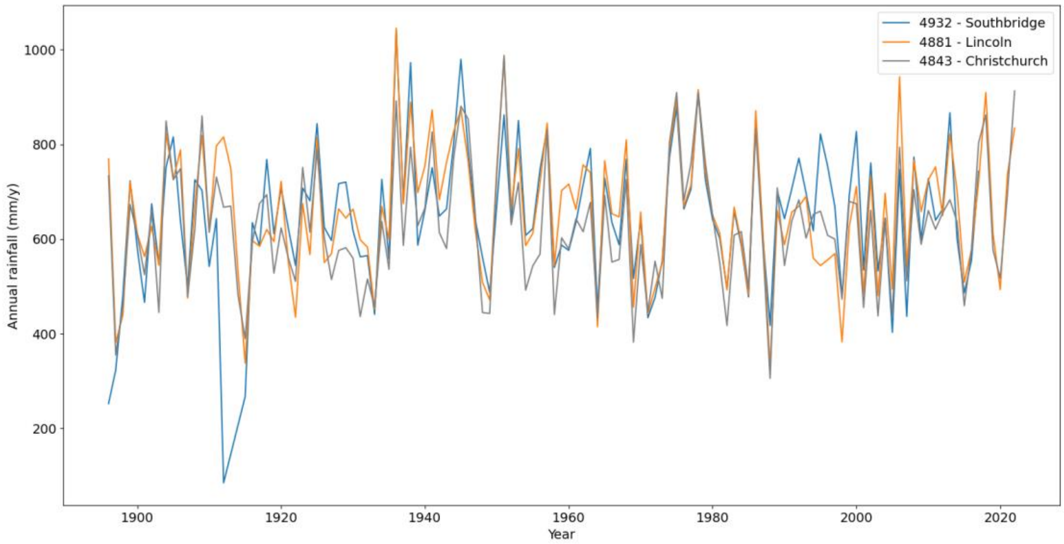


Figure 12. Annual rainfall for three sites on the lower Central Canterbury Plains 1892-2023.

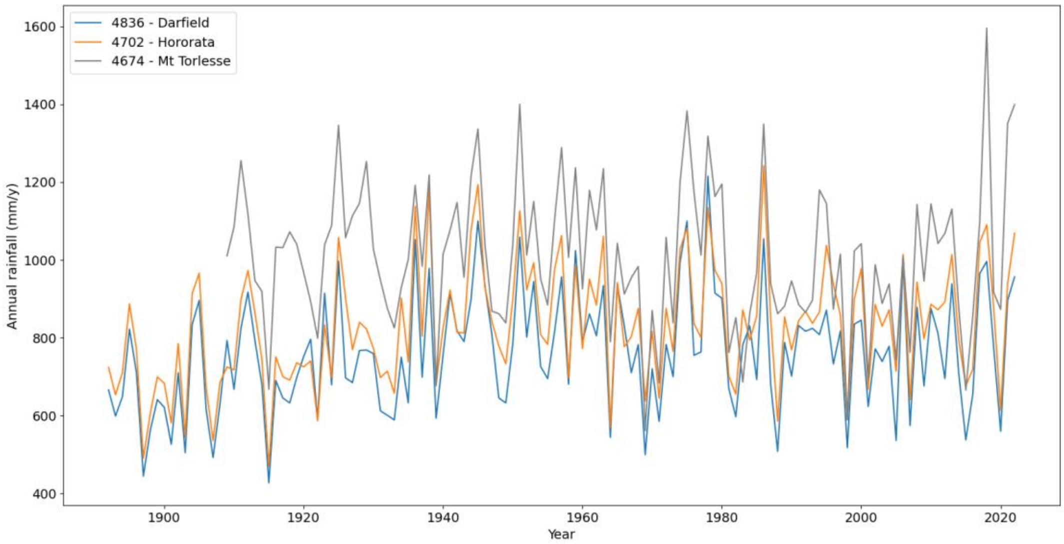


Figure 13. Annual rainfall for three sites on the upper Central Canterbury Plains 1892-2023.

7.2 Dry days

The key messages for this section are:

- **By 2040 under RCP4.5 the annual number of dry days is projected to decrease by up to 5 days for eastern parts of Canterbury and around the Canterbury Plains, while increasing by the same amount elsewhere.**
- **By 2090 under RCP8.5 this is projected to change by up to ±15 days.**

A day is called 'dry' if there is less than 1 mm rainfall on that day. As shown in Figure 14, Selwyn District averages around 200-300 dry days per year. In all emissions scenarios the number of dry days is projected to decrease in eastern parts of Canterbury and in the Canterbury Plains, while increasing in other parts of Canterbury, as shown in Figure 15. By 2040 under RCP4.5 the change in the number of dry days is small and of the order of ±5 days, while by 2090 under RCP8.5 the changes are projected to be of the order of ±15 days per year.

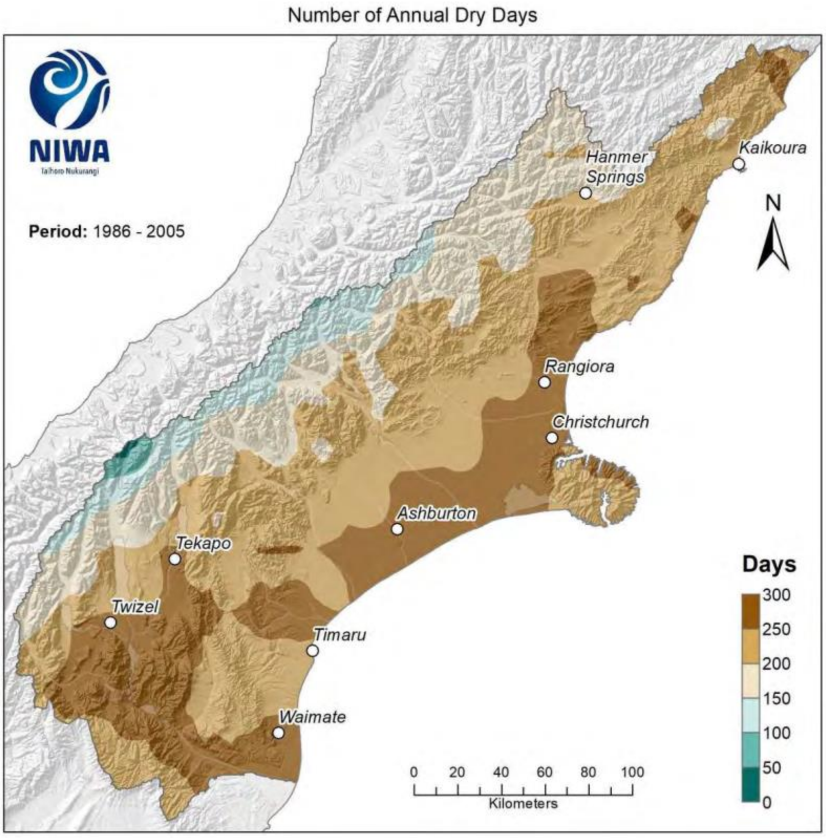


Figure 14. Modelled annual number of dry days (daily rainfall <1mm), average over 1986-2005.

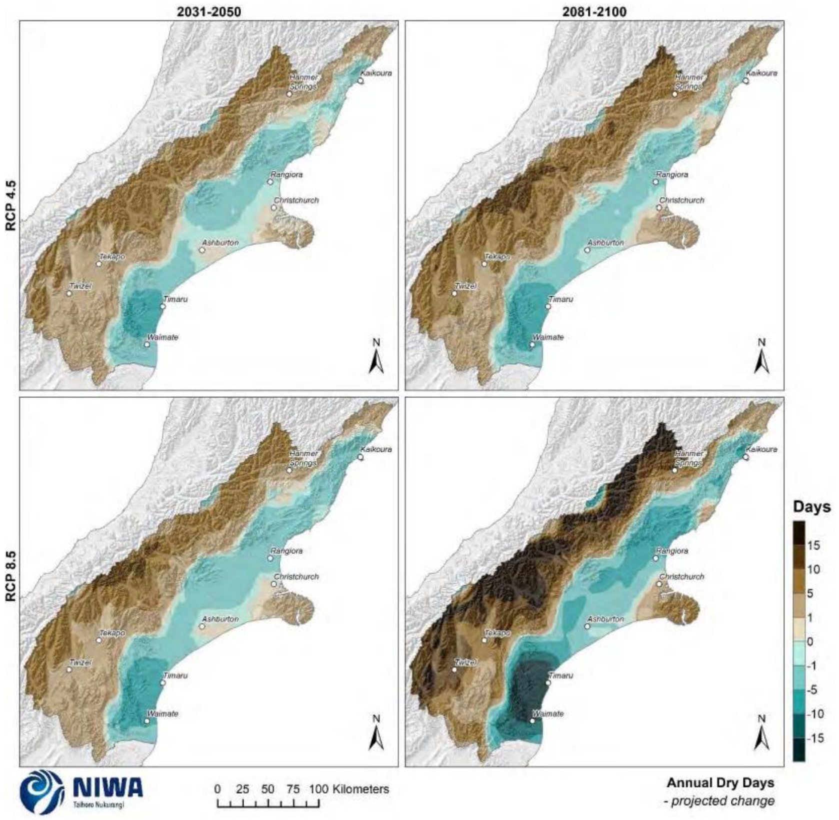


Figure 15. Projected annual number of dry day (daily rainfall <1mm) changes by 2040 and 2090, under RCP4.5 and RCP8.5.

7.3 Extreme rainfall

The key messages for this section are:

- **Extreme rainfall events are expected to increase everywhere in New Zealand.**
- **With 2°C warming, projections of the increase in 50-year Rx1[1]day and Rx5 day events for New Zealand are inconsistent.**
- **With 4°C warming models project a median increase in the intensity and frequency of heavy precipitation of more than 15% in the 50-year Rx1 day and Rx5 day events compared to the 1°C warming level.**

NIWA's 2020 report *Climate change projections for the Canterbury Region* does not contain quantitative information on projected changes to extreme rainfall events. However, it states that '*along with increases in global mean temperature, mid-latitude and wet tropical regions will experience more intense and more frequent extreme rainfall events by the end of the 21st century*'. Similarly, the Ministry for the Environment 2018 report *Climate Change Projections for New Zealand* states that '*very extreme rainfall is likely to increase in all areas with increases more pronounced for shorter duration events*'.

Estimates of projected high-intensity rainfall events to the end of century for a range of RCPs including RCP4.5 and RCP8.5 have been generated by NIWA's High Intensity Rainfall Design System (HIRDS). Table 10 shows estimated rainfall depths for 1 in 10 year and 1 in 100 year rainfall events for three representative locations in the Selwyn District.

[1] Rx1 and Rx5 are the maximum daily and 5 daily precipitation amounts, respectively.

Table 10. Estimated rainfall depths (mm) for different climate futures and representative locations in the Selwyn District.

		Historical		2050 RCP4.5		2100 RCP4.5		2100 RCP8.5	
		1 in 10	1 in 100	1 in 10	1 in 100	1 in 10	1 in 100	1 in 10	1 in 100
Castle Hill	1 hr	19.9	32.7	21.8	36	23.1	38.1	26.6	44.2
	1 day	108	172	115	182	119	189	131	210
	5 day	156	242	162	253	166	260	178	280
Darfield	1 hr	17.6	31.8	19.4	35	20.4	37	23.6	42.9
	1 day	89.9	150	95.3	159	98.8	165	109	183
	5 day	162	260	169	271	174	279	186	300
Leeston	1 hr	17.6	31.3	19.3	34.5	20.4	36.5	23.6	42.3
	1 day	85.3	142	90.4	151	93.7	156	103	173
	5 day	137	220	143	230	147	237	158	255

AR6 provides limited information on increase and intensity of heavy precipitation events in Table 11.11 (IPCC, Climate Change 2021, The Physical Science Basis). For 1.5 and 2°C warming, CPIM6 climate models project inconsistent changes in the region. However, for 4°C warming models project a median increase in the intensity and frequency of heavy precipitation of more than 15% in the 50-year Rx1day and Rx5 day events compared to the 1°C warming level.

In practical terms extreme rainfall events that were traditionally assessed to be 1 in 10-year or 1 in 100-year events will become more frequent.

It is interesting to compare projections with historical rainfall data. Figure 16 shows the average of the five-day maximum of four stations shown in Figure 17. This data as well as the individual station data show.no significant long-term trends. Comparing the historical data summarised in Figure 16 with the projected data in Table 10, it is evident that the 1 in 10 year 5 days events for all climate futures in Table 10 are consistent with the range of historically observed rainfall events. However, the 1 in 100 year high-intensity events lie significantly outside this range which highlights the wide uncertainty associated with events with a 1 in 100 return period.

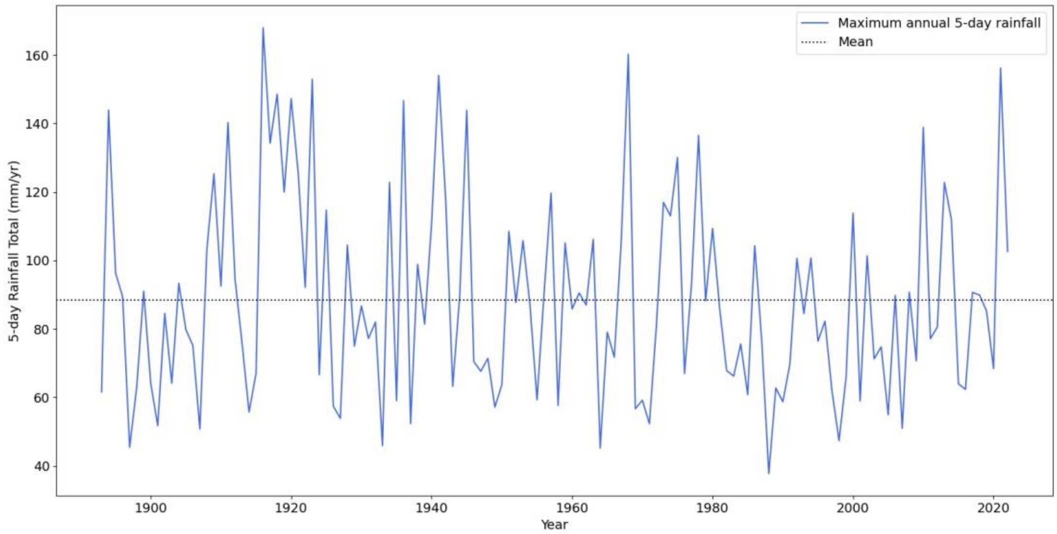


Figure 16. Annual maximum 5 day rainfall for the mean of four long term stations (Southbridge, Lincoln, Hororata and Christchurch Gardens).

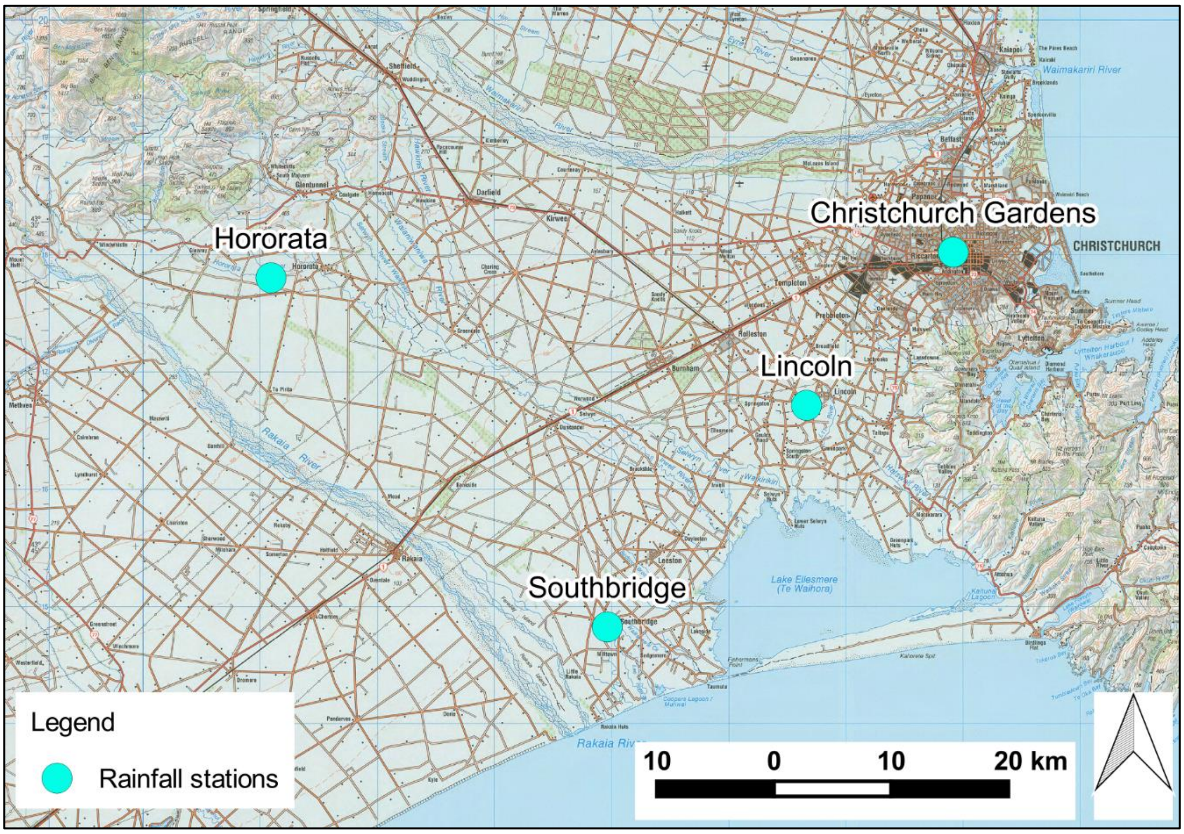


Figure 17. Four long term rainfall stations with records from at least 1893.

8 OTHER CLIMATE VARIABLES

The key messages for this section are:

- **The number of snow days is projected to decrease everywhere in Canterbury, with the largest reductions of the order of 10-25 days in higher elevation regions.**
- **Annual mean wind speed is projected to increase 2-10% for much of Canterbury under RCP8.5.**

8.1 Snow

The number of snow days is projected to reduce everywhere, with the largest reductions in the coldest mountainous areas. In the higher-elevation alpine regions, the number of snow days (days with recorded precipitation and temperatures less than 1°C) varies between 25-100 annually, with the largest reduction of the order of 10-25 days in higher elevation alpine regions (NIWA, 2020).

8.2 Wind

NIWA (2020) projects increases in annual mean wind speed of the order of 2-10% for much of Canterbury by 2090 under RCP8.5, with the largest changes projected to occur during winter and spring months.

9 GROUNDWATER

In the Selwyn District groundwater accounts for approximately two-thirds of the water used for irrigation. Therefore, potential adverse impacts on groundwater systems and dependent infrastructure resulting from changing climate patterns constitute a major issue for the district. Furthermore, the Intergovernmental Panel on Climate Change (IPCC 2021) assessment report AR6 acknowledges a high level of uncertainty of climate related changes to groundwater.

Different climate futures will lead to changes in irrigation demand, groundwater pumping and land surface recharge. To assess the potential impacts on groundwater systems in the Selwyn District we have modelled several climate future scenarios.

The 2020 *Impacts of Climate Cycles and Trends* report compared a climate future in 2050 with the historical case and found insignificant changes to groundwater levels mid-century. In this report we consider climate futures in both 2050 and 2100, which requires estimating pumping and land surface recharge over the simulation period. For 2050 we follow the same method as in the 2020 report, in which modified PET time series is generated based on a 1.5°C increase in mean temperature (consistent with climate futures corresponding to RCP4.5 and 8.5 mid-century). Aqualinc's crop-soil water balance model (IrriCalc) was used to estimate land surface drainage and water demand for the different scenarios. One-dimensional groundwater models calibrated to historical data were then used to simulate groundwater levels at various locations in Selwyn District.

It is clear from the preceding sections that by the end of century we can expect considerably more uncertainty, especially with precipitation patterns especially when considering the broad disparities in climate futures between RCP4.5 and RCP8.5. We have therefore taken a different approach for 2100 and have used simulated rainfall and PET data from NIWA, generated from their regional climate model, to drive the groundwater simulations.

9.1 Land surface recharge

Aqualinc's crop-soil water balance model (IrriCalc) (Bright, 2009) was used to generate time-series of land surface drainage and water demand. The model estimates soil water content as a function of crops and soil types, climate, and irrigation strategies. An overview of the model is given in Appendix A.

IrriCalc requires the following data inputs:

- Land use, specifically the distribution of
    - Irrigated pasture, and
    - Dryland pasture.
- Potential evapotranspiration (PET),
- Rainfall,
- Soil plant available water (PAW) estimated from S-Map, and
- Irrigation parameters.

For the groundwater modelling the aquifer was divided into 7 zones, shown in Figure 18. Representative climate data for each of these zones from the stations shown in Figure 18 are listed in Table 11.

The identification of irrigated areas for each groundwater zone was determined by mapping conducted by Aqualinc. All irrigation water was assumed to be sourced from groundwater. Furthermore, spray irrigation was assumed for all areas, with an equivalent 80% (approximately) water use efficiency. Model parameters are summarised in Table 12.

As noted in Section 4, evaporation transpiration data for the period 1910-2023 was estimated using the McGuinness-Bordne method.

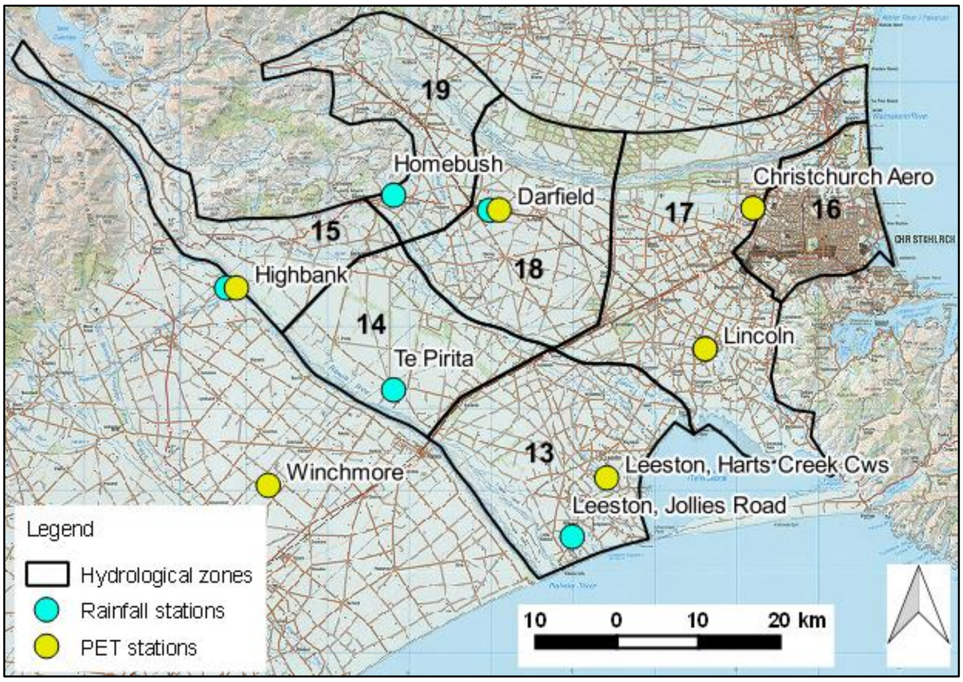


Figure 18. Groundwater model zones.

Table 11. Climate stations used for each groundwater model zone.

Ground water model zone	Climate Variable	
	Rain	Potential evapotranspiration
13	Leeston	Leeston
14	Te Pirita	Winchmore
15	Highbank	Highbank
16	CHCH Aero	CHCH Aero
17	Lincoln	Lincoln
18	Darfield	Darfield
19	Homebush	Darfield

Table 12. Soil and irrigation parameters used in IrriCalc modelling.

Model zone	Average PAW (mm)	Application depth (mm)	System capacity (mm/d)
Leeston	83	60	4.3
Te Pirita	67	43	4.3
Hororata	70	43	4.3
Christchurch City	99	0 (Dryland only)	0 (Dryland only)
Lincoln	84	60	4.3
Darfield	74	43	4.3
Homebush	74	43	4.3

9.2 Groundwater modelling scenarios

Groundwater modelling scenarios are listed in Table 13.

