Akaroa & Duvauchelle Combined Wastewater Schemes Feasibility MCA Assessment Report

Prepared for Christchurch City Council
Prepared by Beca Limited

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Contents

Revision History

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on behalf of	Beca Limited		

Executive Summary

This report sets out a multi-criteria assessment of options for combining the Akaroa and Duvauchelle wastewater schemes. Christchurch City Council (Council) has been working on upgrades to both the Akaroa and Duvauchelle Wastewater Schemes for a number of years. A key objective for the upgrades has been to remove harbour discharges and transfer and treat wastewater for disposal onto land. Extensive optioneering exercises on both schemes have been carried out by Council to identify suitable disposal areas and navigate cultural, social and environmental drivers with key stakeholders.

To date the schemes have been developed separately. As the two schemes are some distance apart, and as the available irrigable land has more or less matched the required irrigation area at each locality, there have not been any obvious initial synergies from combining them. Assessment of the feasibility of a combined scheme has also been complicated by ongoing uncertainties about wastewater flows. The design flow basis and flow and irrigation modelling has recently been concluded. The design basis and model outputs have been used to inform the feasibility assessment for a combined wastewater scheme.

Scheme combination options considered were:

- Option 1: Independent Duvauchelle and Akaroa Wastewater Schemes
- Option 2: Treatment at separate treatment plants but linked irrigation fields and storage
- Option 3: Combined treatment at the new Akaroa WWTP and linked irrigation fields and storage
- Option 4: Combined treatment at the new Akaroa WWTP but irrigation to Akaroa only
- Option 5: Option 1 with additional spray irrigation at the Akaroa Golf Course
- Option 6: Option 2 with additional spray irrigation at the Akaroa Golf Course
- Option 7: Option 3 with additional spray irrigation at the Akaroa Golf Course

A multi-criteria (MCA) analysis tool was used to evaluate options to combine the Akaroa and Duvauchelle wastewater schemes. The outcome of the multi-criteria analysis is shown below.

Option	1. Separate Schemes	2. Separate Treatment but Combined Irrigation	3. Combined Treatment & Combined Irrigation	4. Combined Treatment & Irrigation to Akaroa Only
MCA Ranking – **No Golf Course Irrigation**	4	3	1	2

Option	5. Separate Schemes	6. Separate Treatment but Combined Irrigation	7. Combined Treatment & Combined Irrigation
MCA Ranking – **Including Golf Course Irrigation**	3	2	1

1 Introduction

1.1 Background

Christchurch City Council (Council) has been working on upgrades to both the Akaroa and Duvauchelle Wastewater Schemes to remove their existing harbour discharge consents and commission new and upgraded treatment plants and land disposal systems. Extensive optioneering exercises on both schemes have been carried out over the last decade to identify suitable disposal areas and navigate various cultural, social and environmental drivers with key stakeholders.

To date the two schemes have been developed separately. Assessment of the feasibility of a combined scheme has not been possible due to numerous uncertainties about wastewater flows & loads, required irrigation land areas and storage requirements. The two schemes have now reached a point where they are sufficiently developed for a feasibility assessment of a combined scheme to be completed. The purpose of the work described in this report is to assess the economic feasibility and operational performance of a combined wastewater scheme for Akaroa and Duvauchelle.

1.2 Scope

The scope of work is to canvass a range of scheme combination options and evaluate them using Multi-Criteria Assessment (MCA) developed collaboratively between Council and Beca. A brief overview of both schemes is provided below.

1.2.1 Akaroa Wastewater Scheme

The Akaroa Wastewater Scheme upgrade has been in development since 2013 and involves:

- Network infiltration and inflow (I&I) reduction works.
- Reconfiguration of the reticulation and pumping network to reverse the current network arrangement of pumping from north to south, and instead pump south to north.
- New terminal pump station and rising main to treatment plant.
- New treatment plant including post-treatment wetland north of the town.
- New land disposal irrigation system (including buffering storage).

An extensive optioneering exercise has been completed to assess the most suitable option for the scheme with disposal to land being the preferred disposal system (Beca, Akaroa Wastewater Summary of Disposal and Reuse Options, 2020). The proposed land disposal system (at the time of writing this report) comprises the following areas:

- Robinsons Bay Irrigation Site – 31.9 ha dripper irrigation.
- Hammond Point Irrigation Site – 3.8 ha dripper irrigation.
- Storage in covered tanks (Robinsons Bay) during wet weather conditions.