Table 13. Groundwater modelling scenarios

Scenario	PET	Irrigation
Historic	Estimated from temperature data	Current land-use and water sources.
Climate Change 2050	Estimated from temperature data	
Climate Change 2100, RCP4.5	NIWA projected data	
Climate Change 2100, RCP8.5	NIWA projected data	

Description of scenarios:

- **Historic:** The simulation period 1910-2023 assumed post-earthquake land use, groundwater pumping and irrigation. Land surface recharge was derived from the extended time series of rainfall and PET.
- **Climate Change 2050, RCP4.5 and RCP8.5:** In this case PET data was generated from temperature data assuming a 1.5°C increase in temperature.
- **Climate Change 2100, RCP4.5:** NIWA projected data for RCP4.5 has been used to simulate groundwater responses at end of century.
- **Climate Change 2100, RCP8.5:** NIWA projected data for RCP8.5 has been used to simulate groundwater responses at end of century.

9.3 Groundwater modelling

To simulate groundwater level responses resulting from changes in land surface recharge and pumping, one-dimensional eigenmodels (Bidwell and Burbery, 2011) were fit to historical data from representative wells in the Selwyn District. These simplified bulk-parameter compartment groundwater models are useful for capturing the dynamic response of wells and rapidly exploring scenarios.

The catchment was divided into three slices along which groundwater flow is approximately unidirectional, Figure 20. Each slice was divided into three zones (inland, mid-plains and coastal) and eigenmodels were calibrated to the six representative wells also shown in Figure 19.

9.4 Selected wells

Calibration wells were selected to provide spatial coverage, while including a mix of shallow and deep wells and are summarised in Table 14. These wells were also selected since they have long-term water level data and are broadly representative of SDC well assets.

Well number	Depth (m)	Location	Eigen model slice	Representation
M35/1000	48.8	West Melton	1	Moderately deep groundwater supply
M35/1080	30	Christchurch-West Melton	1	Shallow groundwater supply
M36/0217	41	Rolleston	1	Shallow groundwater supply
L36/0092 & BX22/0003	61 & 93	Charing Cross	2	Deep groundwater supply
M36/0599	9	Lincoln	2	Shallow groundwater levels & drainage
L36/0124	35	Bankside-Dunsandel	3	Shallow groundwater supply
L36/1226	109	Te Pirita-Hororata	3	Deep groundwater supply
M36/0424	13	Doyleston	3	Shallow groundwater levels & drainage
L35/0180	8	Darfield (north)	4	Shallow groundwater supply

Table 14. Description of selected wells.

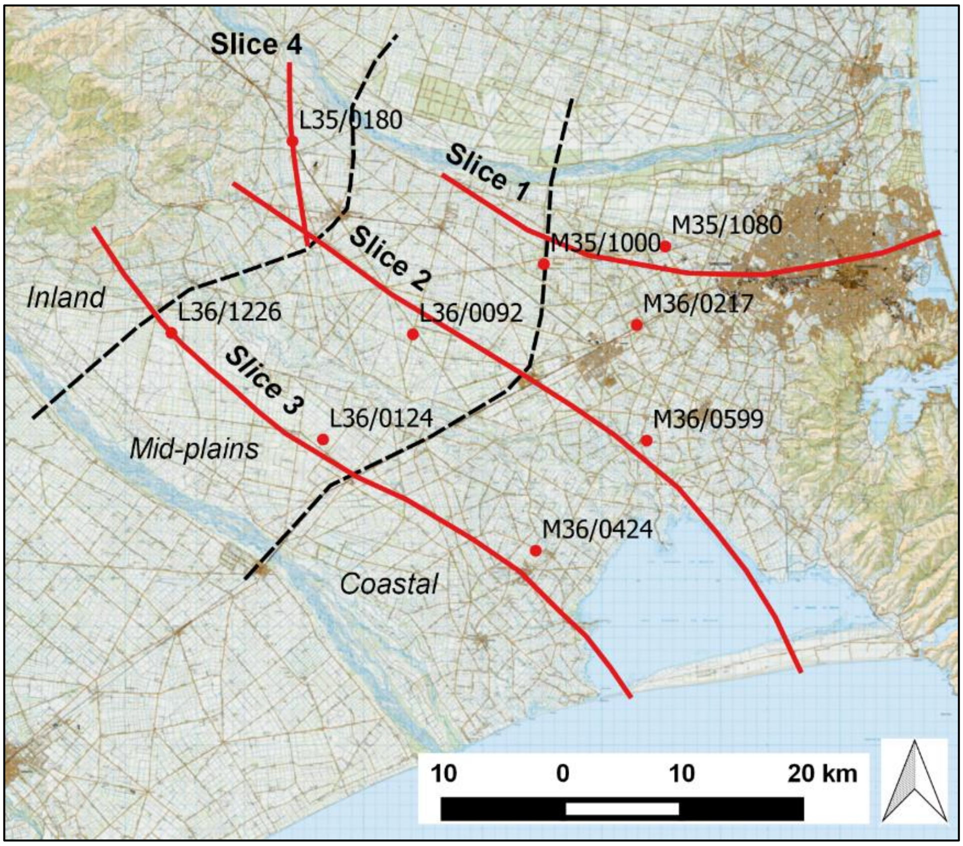


Figure 19. Calibration well locations and conceptual groundwater model slices.

9.5 Model calibration

Each eigenmodel ran from January 1910 to April 2023 with monthly stress periods. Models were calibrated to measured groundwater levels, estimated pumping and land surface recharge over the period August 2011 to December 2014. This period was chosen because:

- model inputs (pumping rates and drainage) assume current water use and land use intensification, and
- to avoid earthquake responses and subsequent changes to groundwater levels that occurred in some wells (Cox *et al*. 2012; Dudley Ward, 2015).

Figure 20 shows the simulated dynamic response of well L36/0092 over the period. Responses for the other wells are given in Appendix B.

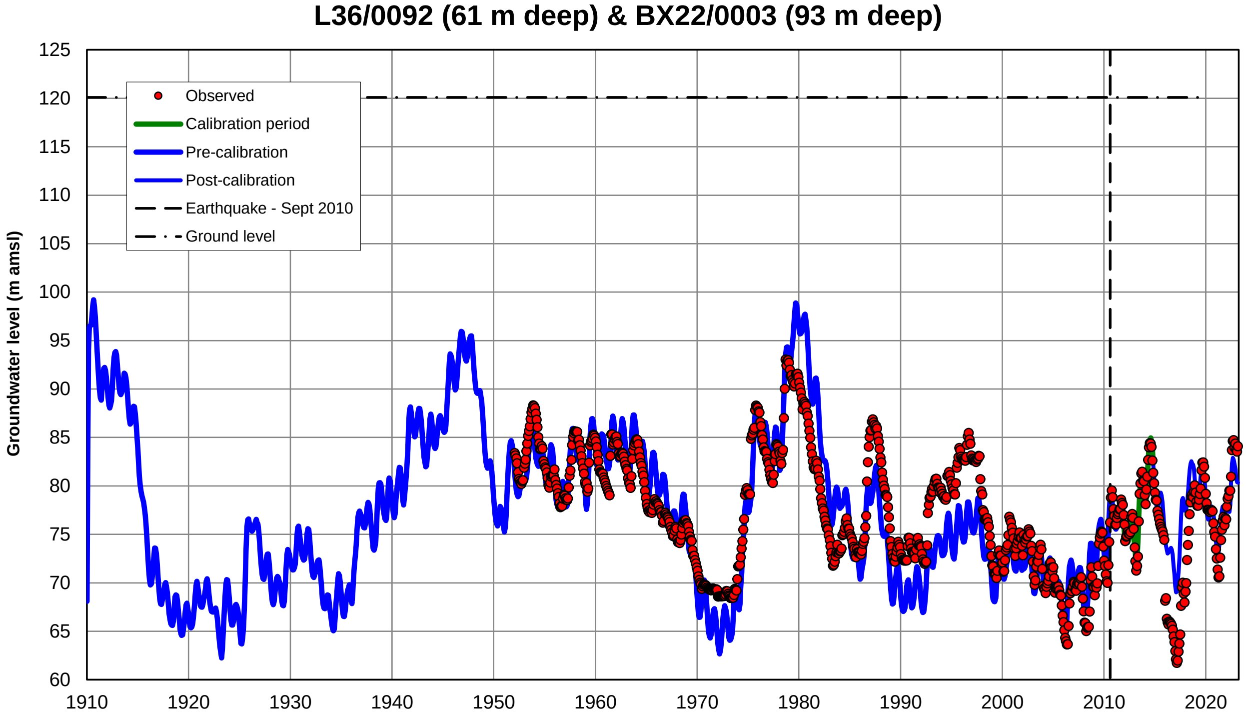


Figure 20. Simulated dynamic response of well L36/0092.

9.6 Results and recommendations – 2050 climate futures

Summary statistics for the historic and 2050 climate future periods for the modelled bores are shown in Table 15 and Table 16. Five out of the nine wells indicate small or insignificant reductions to groundwater levels. However, the other four deeper wells (viz. L36/0092, L36/0124, L36/1226 and M35/1000) show more significant reductions in water levels. These are most pronounced in the summary data on low groundwater levels. Given the possibility of lower groundwater occurring at some stage in the future, we recommend investigation of the following questions:

- can existing physical infrastructure such as pump placement and well hydraulics effectively handle lower projected groundwater levels?
- If not, what emergency operating regime should be implemented to ensure partial water supply?

Table 15. Groundwater modelling summary - Part A

Bore M35/1080 Christchurch-West Melton (GL 60.7m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	45.68	49.53	51.28	52.52	42.57	42.28	41.84
2050	44.09	47.89	49.18	51.28	41.21	40.87	40.49
Bore M36/0217 Rolleston (GL 52.9m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	35.96	41.84	44.23	45.65	31.12	30.76	29.55
2050	34.51	40.14	42.96	43.90	29.98	29.61	28.81
Bore L36/0092 Charing Cross (GL 120.1m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	77.29	92.85	95.67	99.15	65.62	64.20	62.32
2050	70.32	85.88	88.42	93.58	58.88	57.52	55.17
Bore M36/0599 Lincoln (GL 14.7m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	13.01	13.90	14.11	14.43	12.43	12.37	12.28
2050	12.83	13.70	13.93	14.22	12.28	12.23	12.13

Table 16. Groundwater modelling summary - Part B

Bore L36/0124 Bankside-Dunsandel (GL 112.3m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	86.72	93.54	95.22	98.14	80.48	79.32	78.03
2050	83.39	90.42	92.25	95.15	76.96	75.89	74.73
Bore L36/1226 Te Pirita-Hororata (GL 198.3m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	107.35	118.88	121.78	125.47	95.76	94.63	93.24
2050	100.23	116.81	120.60	128.87	88.76	87.13	85.79
Bore M36/0424 Doyleston (GL 21.4m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	20.36	21.09	21.28	21.66	19.68	19.61	19.48
2050	20.10	20.86	21.06	21.32	19.41	19.34	19.20
Bore L35/0180 Darfield (north) (GL 255.2m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	249.93	250.94	251.17	251.65	249.24	249.19	249.13
2050	249.96	251.01	251.29	251.76	249.32	249.22	249.16
Bore M35/1000 West Melton (GL 105.2m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
Historic	68.04	82.06	84.96	89.29	56.85	54.81	54.46
2050	59.88	73.49	77.45	83.67	49.42	47.32	46.33

9.7 Results – 2100 climate futures

The results of this section are based on NIWA's modelled climate data for the 21st century for RCP4.5 and RCP8.5. Summary statistics for the difference between historic and projected levels are given in Table 17 for well L36/0092. The broad picture is of reduced groundwater levels with relatively little difference between RCP4.5 and RCP8.5 at end-of-century. When interpreting these results, it is very important to temper them with the very significant uncertainties when projecting to the end of the 21st century. Furthermore, with little doubt, the next 70 years will also see substantial changes to land-use and irrigation demand; our assessment is unable to take this into account. The main message to take on board is that groundwater levels are projected to get lower on average with more frequent occurrence of 'extreme events' (i.e. lower water levels).

Table 17. Groundwater modelling summary of the differences between historic and projected levels in 2100 for RCP4.5 and RCP8.5 using NIWA projected climate data.

Bore L36/0092 Charing Cross (GL 120.1m amsl)							
Scenario	Average	High GW levels (m amsl)			Low GW levels (m amsl)		
	(m amsl)	1 y in 10	1 y in 25	1 y in 100	1 y in 10	1 y in 25	1 y in 100
2050 RCP4.5	11.68	15.12	16.76	15.3	8.16	7.51	7.55
2050 RCP8.5	11.45	15.01	16.65	15.16	7.55	8.01	7.75
2100 RCP4.5	10.96	15.02	17.47	13.44	6.86	7.03	7.56
2100 RCP8.5	11.24	16.08	18.14	13.25	7.16	6.65	8.13

10 RIVER FLOWS

The key messages for this section are:

- **Historical river flow data in the Selwyn District does not indicate any long-term trends.**
- **Mean annual flows in the alpine rivers (Waimakariri and Rakaia) are projected to increase by 3% by the 2040's, as a result of increased alpine precipitation. Greatest increases are likely to occur in winter.**
- **Foothill river flows may slightly decrease over the next 30 years, due to a small increase in evapotranspiration.**
- **Towards 2100 the annual cycle of river flows may be significantly modified and is highly dependent on climate future.**

Historical time series of flows for the Rakaia River, Waimakariri River, Selwyn River and Doyleston Drain are shown in Figure 21. No long-term trends are evident daily river flows or in the number of days with high flows.

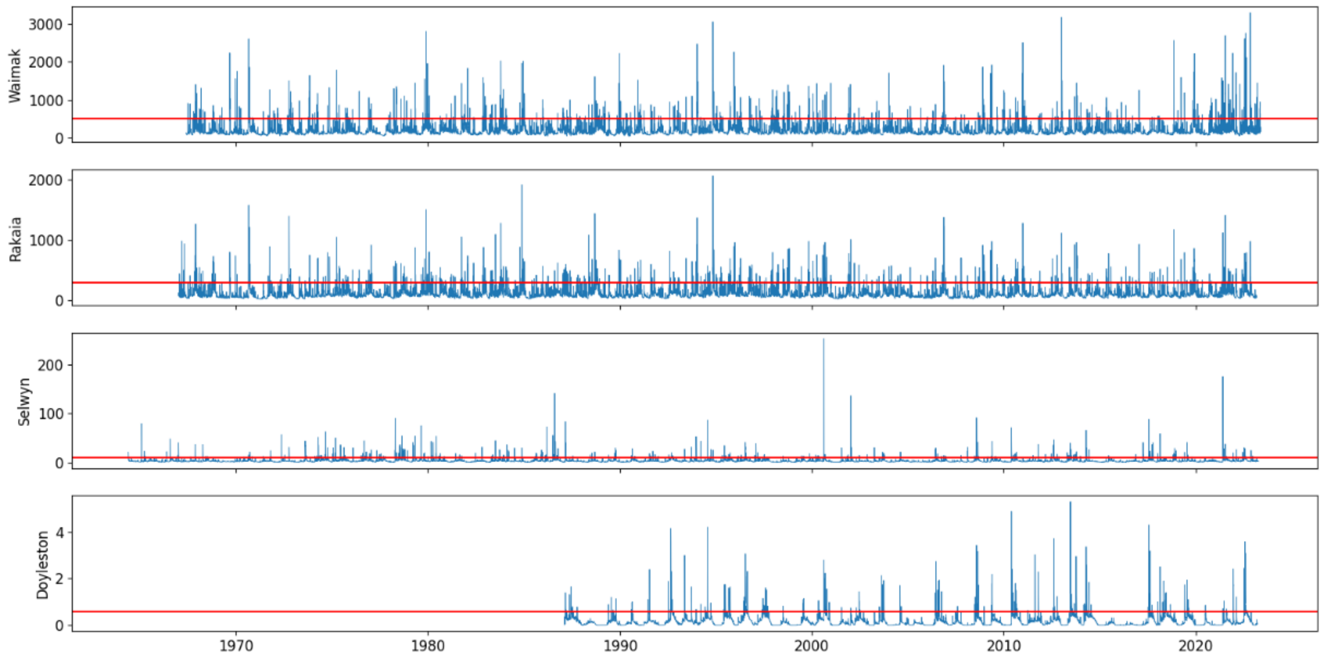


Figure 21. River flow time-series. The red lines are the 95th percentile for daily flows.

McKerchar and Henderson (2003) investigated Rakaia and Waimakariri flows for changes between the IPO phases for the 1947 and 1999 period. They found an increased annual flood levels for the Rakaia River for the positive phase of the IPO, but could not distinguish a change for the Waimakariri River.

Projections of river flows by mid-century (2031 to 2050) for the Rakaia River indicate an increase in mean flow of 3% mostly due to a 14% increase in winter flows, (Collins *et al*. 2018). Low flows are not projected to have any significant change, but the mean annual flood flow is projected to increase by 18%.

Climate change projections of stream flows between 2036-2056 in agricultural land across Canterbury indicate changes to average flow, low flows, the timing of when low flows occurred, flow reliability, and mean annual flood, (Collins and Zammit, 2018). The only variable that showed any significant changes for the Selwyn district was the mean annual floods, which were projected to increase in the upper Canterbury Plains and foothills areas by 20 to 40%.

Foothill river flows (e.g. Selwyn and Kowai River) may decline over the next seventy years. This is a result of a small increase in evapotranspiration (Section 6). Overall, projecting to mid-century, any decrease in flow may be expected to be small compared to natural year to year variability of river flow.

Lowland drains, such as Doyleston Drain, are fed predominately from groundwater. Climate change futures in 2050 project a reduction in groundwater levels (Section 9) with a relatively minor impact on drain flows.

Beyond 2050 the uncertainty increases significantly and is highly dependent on climate future: with the projected increase in volatility of extreme rainfall events noted in section 7, it is reasonable to expect increased volatility in river flows. This means that infrastructure like bridges and stopbanks may become more susceptible to damage.

Furthermore, with the projected decrease in snowfall and shortening winter season, receding snowline and snow cover duration especially at lower elevations, the annual cycle of river flows in the Canterbury region may be significantly modified over time. For example, areas which traditionally experienced snow cover over winter months are projected to experience higher rainfall over these months increasing the chance of larger winter floods.

11 SEA LEVEL RISE

The key messages for this section are:

- **In the last 60 years, sea levels have risen by 2.44 mm per year (0.14 m). If global emissions remain high, sea levels will increase by a further 0.21 m by 2040 and 0.67 m by 2090 (MfE, 2020).**
- **Sea levels are projected to rise by up to 0.90 m by 2100 under RCP8.5.**
- **ESL (extreme sea level) events that are historically rare will become common by 2100 under all emissions scenarios.**
- **With SLR saltwater intrusion into coastal and surface waters and soils is expected to be more frequent and enter farther inwards.**

The 2020 *National Climate Change Risk Assessment* observes that sea levels around New Zealand have risen by 2.44 mm per year over the last 60 years or 0.14 m over this period. It also states that if global emissions remain high then sea levels will increase by a further 0.21 m by 2040, and 0.67 m by 2090. By comparison, if sea level follows the historical trend it would rise by 0.17 m by 2090.

Figure 22 shows measured and projected changes in mean annual sea level at Lyttleton (the closest sea level measurement to the Selwyn District's coastline) based on these estimates. The large disparity in projections indicates the considerable uncertainty associated with sea level rise (SLR).

Apart from having a potentially significant impact on ecosystems and available land for primary industries, shallow coastal groundwater systems become increasingly vulnerable to saltwater contamination with SLR (see section 14). The 2022 IPCC *Special Report on Ocean and Cryosphere in a Changing Climate* states that '*with rising sea levels, saline water intrusion into coastal aquifers and surface waters and soils is expected to be more frequent and enter farther landwards. Salinisation of groundwater, surface water and soil resources also increases with land-based drought events, decreasing river discharges in combination with water extraction and SLR (high confidence)*'.

To give a general picture of SLR futures, the IPCC report further states that '*sea level is rising and accelerating over time and will continue to rise throughout the 21st century and for centuries beyond' and that 'ESL [extreme sea level] events that are historically rare, will become common by 2100 under all emissions scenarios, leading to severe flooding in the absence of ambitious adaptation efforts (high confidence)*'.

In a presentation 'Future projections of sea level rise and the implications for our coasts: IPCC perspective' given in November 2022 in Sydney[2], the speaker and IPCC author Professor Nathan Bindhoff observed that '*SLR greater than 15 m cannot be ruled out'*. He further notes that '*small changes [in SLR] can be critical to sea level [and the incidence of extreme sea level (ESL) events]*'. This means that the consequences of even small projected changes in SLR given under certain emissions scenarios should not be underplayed in planning.

The *National Climate Change Risk Assessment* states that '*Many Māori communities are concentrated around coastal areas, which are particularly vulnerable to rising sea levels'*. We note that while it is not SDC infrastructure, Taumutu Rūnanga's marae, Te Pa o Moki, is close to the coast and may be impacted by SLR and ESL.

[2] https://nesp2climate.com.au/national-adaptation-forum-22

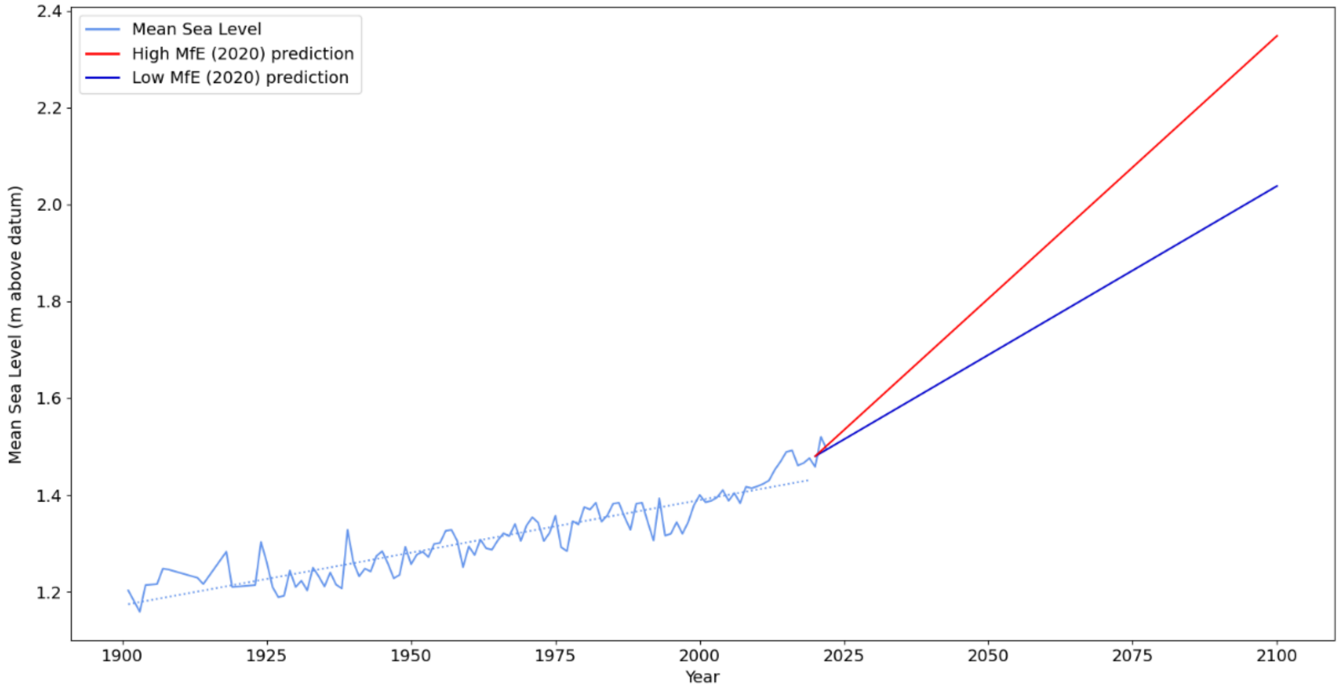


Figure 22. Measured and projected changes in mean annual sea level at Lyttelton: 1901-2050.

12 TE WAIHORA/LAKE ELLESMERE

The key messages for this section are:

- **Te Waihora / Lake Ellesmere is artificially managed to maintain a water level well below the lake's natural operating range.**
- **95% of the time lake levels are between 0.4 m to 1.2 m amsl (above mean sea level), although in an extreme rainfall event levels have been up to 1.8 m amsl.**
- **Sea level rise (SLR) may result in the lake needing to be opened more often or managed under a new operating range. If global emissions remain high, and without any change in lake management, lake levels are projected to rise by 0.21 m by 2040 and 0.67 m by 2090.**
- **Under RCP8.5 lake levels are projected to rise by up to 0.90 m by 2100.**
- **A higher lake level would result in more frequent flooding of areas around the lake (including lower Selwyn Huts) and would reduce the effectiveness of SDC's land drainage network.**
- **The installation of an outlet weir would allow lake levels to be maintained over a narrower range, which could alleviate some of the flooding problems that have occurred historically and offset a projected rise in sea levels.**

12.1 Lake water level management

The water level of Te Waihora has been artificially managed through creating a connection from the lake to the sea since at least 1860. Environment Canterbury estimate that without human intervention the lake level would rise to a range of 2.7 m to 3.6 m amsl before the opening was naturally breached. Environment Canterbury has been involved with Te Waihora openings through the former North Canterbury Catchment Board since 1947 (ECan, 2016). The lake level is managed relative to mean sea level. The National Water Conservation (Te Waihora / Lake Ellesmere) prescribes the levels at which the lake can be opened.

The method currently used to open the lake is to excavate a channel through the gravel beach using excavators, a dragline and bulldozers (Figure 23). This may take from a few days to weeks to complete, depending on the volume of gravel built up on the beach. Once the lake is opened, there is very limited ability to control how long it remains open. The duration of the opening is determined by weather and sea conditions and how quickly gravel is deposited by the sea to close the cut. The ability to successfully open the lake depends heavily on weather and sea conditions, particularly southerlies. Unfavourable weather conditions can cause significant delays in opening the lake (ECan, 2016).

Figure 23. Te Waihora Lake Opening Location

Over the last 30 year,s lake levels have been in the range of 0.4 to 1.2 m amsl 95% of the time. At the extremes, levels have been as low as 0.2 m amsl and as high as 1.8 m amsl. Historic levels are illustrated in Figure 24 and Figure 25. The area of inundation on 30 June 2013, when lake levels were at the highest recorded level of 1.81 m amsl, is shown in Figure 26.

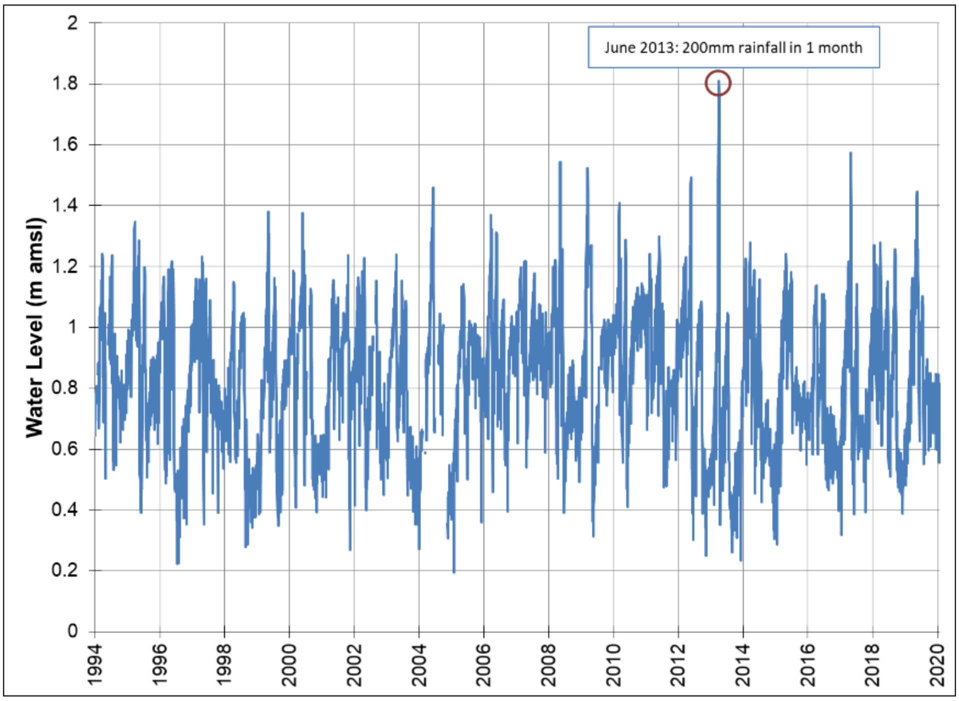


Figure 24. Te Waihora water levels 1994 to 2020.

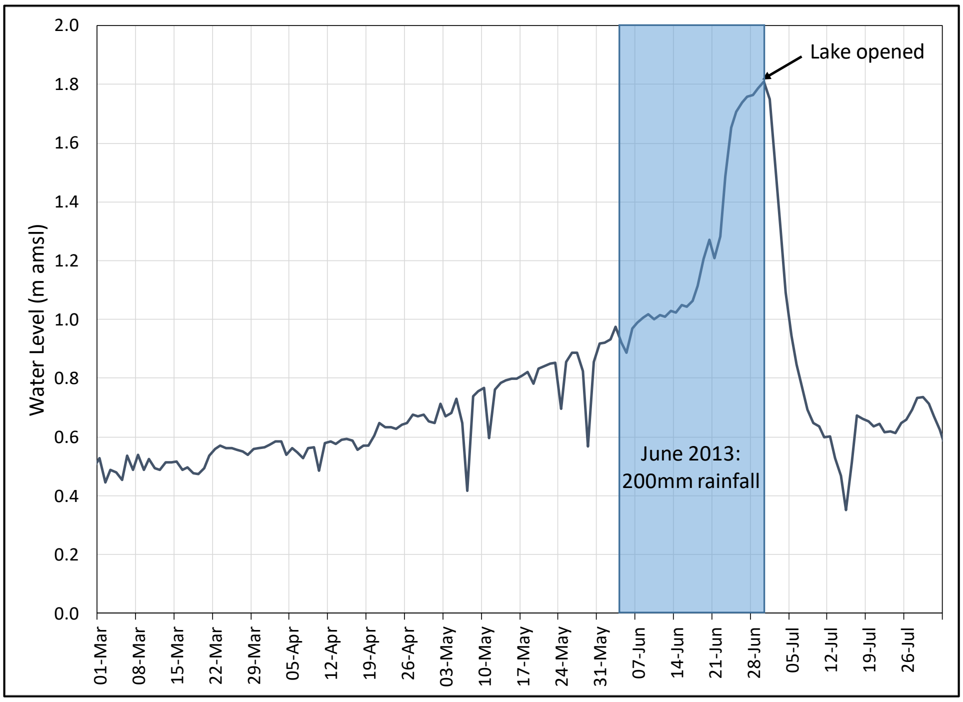


Figure 25. Te Waihora water levels Mar-Jul 2013.

Figure 26. Area inundated due to high lake levels: 30 June 2013.

Higher sea levels will affect Te Waihora/Lake Ellesmere water levels. Sea level rise will make it more difficult to achieve a successful lake opening, and may result in a higher mean lake level. Without any change in lake management, lake levels may rise by 0.21 m by 2050, with respect to the 1999-2019 levels, due to the level differential required to generate flow through the opening.

A higher lake level would result in more frequent flooding of areas around the lake and would reduce the effectiveness of SDC's land drainage network.

Lake levels could be maintained in a narrower range if infrastructure such as an outlet weir was installed, which could alleviate some of the flooding problems that have occurred historically. However, building any such infrastructure in the coastal environment is likely to be incredibly challenging.

12.2 Selwyn Huts

A higher lake level in Te Waihora would result in more frequent flooding of lower Selwyn Huts and may reduce the effectiveness of the Upper Selwyn Huts wastewater system.

The lower Selwyn Huts are already prone to flooding. Figure 28 shows that the settlement was entirely under water on 30 June 2013, when lake levels rose to 1.8 m amsl. Sea level rise has the potential to increase the frequency and magnitude of flooding.

The upper Selwyn Huts (settlement is approximately 2.5 m amsl) are less prone to flooding than the lower huts. However, the current wastewater system uses border dyke irrigation for effluent disposal.

Conditions of the resource consent for the wastewater system include:

- Disposal of wastewater will not result in runoff from the area.
- Disposal of wastewater will not result in discharge to areas where there is standing water, including ponded rainwater or ponded discharge. Also, it cannot occur under circumstances where the discharge is likely to cause ponding for longer than 24 hours.

Given these conditions, shallow groundwater levels are likely to be a concern. M36/0768 is a 27m deep well approximately 2 km to the northwest of the site. This has a long water level record (shown in Figure 27), which shows groundwater levels fluctuating between around 2m and 0.3m bgl. Although this may not be fully representative of shallow groundwater, one-off measurements in shallow bores in the area also show very shallow groundwater levels (from 0.1m to 1m bgl).

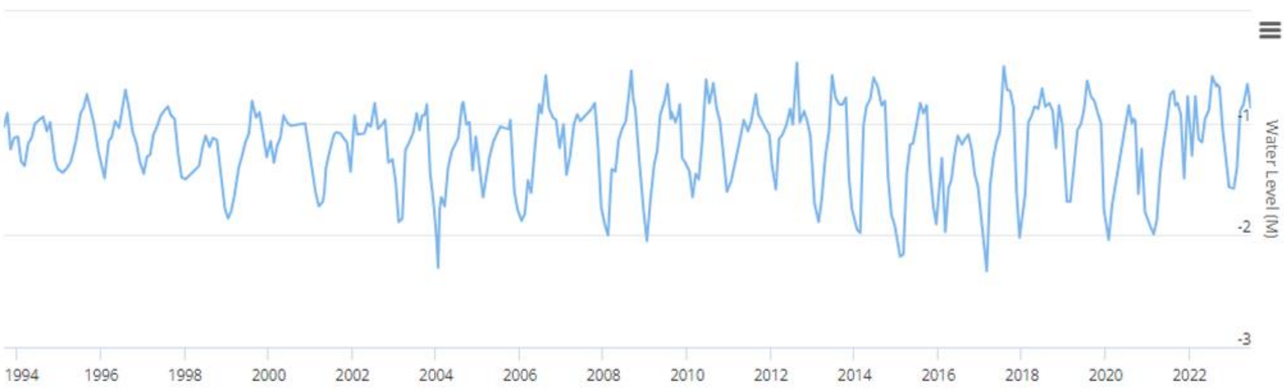


Figure 27. Water level record from bore M36/0768, 2km from Selwyn Huts.

Any factors that affect shallow groundwater are of concern in terms of not causing ponding or runoff. Shallow groundwater is likely to be affected by sea level rise, rising lake levels and increasing extreme events in this area. A long-term increase in sea/lake level will result in an increase in the long term average groundwater level. In addition to this, increasing extreme events are likely to cause short-term peaks in groundwater level that impact on the discharge of treated effluent over shorter time periods.

When lake levels are high irrigation cannot occur. SDC's preferred option at present is to pipe wastewater away from the site, replacing the current disposal system.

Figure 29 and Figure 30 show the difference that a 0.23 m rise in lake level would have had on the 30 June 2013 event. A 0.23 m rise was the maximum sea level rise predicted in the MfE (2008) report, which has now been updated with the MfE (2017) report with a more recent sea level rise prediction of 0.17-0.28 m amsl by 2050, relative to a 1999-2019 baseline (MfE 2017). As noted in the previous section, current estimates of sea level rise are of the order of 0.21 m by 2040 if global emissions remain high. Inundation maps have therefore not been updated since the 2016 climate change report for SDC (Brown *et al*, 2016). Actual impacts may differ because of the wide range of sea level rise scenarios.

Figure 28. Lower Selwyn Huts with a water level of 1.8 m amsl

Figure 29. Upper Selwyn Huts with a water level of 1.8 m amsl.

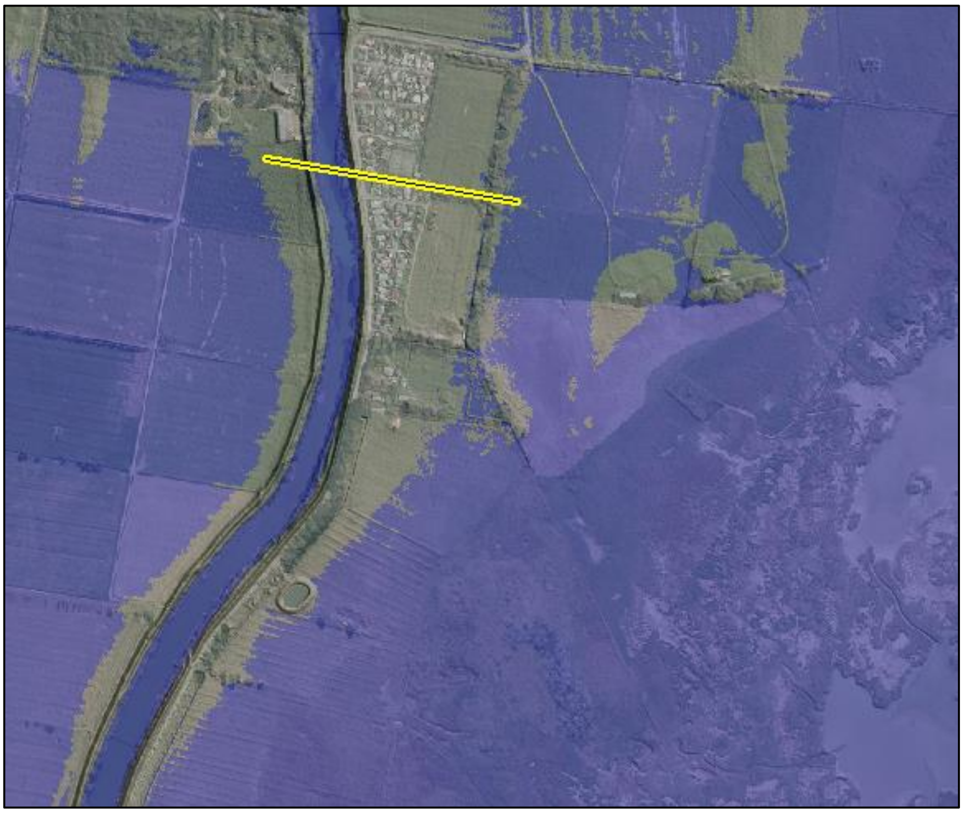


Figure 30. Upper Selwyn Huts with a water level of 2.03 m amsl.

12.3 Land drainage network

A rise in Te Waihora water levels (see Section 12.1) would reduce the effectiveness and flood capacity of SDC's land drainage network. A higher lake level both floods the land in the immediate vicinity of the lake, and increases the lengths of races that are affected by backwater effects. Backwater effects may occur when a rise in water levels at the end of a drain propagates back up the drain, resulting in reduced flow and drainage capacity. For example, Figure 31 shows that for the Ararira / LII drainage network, during a moderate flood, backwater effects can increase water levels in the drains, up to 1.0 m above the level of the Te Waihora lake level (from Samad 2007, Figure 6-17).

During an extreme event, such as on 30 June 2013, lake levels may rise up to 1.8 m above sea level. Allowing for 1 m of backwater effects, and given a typical drain depth of 1 m, this means lake levels can affect land drainage up to an elevation of about 3.8 m amsl (1.8+1.0+1.0). Figure 32 and Figure 33 provide a coarse assessment of the difference that an additional 0.23 m increase in lake water level would make on the affected drainage area. These figures show that there is little difference between the affected areas because there is a reasonable slope on the Canterbury Plains above an elevation of about 2.0 m amsl. Because of this slope, the updated sea level rise maximum prediction of 0.21 m amsl by 2050 (relative to a 1999-2019 baseline) would also show little difference in the affected areas.

Higher water levels in the Ararira / LII drainage network summer, further away from Te Waihora where backwater effects are not significant, are a result of macrophyte growth, and can be addressed via maintenance practices.

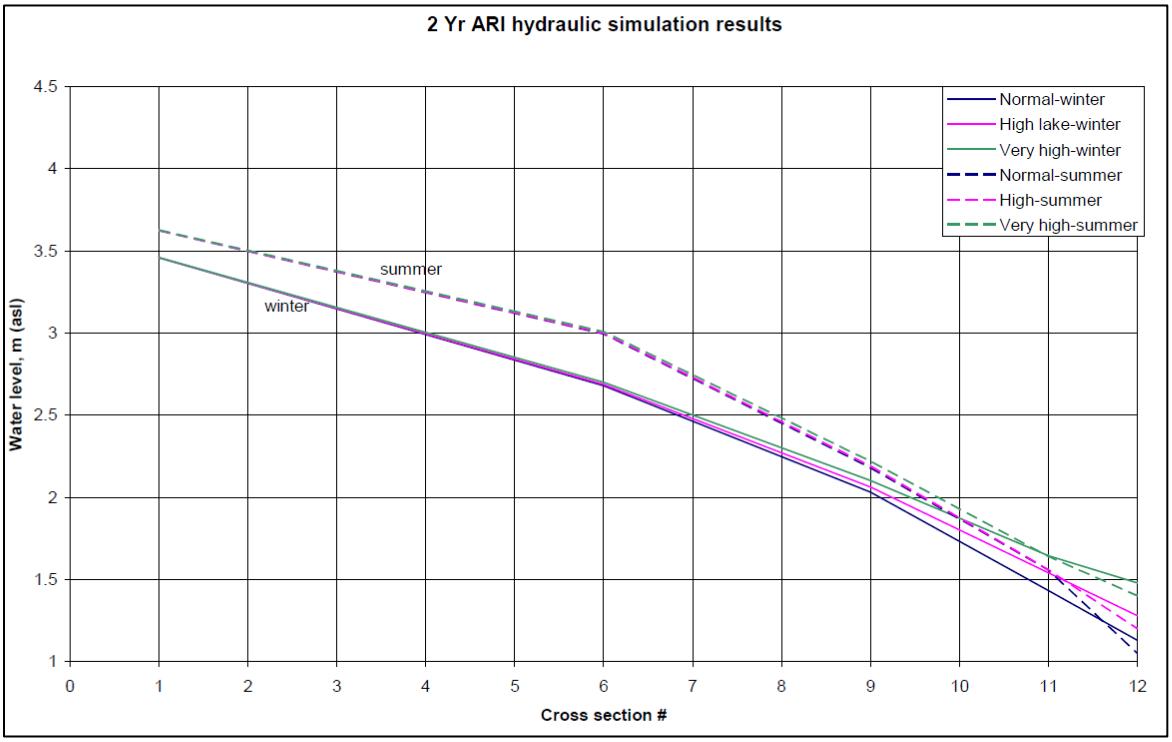


Figure 31. Backwater impacts in Ararira / LII drainage network during a moderate storm event.

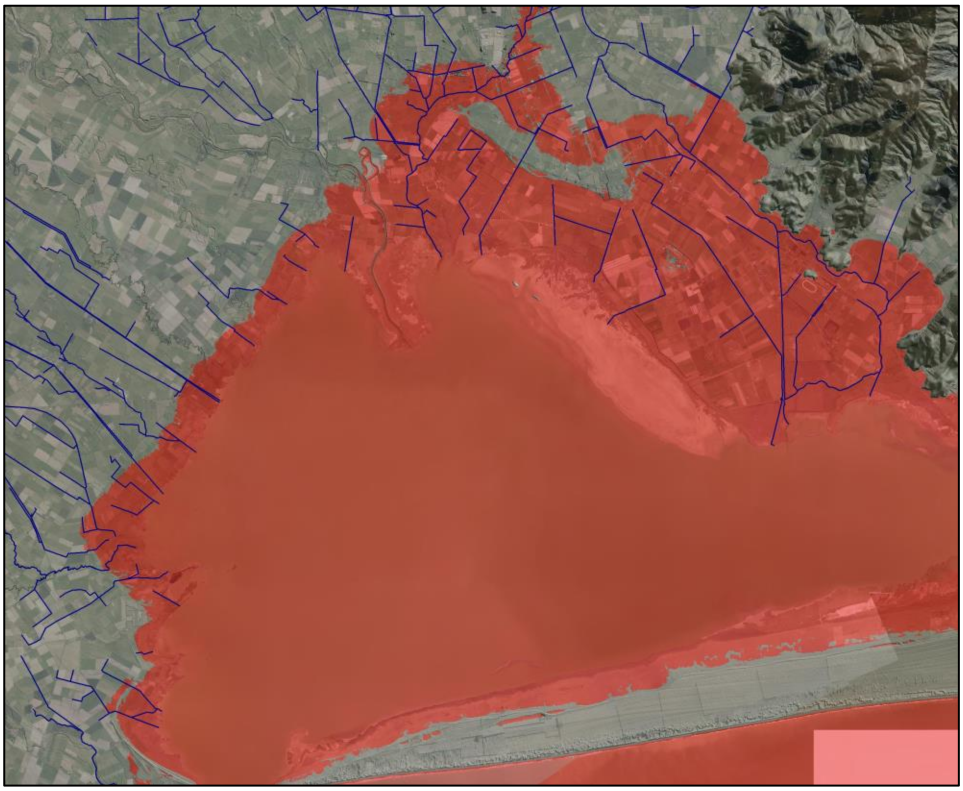


Figure 32. Maximum extent that lake levels affect land drainage (3.80 m amsl).

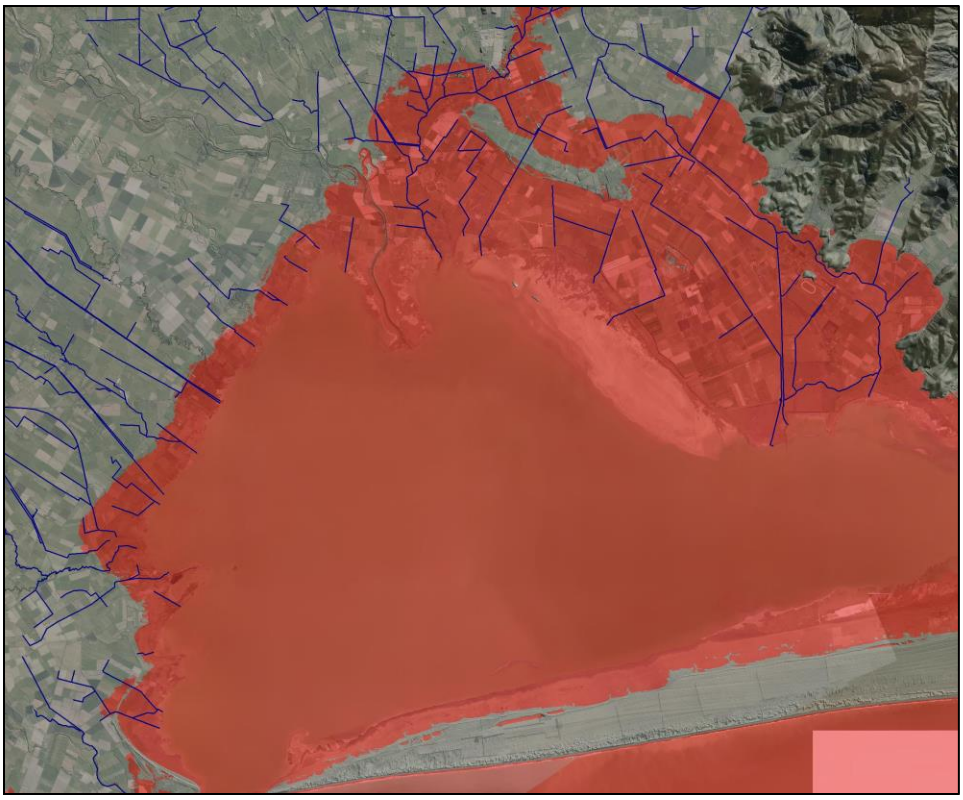


Figure 33. Maximum extent that lake levels affect drainage (4.03 m amsl).