Average daily modelled wastewater flows from the Akaroa scheme are 650m^3/day with peak wet weather flows modelled up to 4,800m^3/day. Design flows for the scheme have been determined in recent flow basis work by Beca[1].

[1] Akaroa Wastewater Scheme – Design Flow Basis Update Report (Beca, 2023)

1.2.2 Duvauchelle Scheme

The Duvauchelle Wastewater Scheme upgrade has been in development since 2018 and involves:

- Infiltration and ingress (I&I) reduction works (network upgrades)
- Upgrading of the existing Duvauchelle WWTP (including slope stabilisation work above the site)
- New land disposal irrigation system (including buffering storage)
- The land disposal scheme approved by Christchurch City Council includes both dripper irrigation to trees and spray irrigation of the Akaroa Golf Club course, located at Duvauchelle

An optioneering exercise has been completed to identify the preferred scheme with irrigation to a tree block behind the Akaroa Golf Club (AGC) identified as the preferred disposal system, largely due to moderate costs and the community stakeholder support for reuse benefits (Beca, Duvauchelle Wastewater Summary of Disposal and Reuse Options, 2022).

Beneficial re-use involving irrigation of treated wastewater to the Akaroa Golf Course during summer periods has also been explored. Golf course irrigation offers no hydraulic benefit to the overall scheme in terms of optimised costs and/or performance. Winter irrigation represents the “worst case” and determines the sizing of key infrastructure, and the golf course cannot be irrigated in winter due to saturated soils. The benefits of golf course irrigation are primarily related to golf playing amenity and broader well-being of the Akaroa Harbour community. The proposed land disposal system comprises the following areas:

- Duvauchelle tree area – 6.4 ha dripper irrigation above Akaroa Golf Course
- Golf course playing areas – 6.4 ha spray irrigation (beneficial re-use when required by AGC)
- Discharge to covered tanks during wet weather conditions.

Average daily wastewater flows from the Duvauchelle scheme are 80m^3/day with peak wet weather flows measured up to 1,040m^3/day. Design flows for the scheme have been determined in recent flow basis work by Beca[2].

1.3 Multi-Criteria Analysis

A multi-criteria (MCA) analysis tool was used to evaluate options to combine the Akaroa and Duvauchelle wastewater schemes. The MCA has been based on the following criteria; noting some common attributes such as environmental impact were not included as all options are considered to have the same or very similar beneficial environmental outcomes (removal of harbour outfall and discharge to land).

- Economic (CAPEX and NPV costs)
- Reliability and Resilience
- Construction and Operation
- Social Acceptance

The above criteria have been considered and assessed for each scheme combination option through a collaborative MCA workshop with Council. CAPEX and NPV costs for each option have been supplied by Council and scored using cost bands. Further details around the scoring and weighting for the above criteria is provided below.

[2] Duvauchelle Wastewater Scheme – Design Flow Basis Update Report (Beca, 2023)

2 Combined Scheme Options

Figure 1 overleaf presents the scheme combination options developed with Council and considered as part of the MCA. A description of these options is presented in Table 1 below.