13 RAKAIA MOUTH

The key messages for this section are:

- **Projected increase in SLR of 0.21 m by 2050 may increase the frequency of 'normal' flooding at Rakaia Huts.**
- **Furthermore, the projected increase in frequency of extreme sea level (ESL) means that the Rakaia Huts will be more exposed to catastrophic flooding.**

The lowest point at Rakaia Huts is about 3.5 m amsl. The huts are protected from the sea by a sand bar, and periodically flood when the Rakaia Mouth is closed. The balance between deposition and erosion at the river mouth and coast is highly dynamic due to river floods and coastal erosion/deposition.

Figure 34 and Figure 35 show the impact of a 0.21 m sea level rise could have on flooding, which is minor. However, the projected increase in frequency of extreme sea level (ESL) means that the Rakaia Huts will be more exposed to extreme flooding events. This needs to be taken in combination with the impacts of coastal and river processes, noting that the single biggest factor that currently controls flooding is whether the river mouth is open.

Projecting to 2100, the magnitude of impacts is highly dependent on emissions scenario.

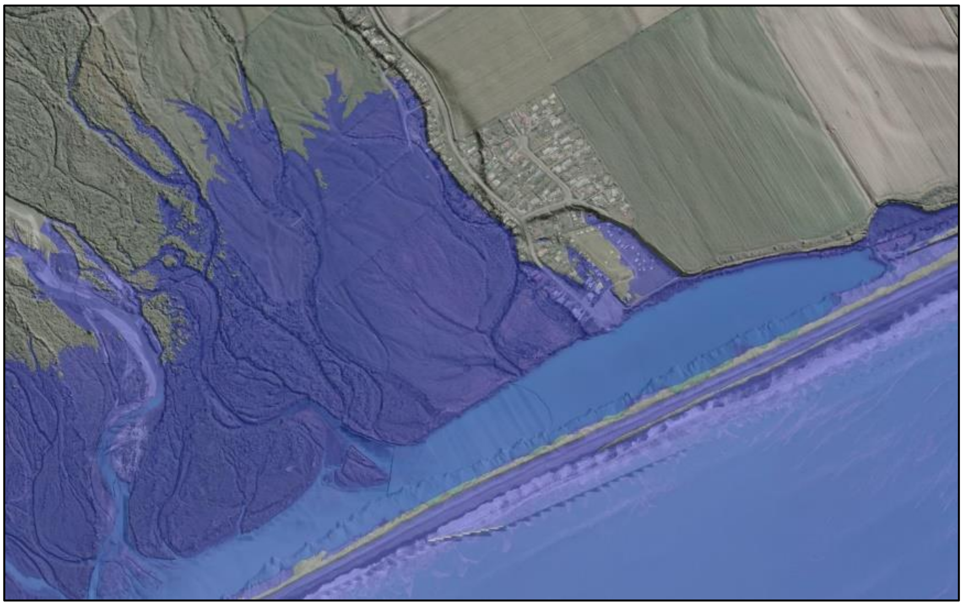


Figure 34. Rakaia Huts with a flood water level of 4.00 m amsl.

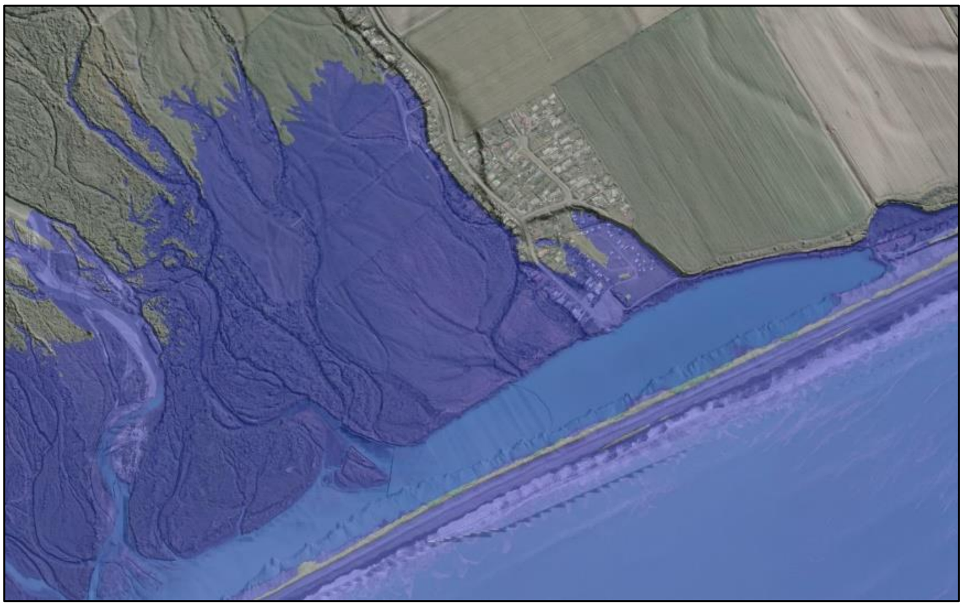


Figure 35. Rakaia Huts with a water level of 4.21 m amsl.

13.1 Rakaia Huts – Culturally Significant Area

Rakaia Huts is a small seaside settlement located on the northern side of the Rakaia River mouth. This was traditionally an early area of occupation and food gathering for local Māori which now holds a high cultural and archaeological significance, particularly to Te Taumutu Rūnanga and Te Rūnanga o Ngai Tahu. This is one of the earliest dated sites in Canterbury so holds regional significance, and with very few (if any) sites of this type, it is also nationally significant. The close proximity of this area to the sea and river, creates the risk of damage or partial loss from natural processes influenced by climate change and more specifically, flooding and sea-level rise. SDC has developed the Rakaia Huts Conservation Plan (2009), that addresses threats to the significant cultural value of the area and inform future management.

The Rakaia River is a braided river with many constantly shifting channels. At the sea entrance the river has created a bar to the east with a lagoon extending behind it. The size and location of the river entrance, bar and lagoon are ever changing by the erosional and depositional processes occurring at the river mouth. Rakaia huts is located on the landward side at the eastern end of the lagoon. The areas of cultural significance from Māori inhabitance were associated with moa and moa hunting, with evidence of hundreds of ovens, some middens, and several house sites, found on the upper and middle terraces. These areas have been mapped by archaeologists and include the foreshore, Rakaia Huts settlement, camping ground, and some surrounding agricultural land (Figure 36).

Figure 36. Figure from Rakaia Conservation Plan (2009), showing areas of Rakaia Huts with Maori artefacts and their management zones.

Climate change over the next 100 years has the potential to cause erosion or damage to the culturally significant areas at Rakaia Huts. A coastal hazard assessment of the north Rakaia Huts settlement has been conducted by Cope (2019) to identify future coastal hazard risk and vulnerability to this small coastal settlement.

A detailed study into the area by Cope (2019) indicates there is an erosion risk to the archaeological area. An eroding archaeological oven can be seen in the road edge at Rakaia Huts along the front of the lagoon (Rakaia Huts Conservation Plan, 2009). The archaeological areas on the higher plains surrounding the huts will be less prone to erosion as they are not as steep as the road cutting, are further from the sea and are more protected from the elements. We note that SDC are not specifically responsible for preserving the archaeological sites.

Cope (2019) also identifies flooding as a primary risk to the township and identified several factors that have contributed to past flooding events; river channel outlet position, gravel beach barrier height, river freshes that don't breach the coastal barrier, and storm waves overtopping the beach barrier. Cope (2019) used a conservative 'bathtub' approach (assumes the inland area will be inundated to the equivalent static sea level as the open coast/lagoon) and the MfE (2017) guidance of a sea level rise with the RCP8.5H+ scenario, to predict a potential future floodable area of all land in this area below 5.8 m, over the next 100 years. Figure 36 shows potential inundation of part of the 'Middle Terrace built up area' historical management area identified in the Rakaia Huts Conservation Plan (2007). In the archaeological investigation conducted as part of the Rakaia Huts Conservation Plan (2007) this residential area is considered a moderate to high potential for containing archaeological material, therefore inundation or flooding of this area may damage archaeological artefacts.

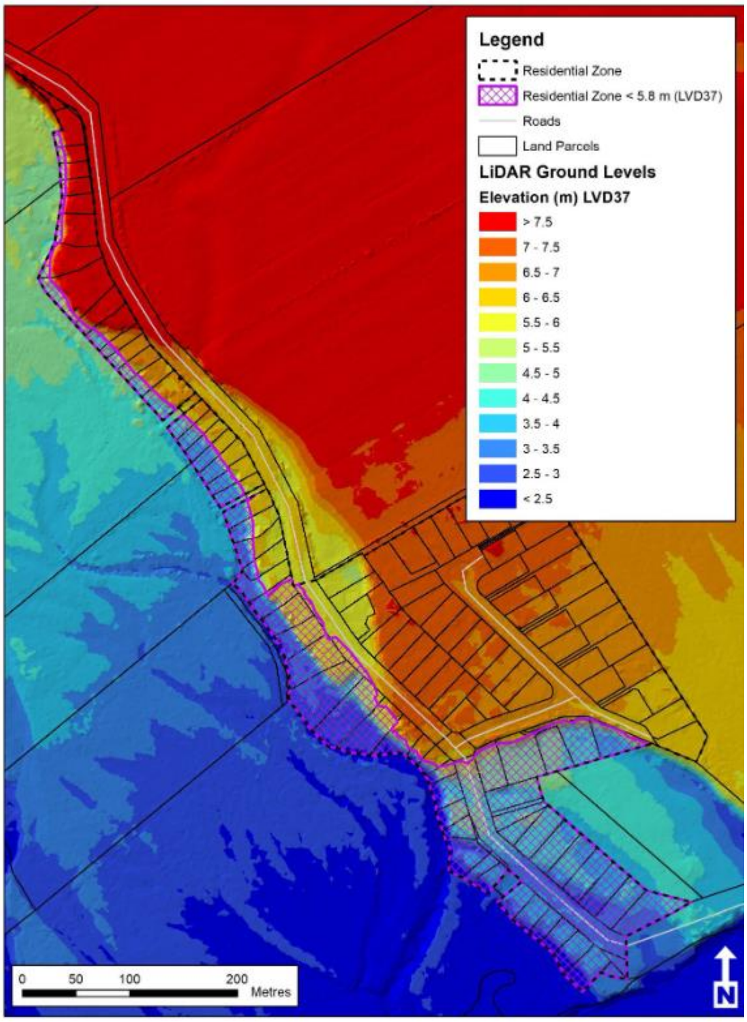


Figure 36: Figure from Cope (2019) showing potential floodable area within the residential zone, based on ground elevation and the MfE 2017 sea level rise prediction.

Coastal erosion was identified as another main risk to the township in the assessment conducted by Cope (2019). Figure 37 shows approximately 30 m of shoreline migration where the bank top is likely to erode into the lagoon over the next 100 years (based on MfE (2017) sea level rise prediction). This area encompasses the foreshore area, and the coastal road where artefacts have been recorded in the road cutting (Rakaia Huts Conservation Plan (2009)), but no residential or council owned land.

Figure 37: Figure from Cope (2019) showing the potential shoreline (bank-top) and the coastal erosion predicted in 100 years.

Based on previous studies of the cultural significance of the area surrounding Rakaia Huts, and coastal risks to the settlement, it is obvious that the risk to a significant cultural area is high. The foreshore area is expected to be the most impacted by coastal erosion and the management area the 'middle terrace built up area' is expected to be inundated or flooded in 100 years. The 'upper terrace' areas will likely avoid significant erosion or flooding in the next 100 years, and the camping ground area may potentially lose a small amount of land to erosion.

A large majority of the Māori artefacts associated with this site remain buried (Rakaia Huts Conservation Plan (2009)) at present.

Although the inundation and erosion estimates from Cope (2019) give an indication to what is likely expected over the next 100 years, it is noted that coastal and river-mouth processes are complex and interconnected and therefore difficult to predict the impact they may have on surrounding sediments. Artificial infilling or protection works along this stretch of coast may be useful to slow the rate of erosion and preserve the culturally significant area but would need to be well-planned and prevent damaging the soils surrounding this area that may also contain artefacts.

14 GROUNDWATER AND SEA LEVEL RISE

The key messages for this section are:

- **SLR level rise of ~0.21 m would lead to a moderate increase in the phreatic surface (water table) near the coast.**
- **Moderate SLR and the increased occurrence of ESL events will mostly impact groundwater and soil quality.**
- **Projecting to 2100 the impacts of SLR on coastal aquifers are highly dependent on emissions scenario.**
- **To prepare for impacts of future SLR on coastal aquifers we recommend a special study on SDC's coastal groundwater.**

Sea level rise (SLR) will lead to higher groundwater levels (jn the shallow aquifer) and saline intrusion near the coast. While SLR of ~0.21 m would lead to a moderate increase in the height of the phreatic surface (water table) near the coast, the impact of SLR on saline intrusion is much less clear. Projecting to end of century, SLR, and hence the impacts on coastal aquifers, could be significantly greater and is highly dependent on the emissions scenario.

Perhaps of greater concern to asset managers when considering the impacts of SLR on coastal aquifers and soil quality are extreme sea level events (ESLs). The 2022 IPCC special report[3] on the cryosphere notes that '*events which are currently rare (e.g., with an average return period of 100 years), will occur annually or more frequently at most available locations for RCP8.5 by the end of the century (high confidence*)'.

The special report considers that SLR will '*mostly impact groundwater quality and in turn exacerbate salination induced by marine flooding events'*. SLR may also lead to soil degradation through salination.

The report notes the importance of improving observational systems for preparing for future SLR. Given the large uncertainties associated with coastal groundwater, we emphasise the need to improve observational systems to improve our understanding of the impacts of SLR on coastal aquifers. These range from direct measurements of groundwater quality to geophysical imaging techniques.

Groundwater, generally, is characterised by large uncertainties due mainly to the sparsity of measurements. Given that large-scale groundwater contamination and soil degradation through salination is likely to be irreversible, we recommend a special study on SDC's coastal groundwater and sea level rise.

[3] section 4.2.3.4.1

15 RISK ASSESSMENT FRAMEWORK

The following sections contain our risk assessment for the following SDC assets:

- Potable water supply,
- Wastewater,
- Stormwater,
- Land drainage
- Water races
- Transportation assets
- Facilities and open spaces
    - Community facilities
    - Developed open spaces.

The district has been divided into three zones (alpine hills and high country, plains, coastal and lower plains), see Figure 37. Environmental factors (e.g. 'temperature' or 'rainfall') are partitioned by zone (e.g. 'extreme rainfall' occurs in all 3 zones) while 'sea level rise' only occurs in the coastal and lower plains zone. Global factors like 'temperature' with similar asset impacts in all zones are grouped together in 'All zones'.

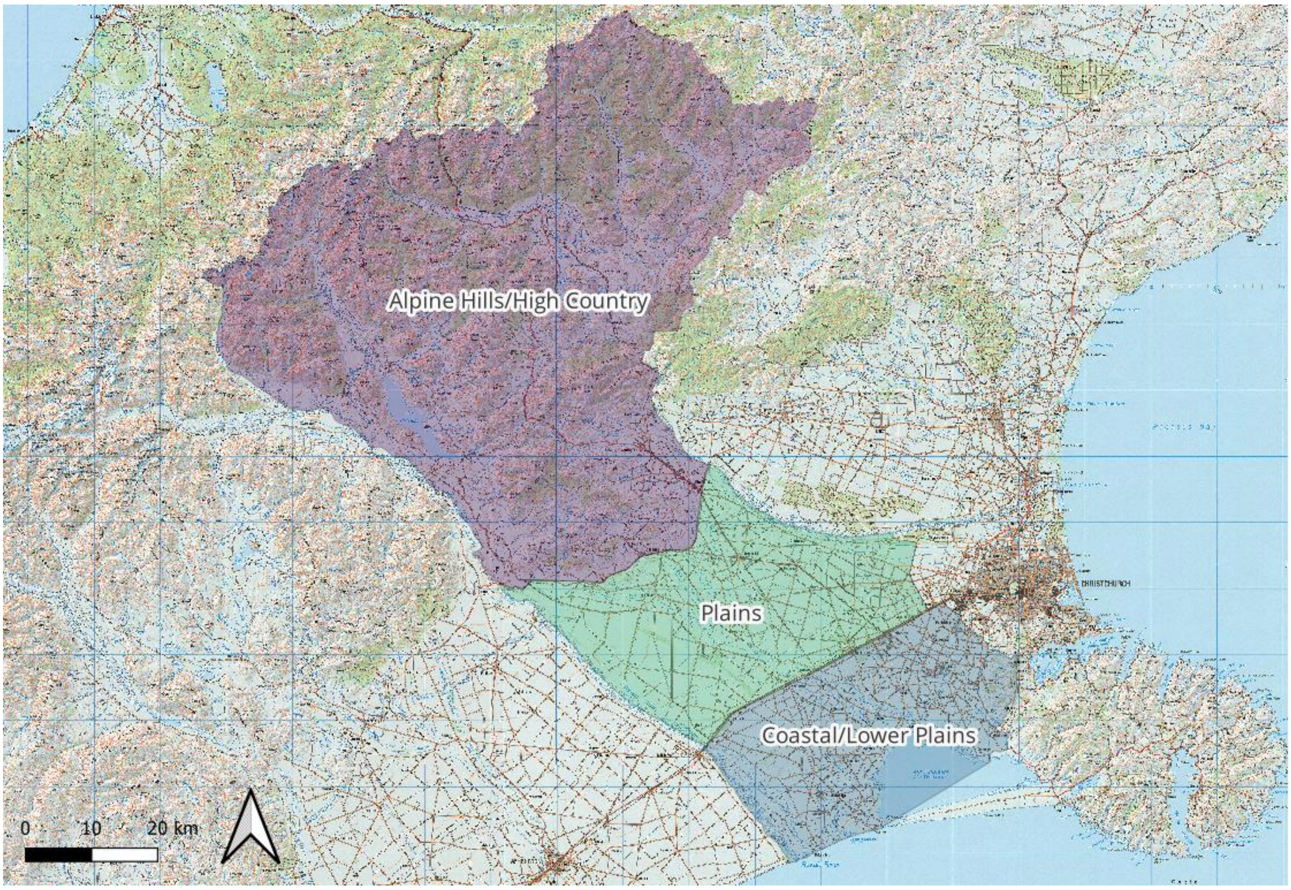


Figure 37. Zone map for Selwyn District

The 'asset impacts' column contains a summary of impacts that result from a projected change to an environmental factor like temperature or river flow. The term 'None' means that there is no obvious impact resulting from a projected climate change future to 2050. Actual impacts may different significantly if the climate turns out worse than projected climate change futures.

We have confined our risk assessment to projecting to 2050 since projected climate futures to 2100 are highly dependent on emissions scenario, and consequently the envelope of uncertainty projecting to 2100 is large. For simplicity we have assigned three levels of risk (‘low’, ‘medium’, and ‘high’) which are a function of the assessed vulnerability (consequence) and the likelihood of impact. Note that these levels are relative to the asset class considered.

There is inevitably a large degree of subjectivity in assigning levels of risk to individual asset classes. In the main we have assigned ‘high risk’ to extreme weather events like extreme rainfall which impacts all assets classes negatively, while we have assessed certain extreme events like drought to impact portability water availability more severely than wastewater or stormwater, for example. Of more relevance to decision makers/planners than the absolute level of assigned risk (which is subjective) are the relative differences between different asset classes and different environmental factors.

Our assessment should be compared with Tonkin and Taylor’s *Canterbury Climate Change Risk Assessment (T+T, 2022).* This report differs substantially from the Tonkin and Taylor report for several reasons including:

- difference of spatial scale – the T+T report covers all of Canterbury and includes all stakeholder and asset owner interests. This report is focused solely on the Selwyn District and the council’s assets.
- granularity – Selwyn district is portioned into three zones (high country. plains and low plains/coastal) and an assessment of risks to assets has been given for each zone

The T+T report has four risk levels (‘low’, ‘moderate’, ‘high’ and ‘extreme’) instead of three. As an example of the difference between the current report and the T+T report, risk to groundwater availability due to sea level rise is assessed as ‘extreme’ for all climate futures in the T+T report whereas we have assessed it to be low (but with substantial uncertainties, refer section 14). SLR poses a significant risk to shallow coastal groundwater systems but since SDC groundwater is sourced from relatively deep bores our assessment is that (moderate) SLR will not significantly impact SDC’s potable water supply projecting to 2050. We also think that effects may be different on shallow and deeper coastal aquifers; while water levels of shallow coastal groundwater systems may increase due to SLR, water levels in deeper wells are projected to decrease on average. Thus, low groundwater levels in deeper bores may impact supply reliability while shallow aquifers may show a moderate increase in the water table.

16 POTABLE WATER SUPPLY

The key conclusions for this section are:

- **Projecting to 2050, environmental factors impacting potable water supply assessed as high risk relate to the occurrence of more extreme weather events.**
- **Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.**
- **Projecting to 2100, climate change impacts on potable water supplies are highly dependent on emissions scenario.**
- **In all emissions scenarios the occurrence of extreme weather events is likely to increase.**

SDC manages 26 potable water supplies. These supplies service 80% of the residential properties within the district. Maps of the schemes are shown in Figure 38 and Figure 39.

Estimated climate change impacts and risk assessment are summarized in Table 18. Environmental factors assessed as high risk mainly relate to the occurrence of more extreme events, like extreme rainfall. These will likely increase under all emissions scenarios. It is impossible to predict the probability of catastrophic failure given the rapidly changing environment; however, recent countrywide experience supports a strategic review of SDC potable water supply assets and the development of an emergency plan focused on emergency water supply.

Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small. However, this does not mean that potential impacts should be ignored. A general message of the IPCC special report on the cryosphere is the need to improve observational data.

Evapotranspiration is likely to increase in all scenarios. With the projected higher incidence of longer periods of drought, peak water demand will increase. Combined with lower groundwater levels this may impact supply reliability during summer months.

SDC have three potable water supplies near the coast: Rakaia Huts (consent CRC991055, Bore L37/0545), Taumutu (consent CRC010894, Bore M37/0106) and Upper Selwyn Huts (consent CRC146688, Bore M36/0529).

The Rakaia Huts bore is 23 m deep. It is a high-yielding well with a take of 12 l/s and a specific capacity of 27 l/s/m. The bore has a static water level of about 5.4 m amsl and is located 1.3 km from the coast.

The Taumutu bore is 73 m deep and 600 m inland from the coast. The consented take from this bore is less than 1 l/s averaged over a day. The bore is flowing artesian. Saltwater intrusion is expected to pose minimal risk to this bore due to its depth and artesian pressure.

The Upper Selwyn Huts bore is 67 m deep and 800 m from Te Waihora. Saltwater intrusion is expected to pose minimal risk to this bore due to its depth and artesian pressure.

While sea level rise of 0.23 m is expected to increase the risk of saltwater intrusion only slightly, long-term future monitoring of the salinity of coastal water supply assets is a prudent step.

Beyond 2050 there is much less certainty about impacts on SDC's potable water supply which is highly dependent on emissions scenario. To close the data gap, we recommend further investigation and strategic review of climate change impacts and risks on SDC groundwater assets, particularly in the lower plains and coastal area, considering the interactions between the groundwater system and sea level rise.