Table 1 Summary of Separate and Combined Wastewater Scheme Options

Option	Wastewater Treatment		Treated Wastewater Irrigation		Storage
	Duvauchelle	***Akaroa***	***Duvauchelle***	***Akaroa***	
Option 1	Upgraded Duvauchelle WWTP	New Akaroa WWTP	Duvauchelle Trees (6.4ha)	Robinson's Bay + Hammond Point (35.7ha)	3,250m^3 (Duvauchelle) 20,000m^3 (Akaroa)
Option 2	Upgraded Duvauchelle WWTP	New Akaroa WWTP	Combined irrigation to Duvauchelle Trees, Robinsons Bay + Hammond Point (42.1ha)		24,000m^3 (Akaroa)
Option 3	New Akaroa WWTP		Combined irrigation to Duvauchelle Trees, Robinsons Bay + Hammond Point (42.1ha)		24,000m^3 (Akaroa)
Option 4	New Akaroa WWTP		Irrigation only to Robinson's Bay + Hammond Point (40.7ha)		24,000m^3 (Akaroa)
Options 5-7 below are based on options 1-3 with inclusion of beneficial re-use (spray irrigation) to the Akaroa Golf Course playing areas					
Option 5	Upgraded Duvauchelle WWTP	New Akaroa WWTP	Duvauchelle Trees (6.4ha) **+ beneficial reuse on AGC playing areas (6.4ha)**	Robinson's Bay + Hammond Point (35.7ha)	3,250m^3 (Duvauchelle) 20,000m^3 (Akaroa)
Option 6	Upgraded Duvauchelle WWTP	New Akaroa WWTP	Combined irrigation to Duvauchelle Trees, Robinsons Bay + Hammond Point (42.1ha) **+ beneficial reuse on AGC playing areas (6.4ha)**		24,000m^3 (Akaroa)
Option 7	New Akaroa WWTP		Combined irrigation to Duvauchelle Trees, Robinsons Bay + Hammond Point (42.1ha) **+ beneficial reuse on AGC playing areas (6.4ha)**		24,000m^3 (Akaroa)

Options 1 and 5 are the base scenarios for the two independent schemes. The separate schemes consist of the following:

- Duvauchelle wastewater treated at an upgraded Duvauchelle Wastewater Treatment Plant and irrigation to the Duvauchelle irrigation site.
- Akaroa wastewater treated at a new Akaroa Wastewater Treatment Plant and irrigated across the Robinsons Bay and Hammond Point irrigation sites.

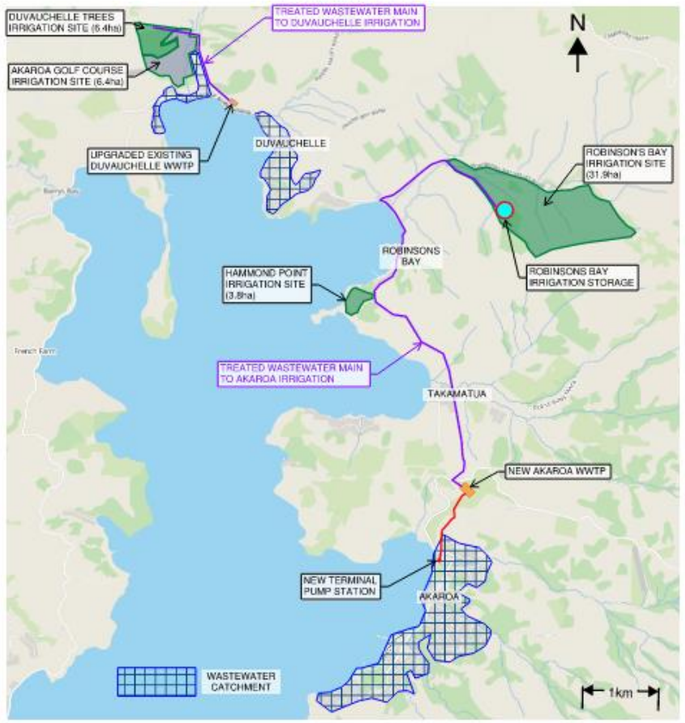
Options 2 and 6 involve localised wastewater treatment for each catchment (upgrading of the Duvauchelle WWTP) but connecting the Akaroa irrigation rising main to Duvauchelle to allow combined irrigation and redistribution across all irrigation sites. Wastewater would generally be irrigated at or near the location where it has originated for most of the time, but can be diverted to different land areas in order to maximise total application to land, optimise the use of storage and reduce overflows.

Options 3 and 7 involve abandoning the existing Duvauchelle Wastewater Treatment Plant and pumping Duvauchelle wastewater to the new Akaroa Wastewater Treatment Plant. Irrigation from the treatment plant would then be combined similar to Option 2.

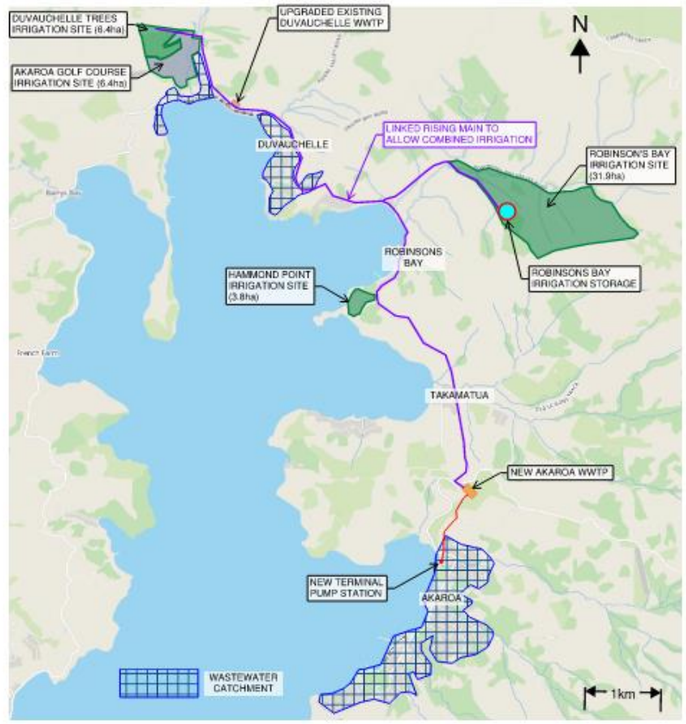
Similarly, Option 4 involves abandoning the existing Duvauchelle Wastewater Treatment Plant and combining treatment at the new Akaroa Wastewater Treatment Plant. However, treated wastewater would then only be discharged back to the two Akaroa irrigation sites (Robinsons Bay and Hammond Point).

Further options 5, 6 and 7 are based on options 1, 2 and 3 but with golf course spray irrigation over 6.4 hectares of playing area added.