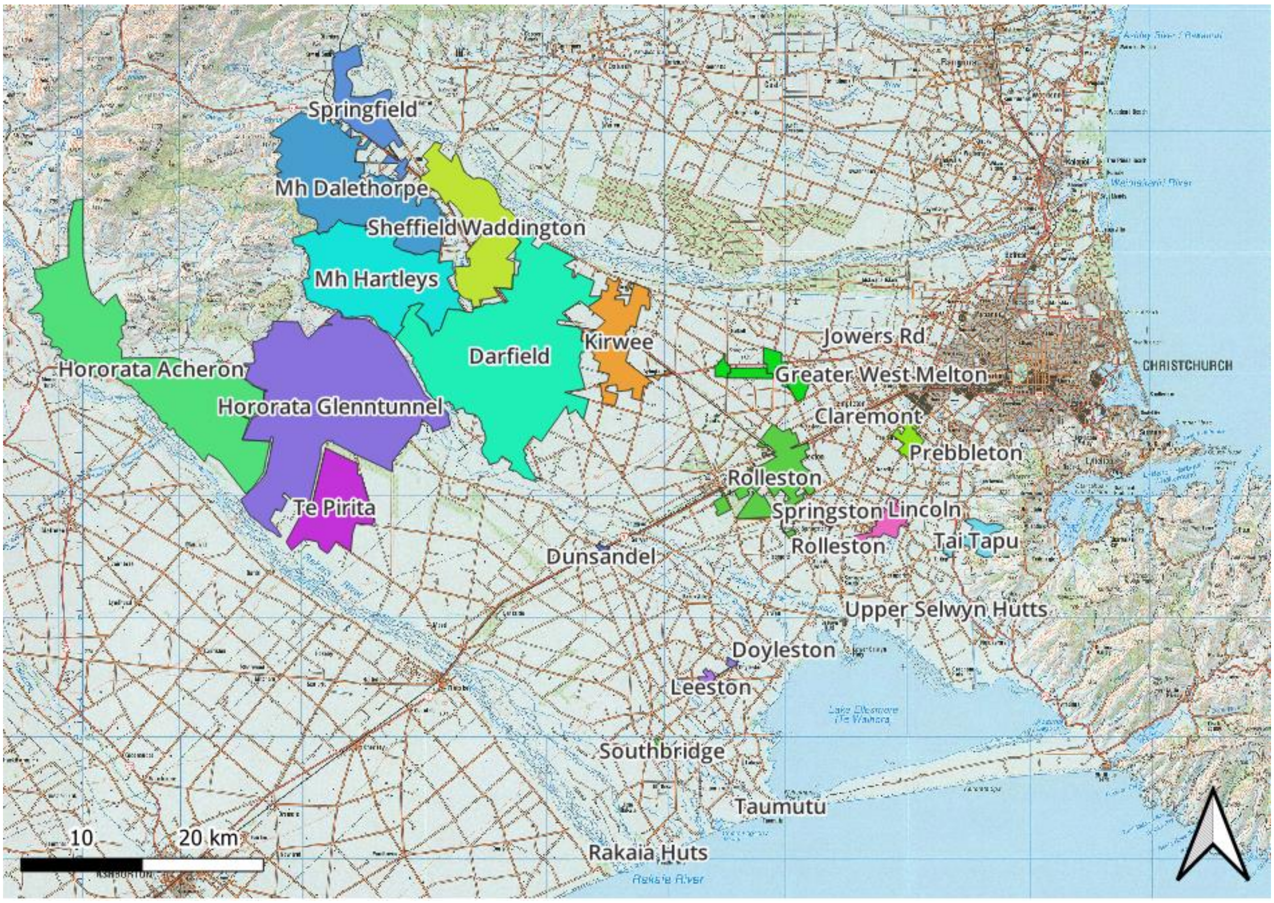


Figure 38. SDC potable water supply schemes – Canterbury Plains.

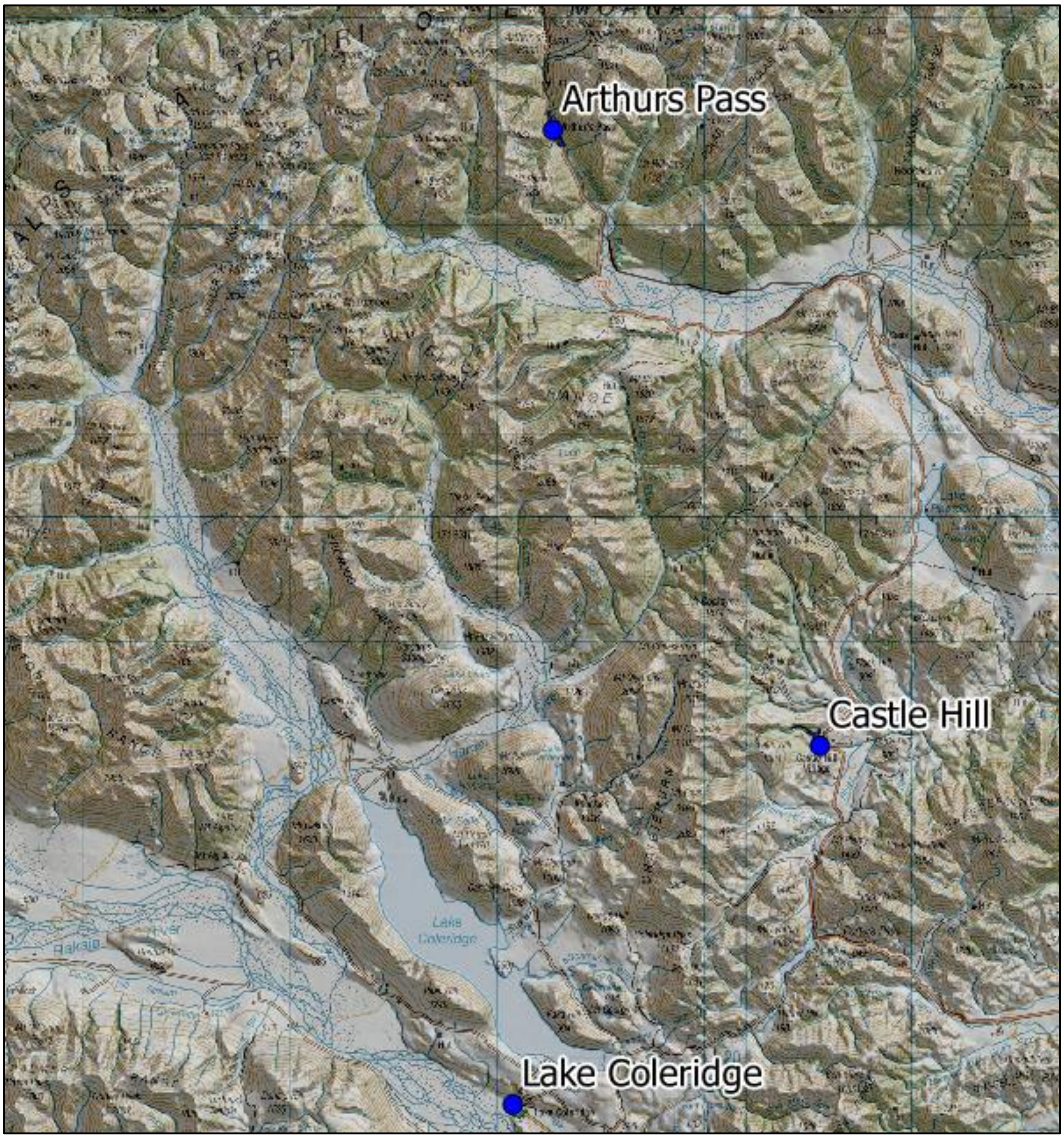


Figure 39. SDC potable water supply schemes – Alpine.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Minor	Increased peak summer water demand	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	Medium
	Annual rainfall	Moderate	Reduced supply reliability; increased water demand	±5% change in average annual rainfall	Low	Low
	Drought	High	Increased peak summer water demand; reduced supply reliability (SW takes)	±5 change in number of dry days	Medium	High
	Evapotranspiration (ET)	Moderate	Increased summer water demand; reduced supply reliability	PED increase of 50-100 mm per year	Medium	Medium
	Wind (excluding ET impacts)	Moderate	Wind damage to assets in a storm	Increase in average wind speed 2-10%	Medium	Medium
	Alpine river flows	Moderate	Reduced supply reliability; increased flood damage to intakes	3% increase in alpine river mean flows, biggest increases in winter	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Intake damage from floods; turbidity.	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	High	Supply reliability - low flows. (e.g. Kowai)	3% increase in alpine river flows, biggest increases in winter	Medium	High
	Snow levels and ice	Minor	Harder access in winter	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	Minor	None	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	Low
	Snow levels and ice	Minor	Asset damage in extreme snowfall events (potential benefit)	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	High	Low GW levels, supply reliability	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Medium
Coastal and lower plains	Sea Level rise	Minor	Saltwater contamination	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Low
	Extreme rainfall events (Coastal)	Moderate	Water quality (wellhead security) (e.g. Upper Selwyn Huts)	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Minor	Low gw levels, supply reliability. (Note links to SLR)	Generally moderately reduced groundwater levels; unquanitifed interactions with SLR.	Low	Low

Table 18. Estimated climate change impacts and risk assessment on SDC potable water supplies projecting to 2050

17 WASTEWATER

The key conclusions for this section are:

- **Projecting to 2050, environmental factors impacting SDC wastewater assessed as high risk relate to the occurrence of more extreme weather events.**
- **Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.**
- **Higher alpine rainfall and flood flows will likely result in an increase of stormwater inflows for the Arthurs Pass, Castle Hill and Lake Coleridge wastewater systems.**
- **An increase in sea level rise of ~0.21 m may impact Upper Selwyn Huts and Rakaia Huts wastewater systems.**
- **Projecting to 2100, climate change impacts on SDC wastewater assets are highly dependent on emissions scenario.**
- **In all emissions scenarios the occurrence of extreme weather events is likely to increase.**

SDC manages 15 reticulated wastewater systems that service 67% of properties within the district. A map of the schemes is shown in Figure 40 and Figure 41. Estimated climate change impacts and risk assessment are summarized in Table 19.

Environmental factors assessed as high risk on SDC's wastewater assets mainly relate to the occurrence of more extreme events, like extreme rainfall. These will likely increase under all emissions scenarios.

Sea level rise (SLR) may impact the Upper Selwyn Huts border-dyke wastewater disposal system (Section 12.2) and the risk of flooding at Rakaia Huts (Section 13). SLR may also impact the Lakeside wastewater system, which has not been assessed in this report.

Under current projections climate change is likely to have a more significant impact in alpine areas. The projected increase in mean annual rainfall and flood flows which may impact Arthurs Pass, Castle Hill, Lake Coleridge and Springfield wastewater systems.

NIWA (2020) project increases in annual mean wind speed of the order of 2-10% for much of Canterbury by 2090 under RCP8.5 (Section 8.2). This may result in an increase in the frequency of wind damage during storms.

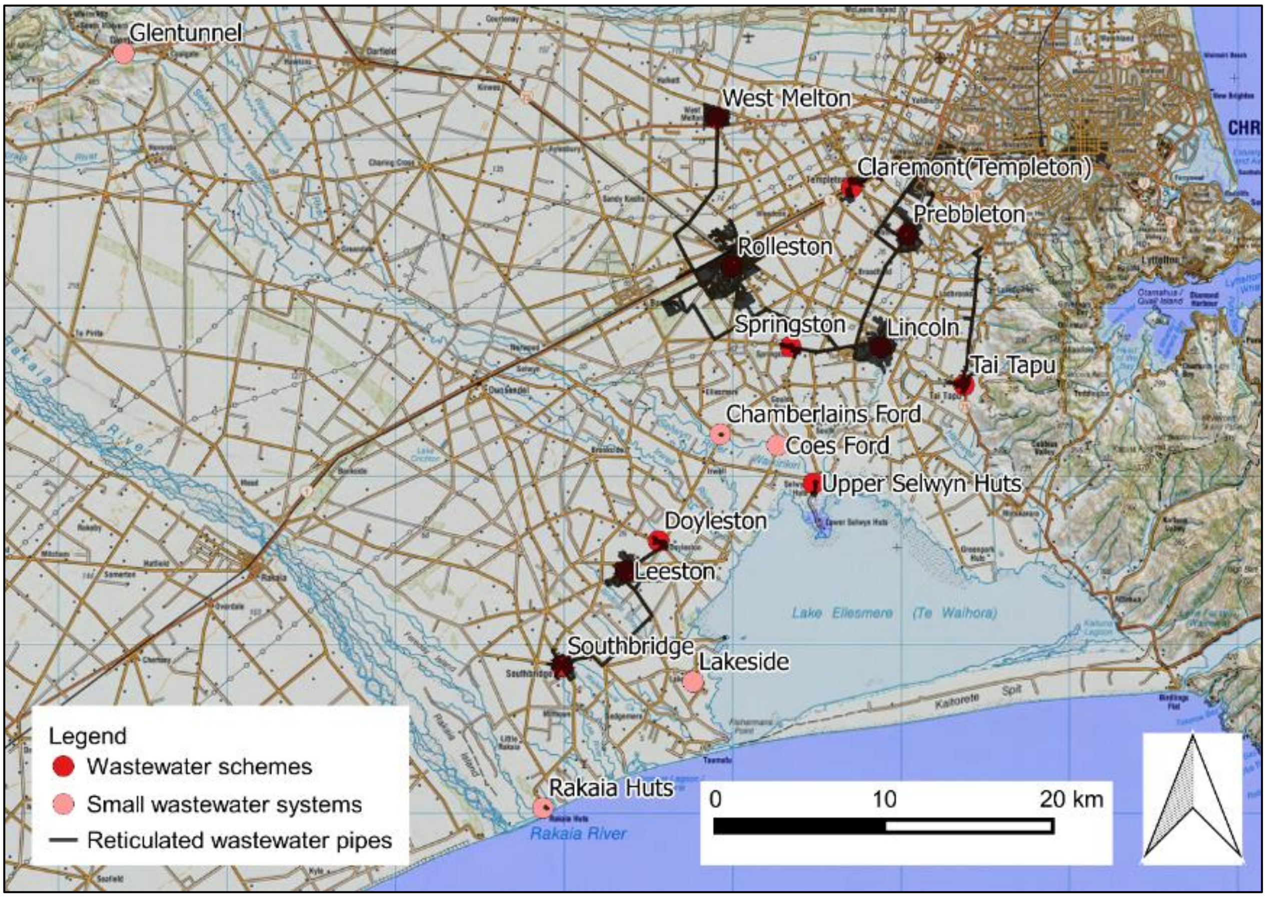


Figure 40. SDC wastewater schemes – Canterbury Plains.

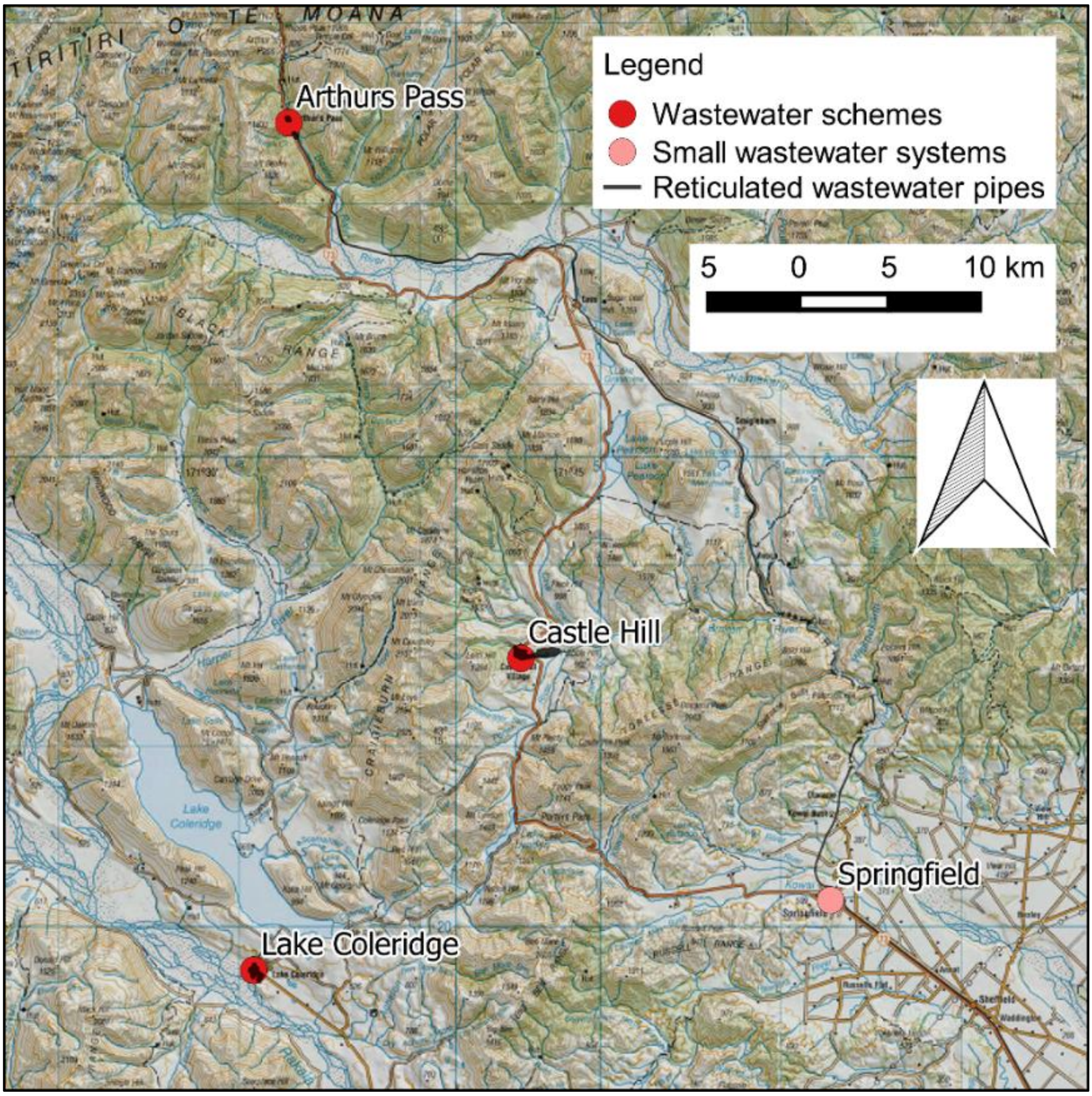


Figure 41. SDC wastewater schemes – Alpine and foothill.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Minor	Efficiency of treatment processes and sludge drying (potential benefit). Odour issues. Algal blooms on ponds.	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	Medium
	Annual rainfall	Moderate	Ability to discharge treated WW to land (potential benefit)	±5% change in average annual rainfall	Low	Low
	Drought	Minor	Ability to discharge treated WW to land (potential benefit)	±5 change in number of dry days	Medium	Low
	Evapotranspiration (ET)	Minor	Ability to discharge treated WW to land (potential benefit)	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	Moderate	Wind damage to assets in a storm	Increase in average wind speed 2-10%	Medium	Medium
	Alpine river flows	Minor	None	3% increase in alpine river mean flows, biggest increases in winter	Medium	Low
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	Moderate	Inflow.	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	Minor	None	3% increase in alpine river flows, biggest increases in winter	Medium	Low
	Snow levels and ice	Moderate	Ability to discharge to land (potential benefit)	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	Moderate	Inflow.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	Asset damage in extreme snowfall events (potential benefit)	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	Reduced infiltration (potential benefit)	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Moderate	Ability to discharge -e.g. Selwyn Huts. Inflow and Infiltration.	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Medium
	Extreme rainfall events (Coastal)	Moderate	Inflow.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Moderate	Ability to discharge -e.g. Selwyn Huts. Infiltration (higher GW levels - note links to SLR).	Generally moderately reduced groundwater levels; unquantified interactions with SLR.	Low	Low

Table 19. Estimated climate change impacts and risk assessment on SDC wastewater assets projecting to 2050.

18 STORMWATER

The key conclusions for this section are:

- **Projecting to 2050, environmental factors impacting SDC stormwater assessed as high risk relate to the occurrence of more extreme weather events.**
- **Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.**
- **Higher alpine rainfall and extreme rainfall events may result in an increase in occurrence of surface flooding at Arthurs Pass, Castle Hill and Lake Coleridge.**
- **An increase in sea level rise of ~0.21 m may impact the efficacy of the stormwater system during coastal storm events at Rakaia Huts.**
- **Projecting to 2100, climate change impacts on SDC stormwater assets are highly dependent on emissions scenario.**
- **In all emissions scenarios the occurrence of extreme weather events is likely to increase.**

SDC manages 22 stormwater management areas within the Selwyn District. These are all urban in nature and have infrastructure in place to collect, convey and dispose of surface water. Many areas also manage stormwater in terms of water quality and quantity. A map of the management areas is shown in Figure 42 and Figure 43. Estimated climate change impacts and risk assessment are summarized in Table 20.

Environmental factors assessed as high risk on SDC's stormwater assets mainly relate to the occurrence of more extreme events, like extreme rainfall. These will likely increase under all emissions scenarios.

Under current projections climate change is likely to have a more significant impact in alpine areas. The projected increase in mean annual rainfall and flood flows which may impact Arthurs Pass, Castle Hill, Lake Coleridge and Springfield stormwater systems.

Sea level rise (SLR) increases the risk of the stormwater system at Rakaia huts being inundated during coastal storm events.

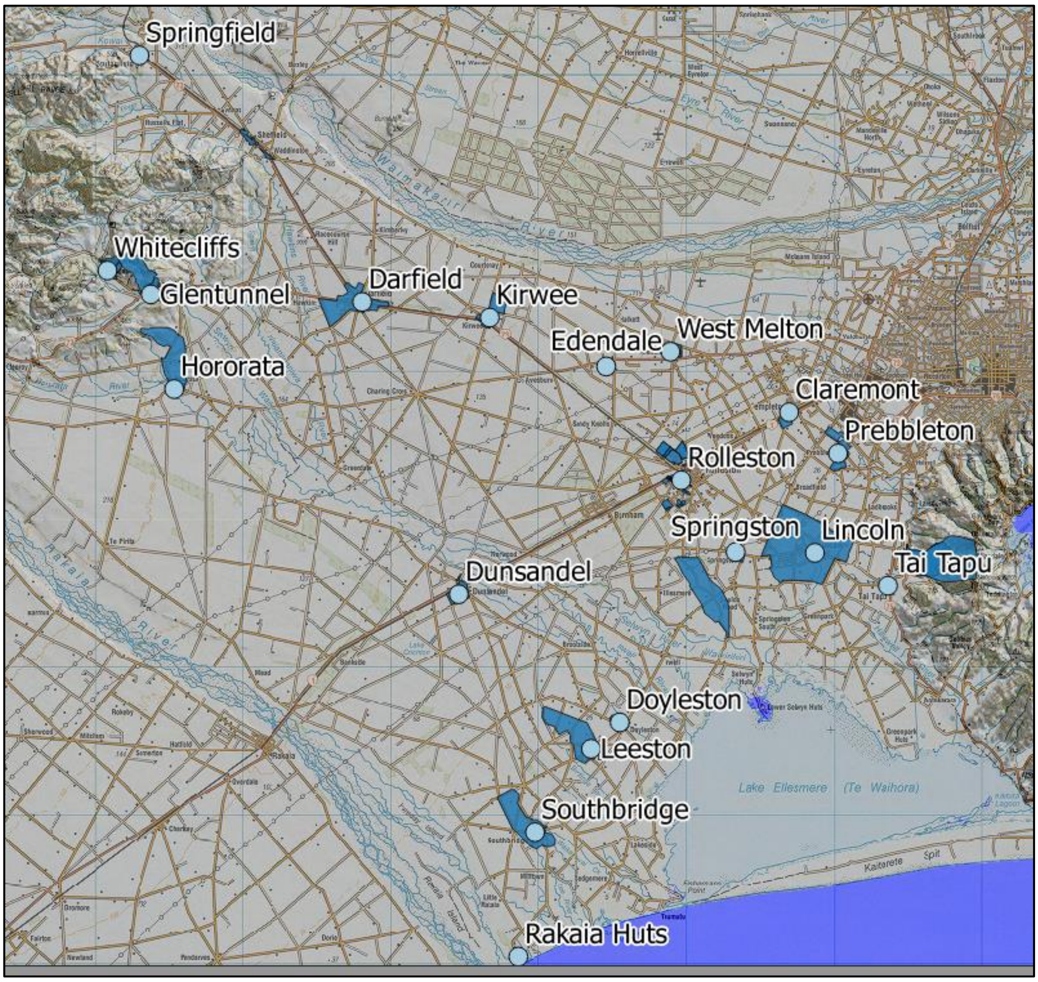


Figure 42. SDC stormwater schemes – Canterbury Plains.

Figure 43. SDC stormwater schemes – Alpine.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Minor	Ecological impacts (wetlands).	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	Medium
	Annual rainfall	Minor	None	±5% change in average annual rainfall	Low	Low
	Drought	Minor	Lower inflows (potential benefit). Soil desiccation / hydrophobicity (reduced infitration). Wetland plant mortality.	±5 change in number of dry days	Medium	Low
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	Minor	None	Increase in average wind speed 2-10%	Medium	Low
	Alpine river flows	Minor	None	3% increase in alpine river mean flows, biggest increases in winter	Medium	Low
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Surface flooding; network capacity. Erosion of channels / swales.	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	Minor	None	3% increase in alpine river flows, biggest increases in winter	Medium	Low
	Snow levels and ice	Minor	Reduced meltwater (potential benefit)	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Surface flooding; network capacity. Erosion of channels / swales.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	None	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Moderate	Infiltration capacity e.g. Rakaia Huts	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Medium
	Extreme rainfall events (Coastal)	High	Surface flooding; network capacity. Erosion of channels / swales.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Moderate	Infiltration capacity (high GW levels) e.g. Rakaia Huts. Note interaction with land drainage network.	Generally moderately reduced groundwater levels; unquantified interactions with SLR.	Low	low

Table 20. Estimated climate change impacts and risk assessment on SDC stormwater assets projecting to 2050.

19 LAND DRAINAGE

The key conclusions for this section are:

- **Projecting to 2050, environmental factors impacting SDC land drainage network assessed as high risk relate to the occurrence of more extreme weather events.**
- **Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.**
- **Higher alpine rainfall and extreme rainfall events may result in an increase in occurrence of surface flooding at Arthurs Pass land drainage systems.**
- **An increase in sea level rise of ~0.21 m will impact Te Waihora /Lake Ellesmere levels and parts of the land drainage network.**
- **Projecting to 2100, climate change impacts on SDC land drainage network are highly dependent on emissions scenario.**
- **In all emissions scenarios the occurrence of extreme weather events is likely to increase.**

SDC manages 9 drainage schemes covering 25,332 ha within the Selwyn District. Seven of these schemes are in place primarily to drain groundwater, but have a secondary stormwater function. The other two schemes are primarily for river protection. The primary purpose of Arthurs Pass drainage scheme is flood protection from the Bealey River, while the primary purpose of the Hororata River drainage is erosion protection management for a section of the Hororata River. A map of the management areas is shown in Figure 44 and Figure 45. Estimated climate change impacts and risk assessment are summarized in Table 21.

Environmental factors assessed as high risk on SDC's land drainage assets mainly relate to the occurrence of more extreme events, like extreme rainfall. These will likely increase under all emissions scenarios.

Under current projections climate change is expected to have a more significant impact in alpine areas. The projected increase in mean annual rainfall and flood flows which may impact Arthur's Pass river protection scheme and Hororata erosion protection works.

Sea level rise (SLR) of ~0.21 m will increase Te Waihora levels and impact coastal sections of land drainage network. These impacts will depend on how the Te Waihora mouth is managed in the future. If Te Waihora lake levels rise, the impact on the drains is estimated to extend around 1 m above the lake level because of backwater effects, see Section 12.

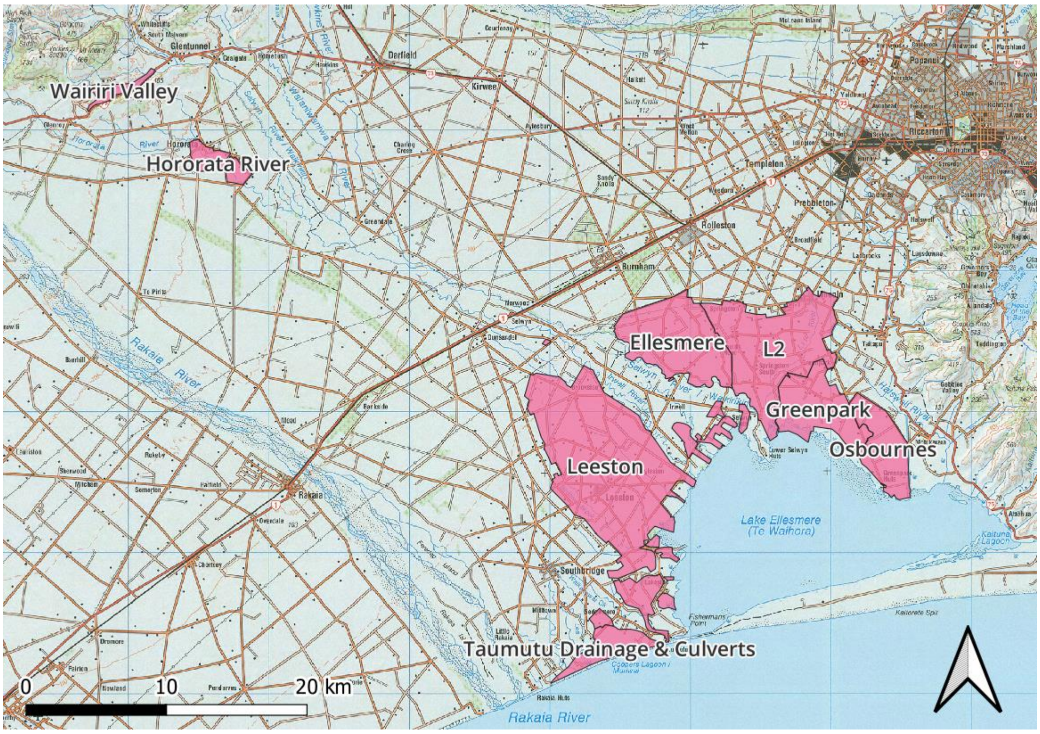


Figure 44. SDC land drainage schemes – Canterbury Plains.

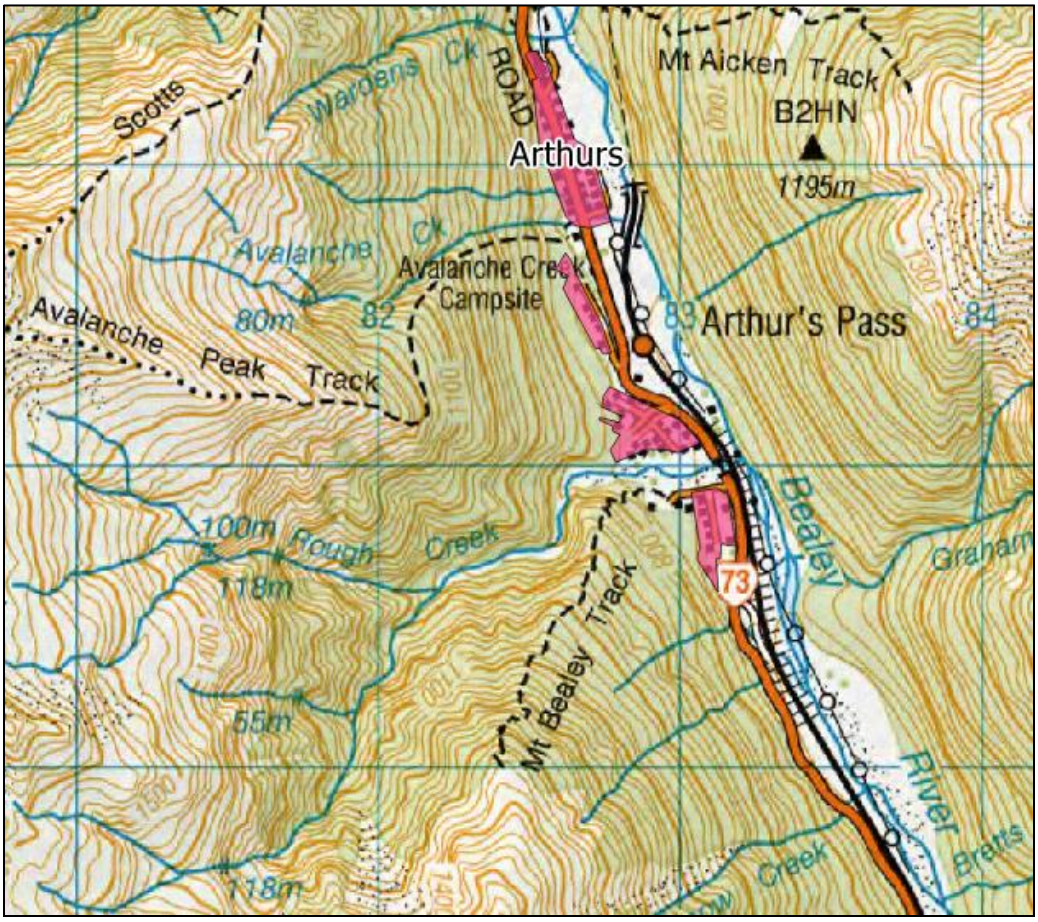


Figure 45. SDC land drainage schemes – Alpine.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Minor	Ecological impacts.	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	Medium
	Annual rainfall	Minor	None	±5% change in average annual rainfall	Low	Low
	Drought	Minor	Potential benefit for maintenance: can spray dry drains.	±5 change in number of dry days	Medium	Low
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	Minor	None	Increase in average wind speed 2-10%	Medium	Low
	Alpine river flows	Minor	None	3% increase in alpine river mean flows, biggest increases in winter	Medium	Low
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Surface flooding; network capacity (Wairiri Valley, Hororata and Arthurs Pass)	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	Minor	None	3% increase in alpine river flows, biggest increases in winter	Medium	Low
	Snow levels and ice	Moderate	Reduced meltwater (potential benefit)	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Increased inflow via interconnection with stockwater and urban stormwater networks.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	None	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	High	Backwater effects - note interaction with Te Waihora opening; coastal inundation and gravel deposition (lower Leeston network and Taumutu Culverts).	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	High
	Extreme rainfall events (Coastal)	High	Surface flooding; network capacity (lowland drainage networks)	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	High	Increased network inflows (high GW levels)	Generally moderately reduced groundwater levels in deeper aquifers; unquantified interactions with SLR.	Low	Medium

Table 21. Estimated climate change impacts and risk assessment on SDC land drainage systems projecting to 2050.

20 WATER RACES

The key conclusions for this section are:

- **Projecting to 2050, environmental factors impacting SDC's water race system assessed as high risk relate to the occurrence of more extreme weather events.**
- **Based on current projections, significant longer-term impacts on environmental factors like groundwater levels up to mid-century may be relatively small.**
- **Projecting to 2100, climate change impacts on SDC land drainage network are highly dependent on emissions scenario.**
- **An increase in alpine flood flows could result in an increase in flood damage to intakes. Conversely higher alpine flows would improve reliability of water supply.**
- **A potential minor reduction in flows in the Kowai River may impact supply reliability.**

SDC has been operating its water race system for about 130 years. Over recent years substantial changes have been identified which are expected to change the need for, and use of, the schemes. There are presently three water race schemes within the district: Ellesmere, Malvern and Paparua; these generally service the plains areas of the old County Councils. The Selwyn scheme with its intake on the Selwyn River was closed in 2009. A map of the management areas is shown in Figure 46.

Estimated climate change impacts and risk assessment are summarized **in** Table 22.

Environmental factors assessed as high risk on SDC's water race assets mainly relate to the occurrence of more extreme events, like extreme rainfall. These will likely increase under all emissions scenarios.

Two potential impacts are an increase in alpine flood flows, which could result in an increase in flood damage to alpine river intakes, and a potential reduction in flows in the Kowai River which might have an impact on supply reliability. A potential positive impact is that higher average alpine flows would improve the reliability of supply.

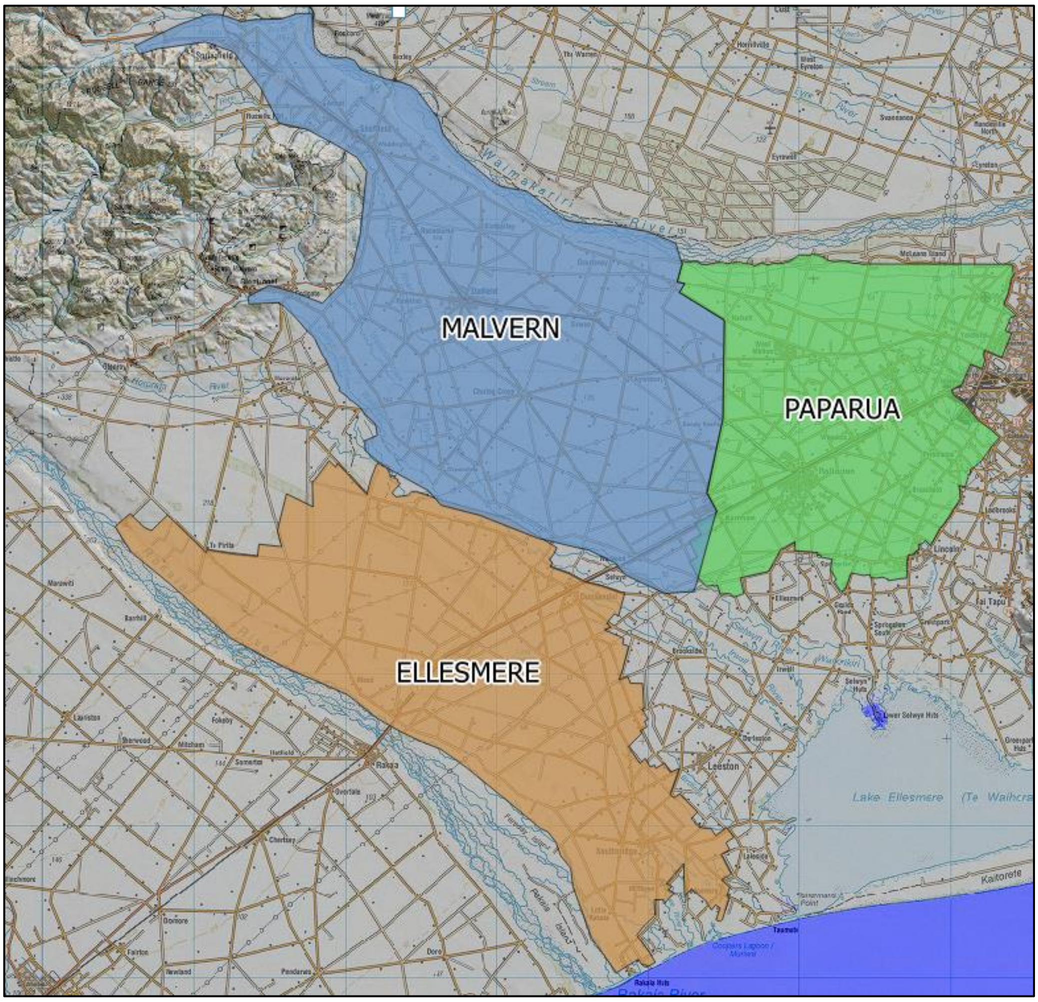


Figure 46. SDC water race networks.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Moderate	Higher demand for stockwater	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	High
	Annual rainfall	Moderate	Reduced supply reliability; increased water demand	±5% change in average annual rainfall	Low	Low
	Drought	Moderate	Increased peak summer water demand; reduced supply reliability	±5 change in number of dry days	Medium	Medium
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	Minor	None	Increase in average wind speed 2-10%	Medium	Low
	Alpine river flows	High	Reduced supply reliability (both low flows and flood shutdowns); increased flood damage to intakes	3% increase in alpine river mean flows, biggest increases in winter	Medium	High
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Surface flooding; network capacity	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	High	Supply reliability; intake damage.	3% increase in alpine river flows, biggest increases in winter	Medium	High
	Snow levels and ice	Minor	None	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Surface flooding; network capacity	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	None	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Minor	None	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Low
	Extreme rainfall events (Coastal)	Minor	None	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	Medium
	Groundwater levels (Lower Plains)	Minor	None	Generally moderately reduced groundwater levels in deeper aquifers; unquantified interactions with SLR.	Low	Low

Table 22. Estimated climate change impacts and risk assessment on SDC water race systems projecting to 2050.

21 TRANSPORTATION ASSETS

The key conclusions of this section are:

- **Projecting to 2050, environmental factors impacting SDC transportation assessed as high risk relate to the occurrence of more extreme weather events and river flooding.**
- **Projecting to 2100, climate change impacts on SDC transportation network are highly dependent on emissions scenario.**
- **Under all emissions scenarios the incidence of extreme events is expected to increase resulting in more frequent road closures.**
- **Flood events previously categorised as 1 in 100 year events may become 1 in 10 year events**

SDC's transportation assets may be categorised into three classes:

- Roads
- Fords
- Bridges

Summary data is given in Table 23.

Table 23. Summary of SDC transportation assets.

Asset		Asset	
Sealed roads	1,520 km	Unsealed Roads	1,130 km
Urban Roads	340 km	Rural Roads	2,310 km
Bridges	98 bridge structures plus large culverts		
Fords	49 approx.		
Total road network	2,650 km		

Figure 47 shows the roading network in the district in each risk assessment zone; alpine hills and high country, plains, coastal and lower plains. Estimated climate change impacts and risk assessment are summarized in Table 24.

Fords are especially vulnerable to extreme rainfall events. With more extreme events predicted under all emissions scenarios, more frequent road closures may be expected.

The extent to which extreme events may result in catastrophic failure of transportation infrastructure is highly uncertain, though the likelihood of catastrophic failure will evidently increase flood events previously categorised as 1 in 100 year events may become 1 in 10 year events.

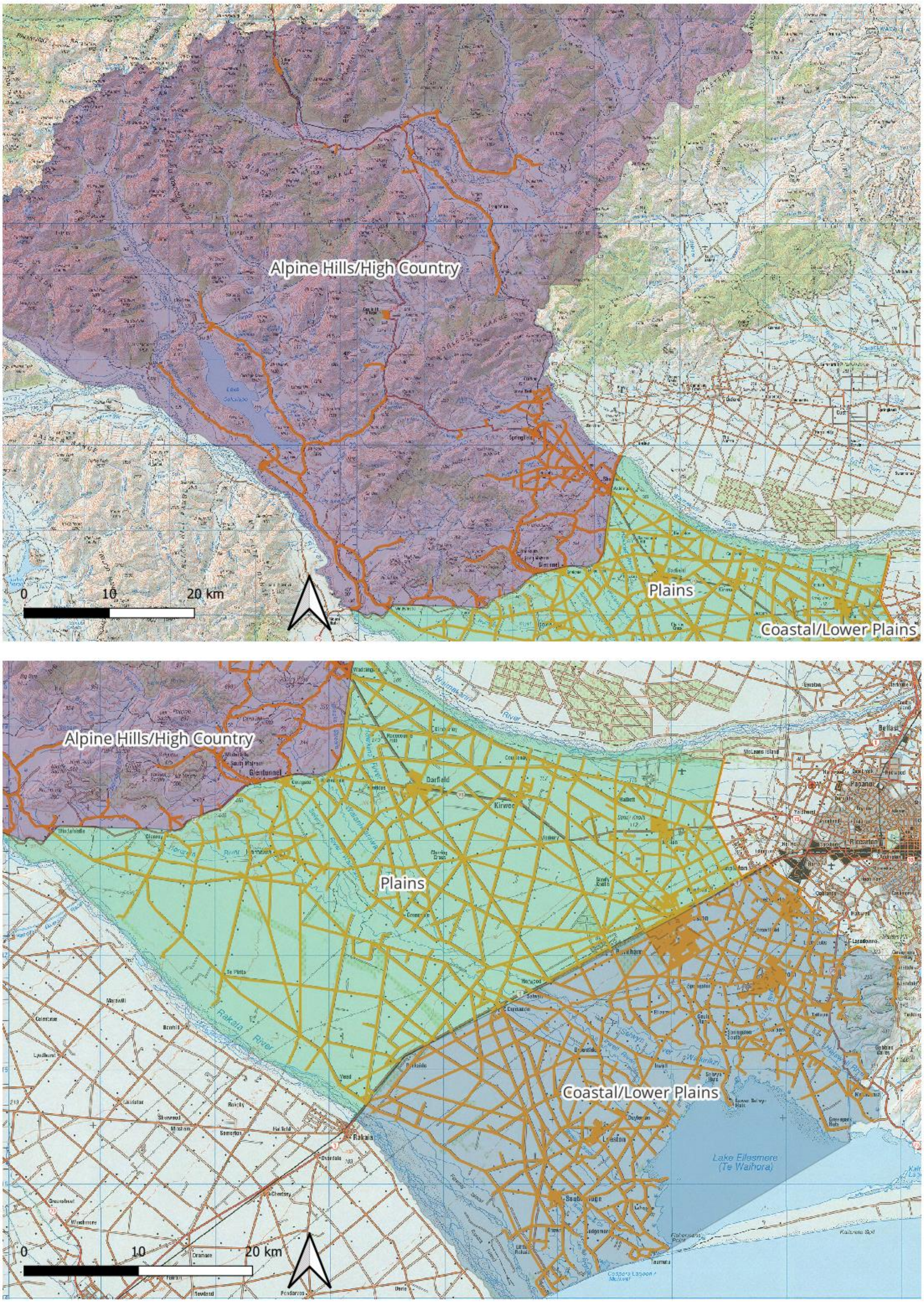


Figure 47: SDC managed roading network (orange line), including risk assessment category areas.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Moderate	Road and car-park surface degradation: bitumen melting	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	High
	Annual rainfall	Minor	None	±5% change in average annual rainfall	Low	Low
	Drought	Minor	Potential benefit: increased fine weather for maintenance.	±5 change in number of dry days	Medium	Low
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	Minor	Tree-fall (blocking roads)	Increase in average wind speed 2-10%	Medium	Low
	Alpine river flows	Moderate	Flooding or erosion of roads on alpine river margins; increased debris blocking culverts	3% increase in alpine river mean flows, biggest increases in winter	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Surface flooding; road surface damage / subsidence; slips; bridge and abutment damage due to high-country stream flooding; increased debris blocking culverts	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	High	Bridge and abutment damage due to high-country stream flooding in extreme rain events; more frequent and longer duration ford closure and damage; increased debris blocking culverts	3% increase in alpine river flows, biggest increases in winter	Medium	High
	Snow levels and ice	Moderate	Freeze-thaw effects (potential benefit of less occurrence)	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Surface flooding; road surface damage / subsidence; slips; increased debris blocking culverts	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	Upper plains perched shallow GW levels (e.g. Springfield and Hororata areas)	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Moderate	Inundation of coastal roads (limited exposure). [Note interactions with shallow GW and Te Waihora levels.]	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Medium
	Extreme rainfall events (Coastal)	High	Surface flooding; road surface damage / subsidence; bridge and abutment damage due to stream flooding in extreme rain events; more frequent and longer duration ford closure and damage; increased debris blocking culverts	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Moderate	Road surface and subgrade stability (high GW levels - note interaction with SLR)	Generally moderately reduced groundwater levels in deeper aquifers; unquantified interactions with SLR.	Low	Low

Table 24. Estimated climate change impacts and risk assessment on SDC transportation assets projecting to 2050.