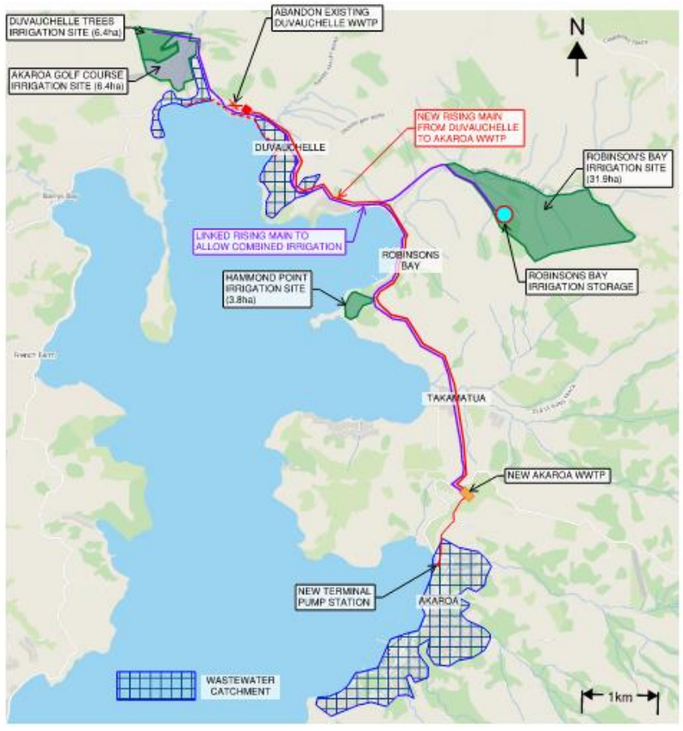
OPTION 1
INDEPENDENT SCHEMES
SEPARATE TREATMENT
SEPARATE IRRIGATION



OPTION 2
SEPARATE TREATMENT
COMBINED IRRIGATION



OPTION 3
COMBINED TREATMENT
COMBINED IRRIGATION



OPTION 4
COMBINED TREATMENT
IRRIGATION TO AKAROA FIELDS ONLY

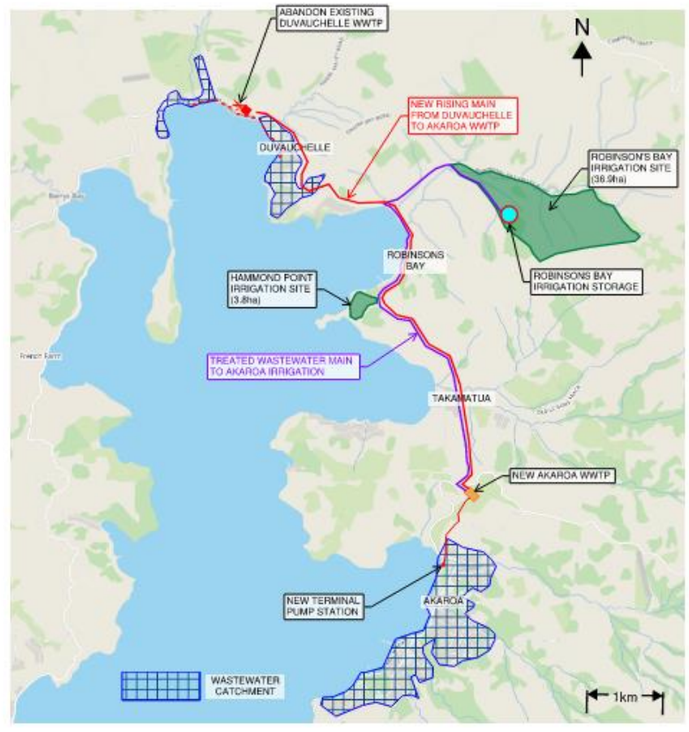


Figure 1 - Scheme Combination Options for MCA

2.1 Combined Schemes Irrigation Modelling

Irrigation soil moisture balance models have been run for the above combined irrigation options to understand how the combined irrigation scheme performs compared with independent irrigation based on two separate schemes. For further details around the setup and parameters of these models see the latest flow basis update work for the two schemes[3,4].

Irrigation capacity, and associated storage and overflow behaviour, is highly sensitive to daily rainfall depth. Rainfall trigger levels have been adopted in the model above which irrigation ceases in order to prevent overland flow (30mm/day at Duvauchelle and 50mm/day at Robinsons Bay). While rainfall and soil moisture levels are expected to be generally consistent across the two irrigation sites, soil moisture at different sites may vary and this presents an opportunity to redistribute wastewater to optimise performance.

The combined irrigation modelling has linked the two fields so that if on a given day the Duvauchelle scheme rainfall trigger limit is reached and the Akaroa trigger is not (and has spare irrigation capacity), Duvauchelle wastewater will be irrigated to the Akaroa field – and vice versa.

Note that 'overflow seasons' are reported below which indicate the number of irrigation seasons (i.e. years) that overflows occurred in the model. Whether or not repeat overflows occur within an irrigation season is subject to a number of operational and regulatory aspects such as;

- how overflows will be managed (whether storage will be further drawn-down to provide capacity following an overflow) – how much and at what rate? etc.
- What will define an overflow 'event' – i.e. how many days between storage spilling defines a new event?

The irrigation modelling undertaken does not capture the above resolution and therefore 'overflow seasons' have been reported and are discussed further below.

Combined scheme irrigation results across 50-years are summarised in Table 2. The upper and lower range columns represent a 10% sensitivity acknowledged in the comparison of the modelled 50-year Akaroa flows against measured flow meter data. In other words, there is uncertainty in the modelling and this is reflected in a range of results. For further details around the Akaroa flows and modelling uncertainty see the Akaroa Flow Basis Update Report[4].

Table 2 - Separate vs Combined Scheme Irrigation Results

	Irrigation Area (ha)	Storage Volume (m^3)	# Overflow Seasons (upper range)	# Overflow Seasons (lower range)
Separate Irrigation	6.4 ha Duvauchelle 35.7 ha Akaroa	3,250 m^3 Duvauchelle 20,000 m^3 Akaroa	22 seasons Duvauchelle 23 seasons Akaroa	22 seasons Duvauchelle 11[1] seasons Akaroa
Combined Irrigation	42.1 ha	24,000 m^3	21 seasons	11[1] seasons
Combined Irrigation	42.1 ha	20,000 m^3	25 seasons	18[1] seasons
Combined Irrigation	47.1 ha[2]	20,000 m^3	21 seasons	11[1] seasons

Note 1. 10% reduction applied to Akaroa 50-year flows to represent sensitivity of modelled flows against measured.

Note 2. Includes additional 5 hectares at Robinsons Bay irrigation site.