22 FACILITIES AND OPEN SPACES

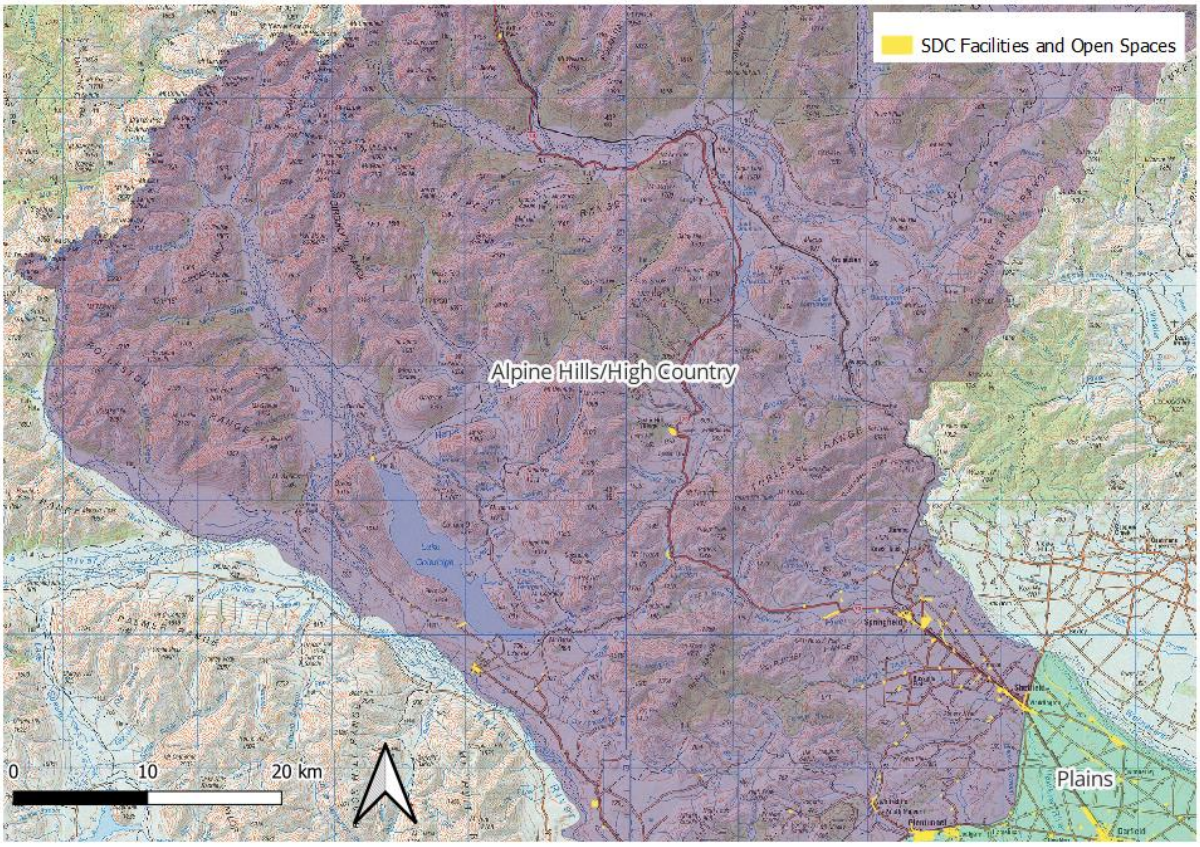
The key conclusions of this section are:

- **Projecting to 2050, environmental factors impacting SDC facilities and open spaces assessed as high risk relate to the occurrence of more extreme weather events and river flooding.**
- **Projecting to 2100, climate change impacts on SDC facilities and open spaces are highly dependent on emissions scenario.**
- **Under all emissions scenarios the incidence of extreme events is expected to increase resulting in more frequent road closures and inundation of areas.**
- **Flood events previously categorised as 1 in 100 year events may become 1 in 10 year events.**

Estimated climate change impacts and risk assessment for facilities, developed and natural open spaces are summarized in Table 25, Table 26 and Table 27 respectively.

Environmental factors assessed as high risk on facilities and open spaces mainly relate to the occurrence of more extreme events, like extreme rainfall and flood flows. These will likely increase under all emissions scenarios.

Figure 48 shows the location of SDC managed facilities and open spaces.



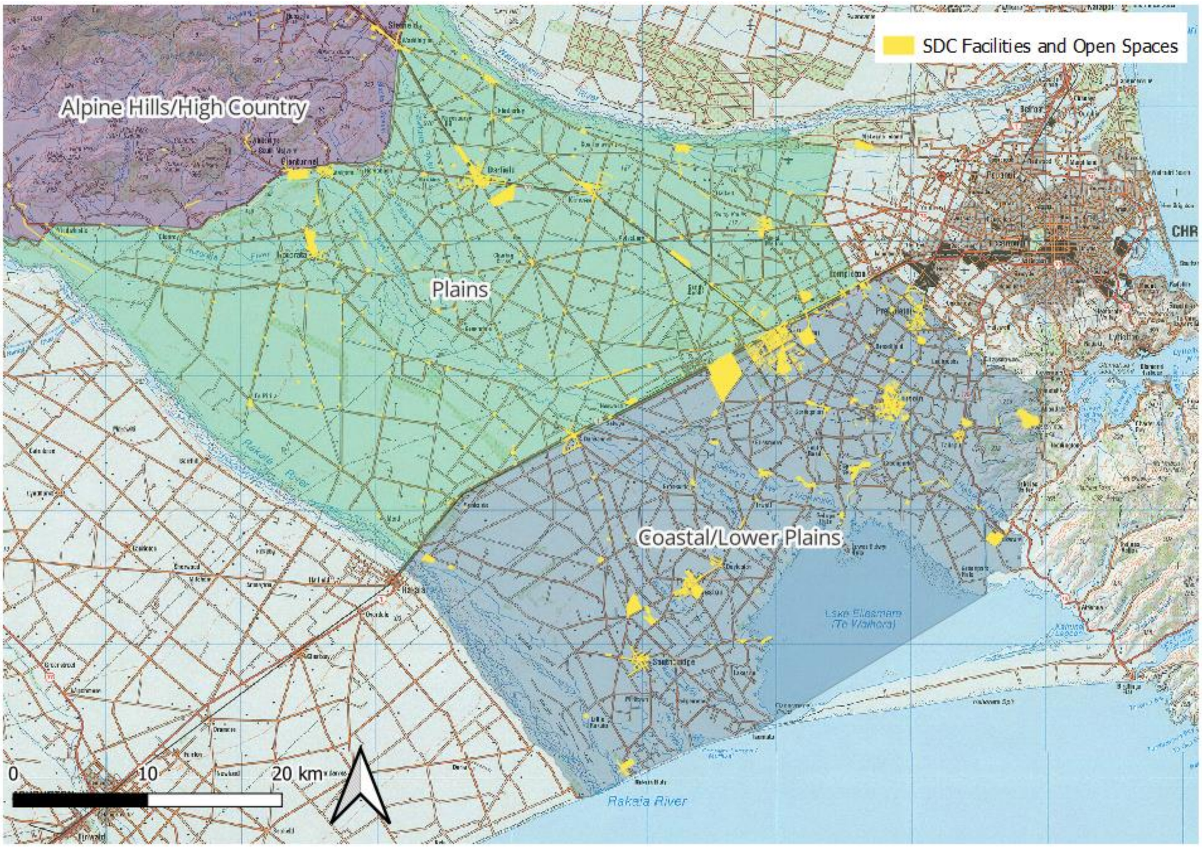


Figure 48: Location of SDC managed facilities and open spaces, including risk assessment category areas.

22.1 Community Facilities

The risk summary is shown on the next A3 page.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Moderate	HVAC and air handling systems - increased demand for heating and cooling. Longevity of building envelope (coatings and claddings)	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	High
	Annual rainfall	Minor	None	±5% change in average annual rainfall	Low	Low
	Drought	Minor	Dust impacts on HVAC systems (combination of low rainfall and wind). Increased cladding / window washing.	±5 change in number of dry days	Medium	Low
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	High	Wind damage to assets (roof / structure) in a storm. Impact on HVAC systems (external fans).	Increase in average wind speed 2-10%	Medium	High
	Alpine river flows	Minor	Rakaia Huts community centre.	3% increase in alpine river mean flows, biggest increases in winter	Medium	Low
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Flooding: floodwaters entering buildings; inundation of below-ground areas; access to buildings required for emergency response. Building envelope: roof leaks; Longevity of coatings and claddings.	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	High	Flooding of facilities close to river margins.	3% increase in alpine river flows, biggest increases in winter	Medium	High
	Snow levels and ice	Moderate	Building envelope: freeze-thaw effects, longevity of coatings and claddings (potential benefit of less occurrence)	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Flooding: floodwaters entering buildings; inundation of below-ground areas; access to buildings required for emergency response. Building envelope: roof leaks; Longevity of coatings and claddings.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	Building envelope: reduced snow loadings on buildings. Fewer slippery surfaces. (potential benefit of less regular occurrence)	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	None	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Moderate	Inundation of facilities (particularly during storm events). Wastewater disposal for non-reticulated areas. Impact on shallow well supplies for community facilities.	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Medium
	Extreme rainfall events (Coastal)	High	Flooding: floodwaters entering buildings; inundation of below-ground areas; access to buildings required for emergency response. Building envelope: roof leaks; Longevity of coatings and claddings.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Moderate	Wastewater disposal for non-reticulated areas (high GW levels - note interaction with SLR). Impact on shallow well supplies for community facilities.	Generally moderately reduced groundwater levels; unquantified interactions with SLR.	Low	Low

Table 25. Estimated climate change impacts and risk assessment on SDC community facilities projecting to 2050.

22.2 Developed open spaces

The risk summary is shown on the next A3 page.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Moderate	Increased water demand for park and horticultural irrigation. Increased winter mowing due to fewer frosts.	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	High
	Annual rainfall	Moderate	Increased water demand for park and horticultural irrigation.	±5% change in average annual rainfall	Low	Low
	Drought	High	Increased water demand for park and horticultural irrigation. Increased fire risk. Difficulty of establishing new planting. Loss of existing tree canopy.	±5 change in number of dry days	Medium	High
	Evapotranspiration (ET)	Moderate	Increased water demand for park and horticultural irrigation	PED increase of 50-100 mm per year	Medium	Medium
	Wind (excluding ET impacts)	High	Wind damage to assets (trees, structures) in a storm	Increase in average wind speed 2-10%	Medium	High
	Alpine river flows	Moderate	Flooding of open spaces close to river margins. Safe evacuation of camping ground occupants. (Rakaia Huts)	3% increase in alpine river mean flows, biggest increases in winter	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	High	Surface flooding of open spaces. Slips. Damage to tracks and foot-bridges. Restricted use of playing fields. Safe evacuation of camping ground occupants. Tree fall (combination of wind and saturated ground).	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	High	Flooding of open spaces close to river margins. Safe evacuation of camping ground occupants. (Coes Ford)	3% increase in alpine river flows, biggest increases in winter	Medium	High
	Snow levels and ice	Minor	Slight benefit (improved winter access).	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	High	Surface flooding of open spaces. Damage to tracks and foot-bridges. Safe evacuation of camping ground occupants.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	Upper plains perched shallow GW levels - impact on non-reticulated effluent systems (e.g. Springfield, Hororata)	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	High	Inundation of open spaces (particularly during storm events). Wastewater disposal for non-reticulated areas. Salt-water intrusion for small water supplies (domains, etc).	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	High
	Extreme rainfall events (Coastal)	High	Surface flooding of open spaces. Damage to tracks and foot-bridges. Safe evacuation of camping ground occupants.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	High	Surface ponding and poor drainage of parks and playing fields. Wastewater disposal for non-reticulated areas. Ability to operate cemeteries. Cemetery compliance with resource consent conditions. Uplift pressures on swimming pools. (High GW levels - note interaction with SLR).	Generally moderately reduced groundwater levels in deeper aquifers; unquantified interactions with SLR.	Low	Medium

Table 26. Estimated climate change impacts and risk assessment on developed open spaces projecting to 2050.

22.3 Natural Open Spaces.

The risk summary is shown on the next A3 page.

Zone	Environmental factor	Vulnerability (Consequence)	Asset impacts	Summary of projected changes	Projected change (Likelihood of impact)	Impact (Risk)
All zones	Temperature (excl. ET impacts)	Minor	Loss of biodiversity. Establishment of invasive weed species.	1.5 °C average increase, 10-20 more hot days , 5-10 fewer frost days	High	Medium
	Annual rainfall	Minor	None	±5% change in average annual rainfall	Low	Low
	Drought	Moderate	Increased fire risk. Difficulty of establishing new planting. Mortality of existing planting.	±5 change in number of dry days	Medium	Medium
	Evapotranspiration (ET)	Minor	None	PED increase of 50-100 mm per year	Medium	Low
	Wind (excluding ET impacts)	High	Wind-throw / damage to forest crops.	Increase in average wind speed 2-10%	Medium	High
	Alpine river flows	Moderate	Flooding of open spaces close to river margins. Safe evacuation of freedom campers and other users.	3% increase in alpine river mean flows, biggest increases in winter	Medium	Medium
Alpine, hills and high-Country	Extreme rainfall events (foothills and alpine)	Moderate	Surface flooding of open spaces. Slips. Damage to tracks and foot-bridges. Safe evacuation of freedom campers and other users.	Increased incidence of high-intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Foothills-sourced river flows	Moderate	Flooding of open spaces close to river margins. Safe evacuation of freedom campers and other users.	3% increase in alpine river flows, biggest increases in winter	Medium	Medium
	Snow levels and ice	Minor	None	Reduction in number of average annual snow days by 10-25 days	Low	Low
Plains	Extreme rainfall events (Plains)	Moderate	Surface flooding of open spaces. Damage to tracks and foot-bridges. Safe evacuation of freedom campers and other users.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Snow levels and ice	Minor	None	Reduction in extreme snowfall and elevation in snowline	Low	Low
	Ground water levels (upper /mid plains)	Minor	None	Reduced groundwater levels, possibly significant in deeper aquifers towards 2050.	Low	Low
Coastal and lower plains	Sea Level rise	Moderate	Inundation / wave erosion of open spaces (particularly during storm events). Salt tolerance of plant species - salinity propagating inland.	Mean sea level increase ~0.21 m; increased frequency of extreme sea-level events, unquantified impacts on saltwater intrusion	Medium	Medium
	Extreme rainfall events (Coastal)	Moderate	Surface flooding of open spaces. Damage to tracks and foot-bridges. Safe evacuation of freedom campers and other users.	Increased incidence of high intensity rainfall events, large uncertainty, highly dependent on emissions scenario	High	High
	Groundwater levels (Lower Plains)	Moderate	Surface ponding and poor drainage of open spaces. (High GW levels - note interaction with SLR).	Generally moderately reduced groundwater levels; unquantified interactions with SLR.	Low	Low

Table 27. Estimated climate change impacts and risk assessment on developed natural spaces projecting to 2050.

23 NON-SDC ASSETS

Most impacts on SDC assets assessed as high risk in previous sections related to the incidence of extreme/high-intensity weather events and SLR. However, it is important to recognise that these assessments extend to non-SDC assets, since they are exposed to the same physical risks. Notable examples of such assets include:

- Waimakariri River Stopbanks (owned and maintained by ECan),
- Central Plains Water Headrace (owned and maintained by Central Plains Water Ltd), and
- Electricity networks (owned and maintained by Orion Networks).

Damage or, in extreme cases, catastrophic failure to non-SDC assets may have a huge impact on SDC assets. For instance, failure of the electricity network managed by Orion could result in road blockages in the case of downed powerlines or prevent SDC operating critical infrastructure like pump stations in the case of power outages. Similarly, failure of non-SDC transportation assets like state highways or rail links may increase pressure on SDC transportation assets (which may themselves be compromised by damage following an extreme event).

These examples underscore the interconnectivity between various asset classes and demonstrate the cascading effects that arise from damage and failure within a particular asset class, regardless of whether it belongs to SDC or non-SDC entities. Consequently, the following elements are important in SDC's future planning and management:

- Recognition that shared risks extend beyond the boundaries of local council, and that collaboration between different stakeholders is crucial for effective climate change adaptation.
- Collaboration and coordination between relevant entities including SDC and non-SDC organisations, government agencies and infrastructure operators.
- Strengthening of infrastructure resilience.
- Investment in redundancy and backup systems. For example, redundant electricity supply systems or alternative transportation routes to ensure continuity of services.
- Enhance emergency response capability.
- Engage community in climate change resilience efforts.
- Monitoring and review of climate change impacts and adaptation/maladaptation measures.

24 RECOMMENDATIONS AND LIMITATIONS

This report reviewed a large number of information and data sources. Projected climate futures were used to assess risks to SDC assets as defined in the scope of this report. The assignment of risk levels is necessarily subjective. The aim of this exercise was to help SDC asset managers and planners prioritise resilience planning. Projected climate futures may not be how the future climate turns out and recent collective global experience suggests that impacts may be accelerating. The general message of climate change is that we need to brace ourselves to greater volatility in weather patterns with a greater incident of extreme events like extreme rainfall, wind and droughts. But the envelope of uncertainty is large, especially when projecting to end of century. This report provides a high-level assessment of climate change impacts that is meant as a guide for this moment in time. We recommend a serious revision and rescoping of this work within two years with significant refocus on adaptation.

Projecting even into the near future the biggest uncertainty is groundwater. While modelling results indicate a greater incidence of low water levels in deeper supply bores, we cannot be sure that in 10 or 20 years' time the extreme low levels may not be somewhat worse or more frequent than our results indicate. Low groundwater levels need to be monitored and observed very carefully.

Moreover, the impact of sea level rise on (especially) shallow coastal groundwater systems is a very significant uncertainty. It is frequently referenced in IPCC reports in descriptive terms but very little is known about the magnitude of impact (i.e. degree and rate of salination) on either shallow coastal aquifers and land degradation. Whereas changes in surface flows are directly observable, groundwater systems have much greater uncertainties on several accounts including:

- they are not directly observed except at sparse measurement points.
- Canterbury groundwater systems are structurally complex.
- groundwater is relatively much slower moving so cause and effect is hard to quantify.

Given the large uncertainties associated with groundwater systems and that large-scale saline contamination and soil degradation through salination is likely to be effectively irreversible, we recommend a special study on SDC's coastal groundwater and sea level rise. The purpose of this study is to provide recommendations to better monitor the state of shallow coastal groundwater systems to enable more robust decision-making in the future.

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Appendix A: IrriCalc crop-soil water balance model

To calculate the irrigation demand and subsequent land surface drainage, Aqualinc's IrriCalc water balance model was used. The model simulates how the use of water in agriculture varies with crop, soil type, representative daily climatic conditions and irrigation strategies. The basis of the model is a daily soil moisture balance and an irrigation scheduling component. These components are described in more detail below.

The model was developed by Lincoln Environmental as part of a research project funded by the Foundation for Research, Science and Technology (FRST). It has been based on New Zealand field data and was initially tested on Canterbury irrigation schemes. Further details and this testing can be found in AEI (1991)[4]. More recently, the model has been tested by Aqualinc (2013)[5].

Soil Moisture Balance Component

The model is designed to simulate a single paddock in which a specified crop is grown. The soil is treated as a reservoir, with a capacity equal to the maximum plant available water content of the soil. Soil moisture levels are calculated on a daily basis in response to daily data on climate (rainfall and potential evapotranspiration), crop uptake and irrigation using the following equation:

$$Soil\ moisture\,(day_t) = Soil\ moisture\,(day_{t-1}) + rainfall + irrigation - actual\ evapotranspiration$$

Actual evapotranspiration (AET) describes the combined effects of evaporation from the soil and transpiration by the crop. The model considers AET to be a function of the atmospheric demand for water, crop characteristics (including stage of growth) and the soil moisture content in the root zone. The atmospheric demand for water is the daily potential evapotranspiration calculated from meteorological conditions such as radiation, wind run and temperature. Crop characteristics can vary throughout a season to reflect relative ground cover, root development and the onset of crop maturity. Soil moisture influences evapotranspiration because as the soil becomes drier, it becomes increasingly difficult for more moisture to be transpired or evaporated.

Once calculated, soil moisture levels then become an input to the irrigation scheduling component of the model. The model assumes that the maximum amount of water a soil can hold is the soil's available water capacity. Water (either from rainfall or irrigation) in excess of the soil's available water capacity is assumed to drain through the root zone and into underlying substrata as land surface recharge.

Irrigation Scheduling Component

The depth of water applied and the timing of irrigation is determined by the irrigation strategy. For a given irrigation strategy, the model predicts the timing and depth of irrigation applications based on the crop type, stage of growth, and subsequent water requirements. It also accounts for the irrigation return period.

Irrigation is triggered when the soil water content is reduced below a user-defined level (e.g. 50% of the maximum available soil water). The irrigation depth can be determined in two ways. Firstly, it can be specified by the user as a fixed amount. Secondly, it can be calculated by the model as the depth required to restore the soil water content to a user defined level (e.g. field capacity).

A user-defined irrigation efficiency factor is also set to allow for on-farm losses due to wind losses, surface runoff and non-uniform distribution of water.

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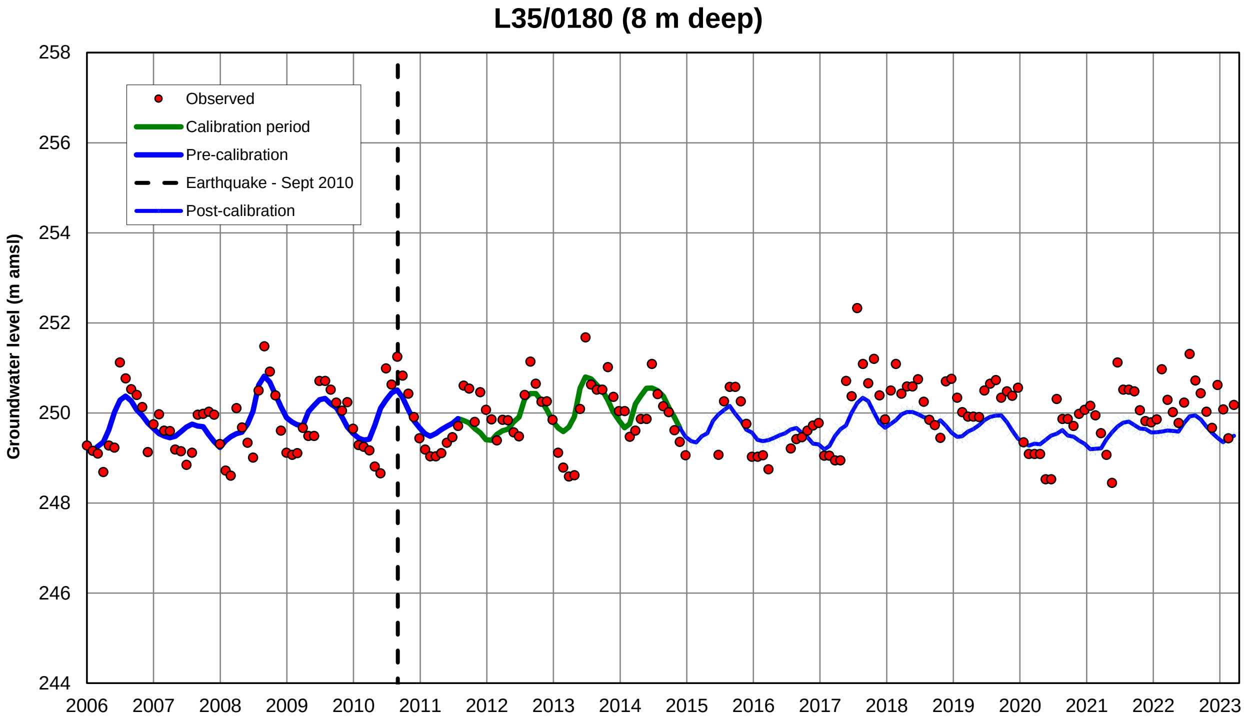
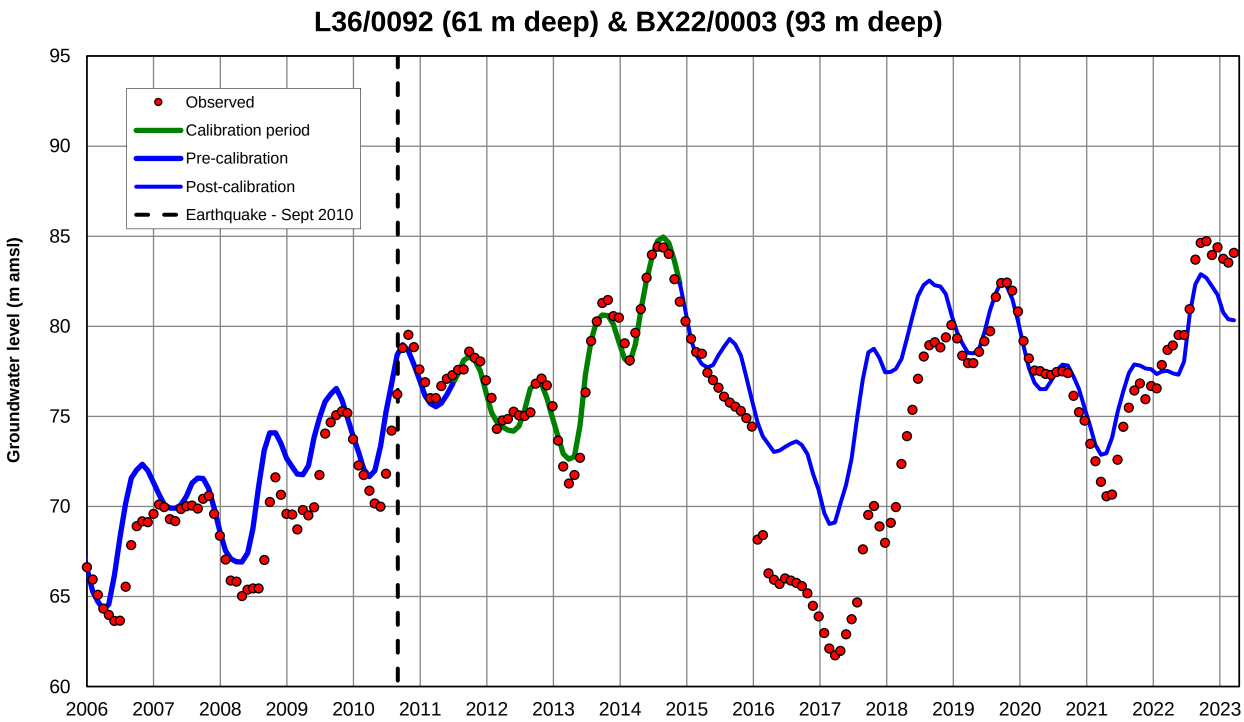
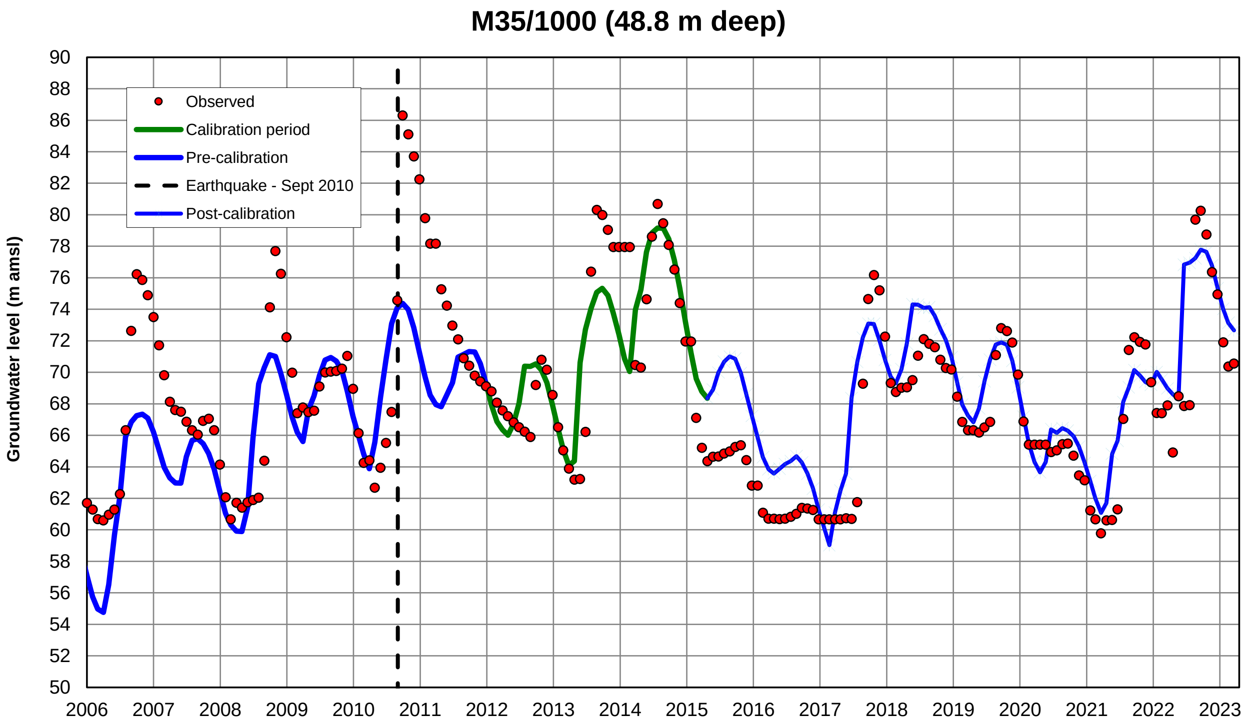
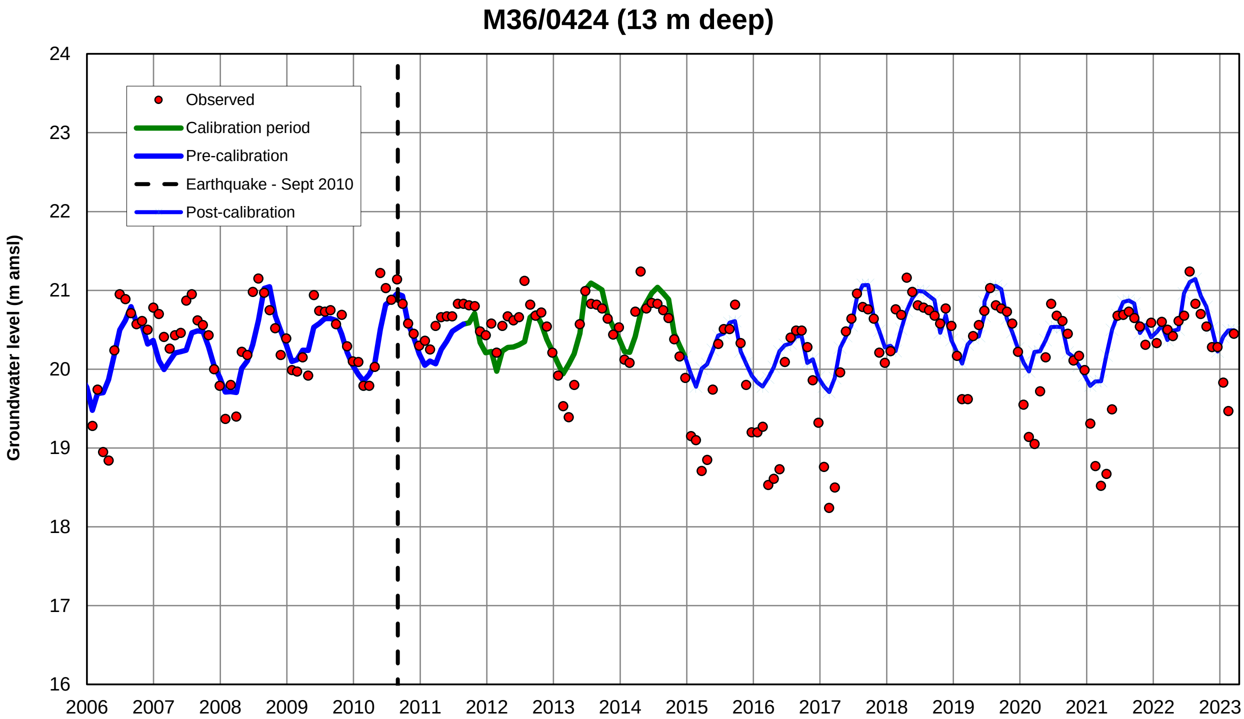
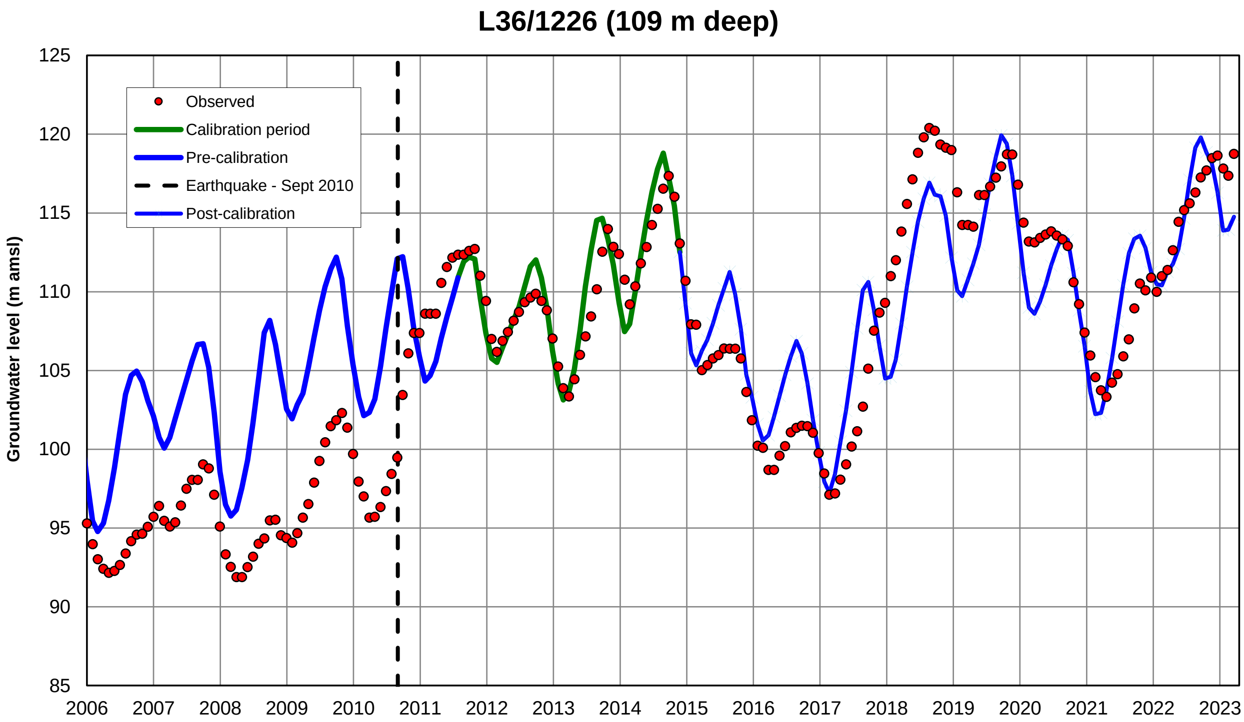
Appendix B: Groundwater model calibration



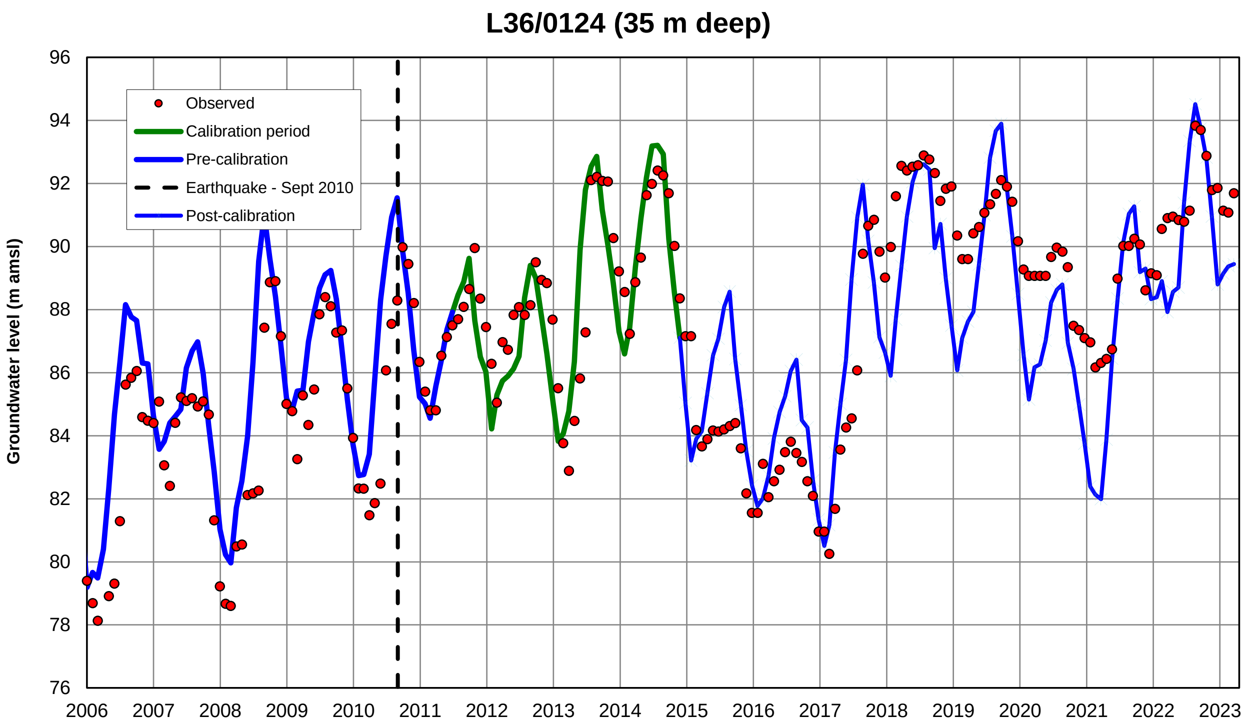



M35/1000 (48.8 m deep)
Observed
Calibration period
Pre-calibration
Earthquake - Sept 2010
Post-calibration
Groundwater level (m amsl)
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

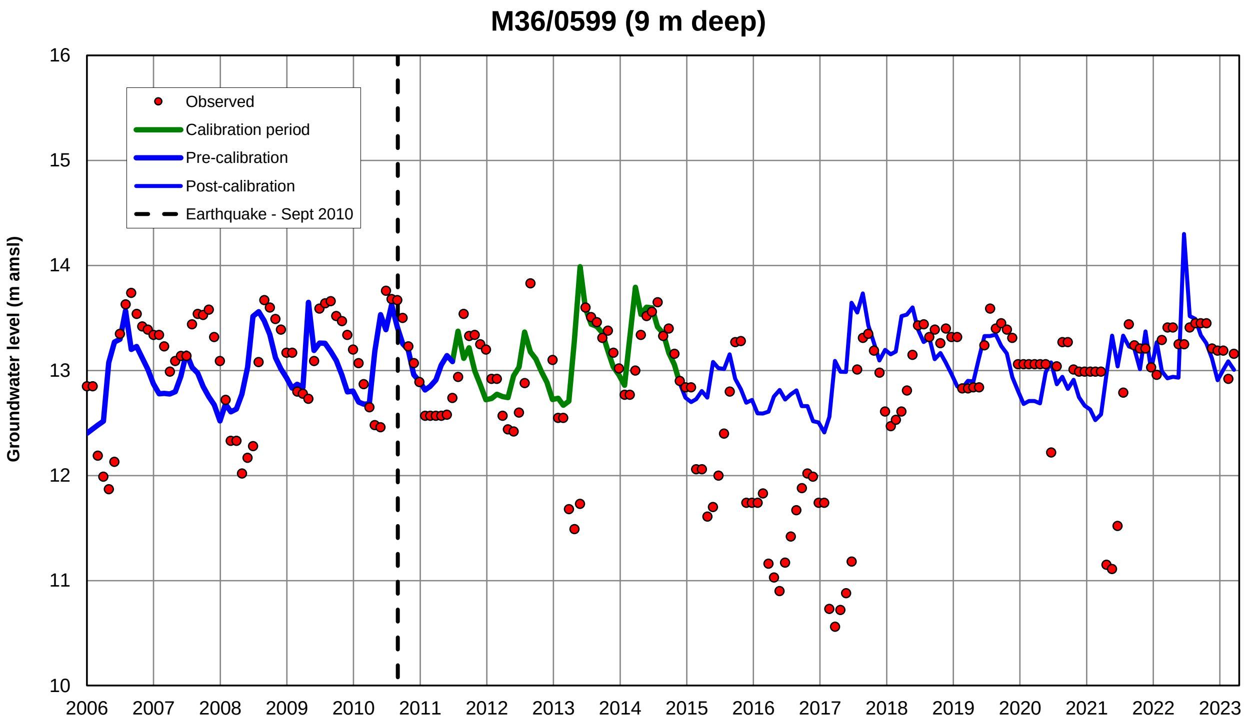

M36/0424 (13 m deep)
Observed
Calibration period
Pre-calibration
Earthquake - Sept 2010
Post-calibration
Groundwater level (m amsl)
24
23
22
21
20
19
18
17
16
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

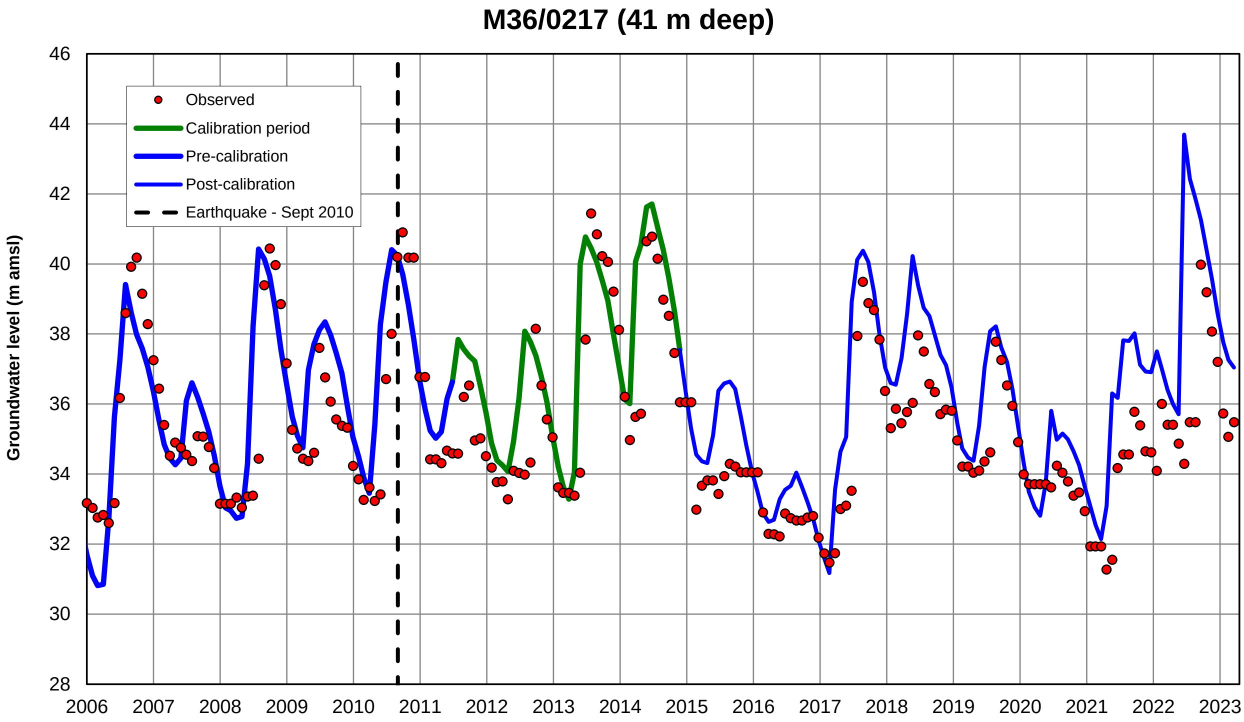


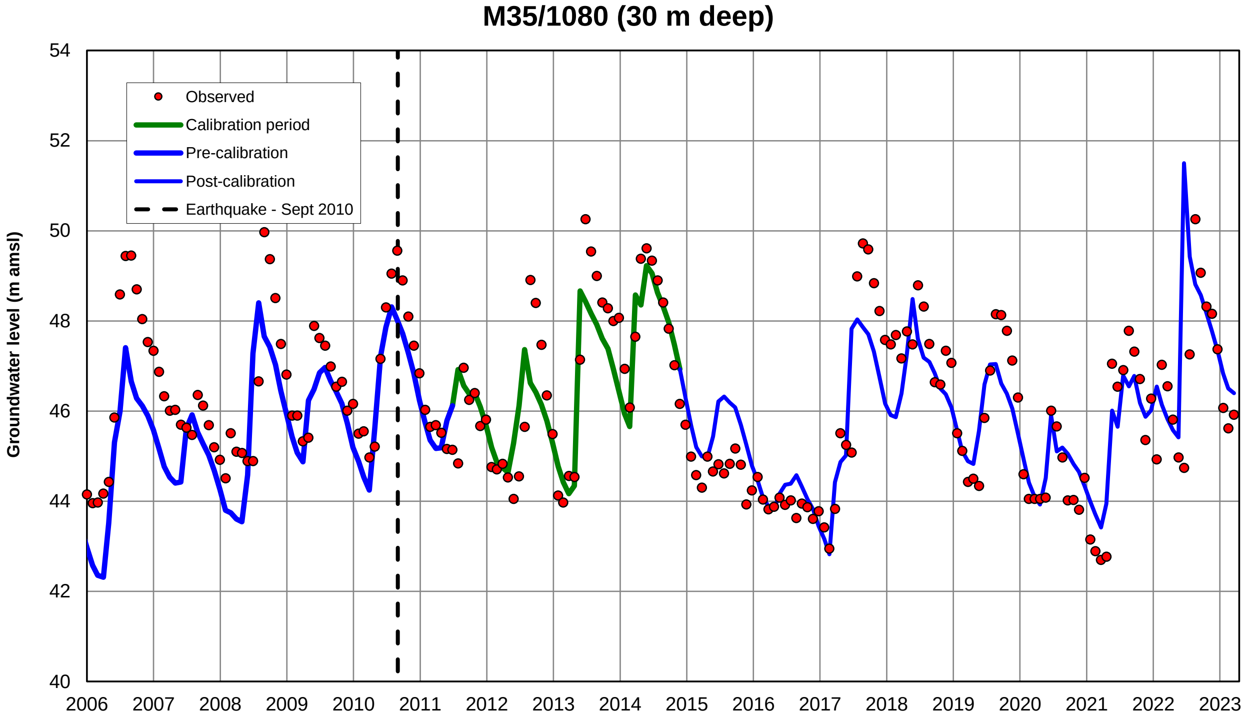
L36/1226 (109 m deep)
Groundwater level (m amsl)
Observed
Calibration period
Pre-calibration
Earthquake - Sept 2010
Post-calibration
125
120
115
110
105
100
95
90
85
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



L36/0124 (35 m deep)
Groundwater level (m amsl)
Observed
Calibration period
Pre-calibration
Earthquake - Sept 2010
Post-calibration
96
94
92
90
88
86
84
82
80
78
76
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


M36/0599 (9 m deep)
Groundwater level (m amsl)
16
15
14
13
12
11
10
Observed
Calibration period
Pre-calibration
Post-calibration
Earthquake - Sept 2010
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023


M36/0217 (41 m deep)
Groundwater level (m amsl)
46
44
42
40
38
36
34
32
30
28
Observed
Calibration period
Pre-calibration
Post-calibration
Earthquake - Sept 2010
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023



M35/1080 (30 m deep)
Groundwater level (m amsl)
54
52
50
48
46
44
42
40
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Observed
Calibration period
Pre-calibration
Post-calibration
Earthquake - Sept 2010

Appendix 4 Evidence regarding Sea Level Rise

Global
Intergovernmental Panel Report on Climate Change (IPCC) Sea level change 2013
https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf

Extract - In summary, dynamical and statistical methods on regional scales show that it is very likely that there will be an increase in the occurrence of future sea level extremes in some regions by 2100, with an increase in the early 21st century. Page 1200

National

- MFE Preparing for coastal change 2017
  https://environment.govt.nz/assets/Publications/Files/coastal-hazards-summary.pdf
  Extract - According to the Intergovernmental Panel on Climate Change's (IPCC)1Fifth Assessment Report (2013), sea-level rise in our region (New Zealand) is expected to be up to 10 per cent more than the global average.

- MFE Our atmosphere and climate 2020
  https://environment.govt.nz/assets/Publications/Files/OAC2020-summary-english.pdf
  Extract - New Zealand's mean relative sea level has risen by 1.81 (±0.05) millimetres per year on average since records began more than 100 years ago, and the average rate for 1961–2018 was twice the average rate for the time since records began to 1960.

Regional
MIWA Climate change projections for the Canterbury Region Prepared for Environment Canterbury February 2020
https://niwa.co.nz/sites/niwa.co.nz/files/ClimatechangeprojectionsfortheCanterburyRegionNIWA.PDF (page 129)

Local Te Waihora
The effects of high lake levels due to climate change on lakeside communities and adjacent land use Case study: Lake Ellesmere/Te Waihora Lincoln University 2019
https://researcharchive.lincoln.ac.nz/server/api/core/bitstreams/b7ff7f3c-28ad-458d-afac-a018f110387c/content