[3] Duvauchelle Wastewater Scheme – Design Flow Basis Update Report (Beca, 2023)

[4] Akaroa Wastewater Scheme – Design Flow Basis Update Report (Beca, 2023)

The above summary demonstrates that:

- The total number of seasons when overflows occur across both schemes is reduced if the irrigation is combined – noting this is largely as a result of sharing a larger storage facility.
- The number of overflow seasons at Akaroa is sensitive to a 10% change in adopted flows.
- Reducing the combined storage down to 20,000m^3 results in an increase in modelled overflow seasons ranging from 18 to 25 (lower and upper range) in the 50-year modelled period.
- Introducing an additional five hectares of irrigable land and reducing combined storage by 4,000m^3 (down to 20,000m^3) results in a similar overflow season recurrence to the base case.
- While not shown in the above table, modelled climatic differences across the two irrigation sites appears to have little if any benefit in reducing total overflow volumes (i.e. the sum of the parts still more or less equals the whole). However, this is not surprising as the irrigation model applies the set application depth regardless of soil moisture levels and it is only the daily rainfall trigger that prevents irrigation in the model.

It should be noted that linking the two irrigation systems offers other benefits not necessarily captured in the above modelling. These include the following:

- Combining the schemes allows for a single overflow discharge point and reduces the number of different overflow discharge points
- Real time monitoring of soil conditions (once the scheme is operational) may permit higher application rates and/or adjusted rainfall trigger levels which may reduce the occurrence or magnitude of overflows. Linked irrigation systems could benefit from preferable conditions in the other catchment (to a greater extent than the modelling above suggests).
- Improved resilience from linking irrigation systems in the event that one system may become non-operational and could provide buffer time to bring the system back online.
- Any under and over-estimations in design flows across the two schemes may be offset and allow more flexibility in the overall performance across the irrigation schemes.

Note that irrigation performance for Option 4, which involves irrigation only to Robinsons Bay and Hammond Point (with 5 hectares of additional irrigation area) was not modelled. This option has slightly less (1.4ha) total irrigable area, however winter application rates at these sites are higher than at the Duvauchelle trees irrigation site and this scheme option is expected to have a similar modelled overflow recurrence.

Irrigation modelling has confirmed that the inclusion of the Golf Course spray irrigation during summer months has no impact on irrigation and storage requirements as these are driven by winter conditions.

2.2 Cost Estimates

Council has provided cost estimates (developed by QSolutions as at 15th December 2023) for each scheme combination option which are summarised in Table 3. Note that these estimates reflect only the scheme components that differ across the combination options being considered. For example, the Terminal Pump Station is required for all options and does not vary across options and is therefore not included in cost estimate comparisons.

Table 3 - Cost Estimates for Scheme Combination Options

Option	30 Year NPV Estimate ($M)
Excluding Golf Course Irrigation	
Option 1 (independent schemes)	$105.7
Option 2 (separate treatment, combined irrigation)	$106.6
Option 3 (combined treatment, combined irrigation)	$96.0
Option 4 (combined treatment, Akaroa irrigation only)	$87.5
Including Golf Course Irrigation	
Option 5 (independent schemes)	$107.5
Option 6 (separate treatment, combined irrigation)	$108.5
Option 7 (combined treatment, combined irrigation)	$97.9

3 MCA Scoring

3.1 MCA Criteria and Weighting

Attributes and weightings for the MCA were selected by Beca and discussed with CCC prior to the scoring workshop. The overall selection of attributes was cognisant of the fact that extensive work had already been done to select scheme options that performed comparatively well in terms of the "four well-beings" (i.e. social, cultural, economic and environmental wellbeing) as set out in the Local Government Act 2002.

It was also assumed that any combined scheme would incorporate the favourable features of the individual schemes and would therefore perform similarly in terms of the four well-beings.

Accepting this, the MCA criteria chosen for this assessment were focussed on the "next level down" operational performance features including costs (NPV), reliability and resilience, and construction and operation. Social acceptance was subsequently added as a criterion because important differences between the schemes in terms of social acceptability were identified during the workshop and this factor is not considered anywhere else. The final MCA attributes and weightings are shown in Table 4.

Table 4 - MCA Criteria and Weightings

MCA Assessment Criteria	Criteria weighting	Objective	Objective weighting	0 Does not meet	1 Partially meets	2 Meets	3 Exceeds
Economic	30%	30-year NPV	30%	Scored quantitatively against alternative options (1-3)			
Reliability and resilience	30%	Infrastructure resilience, incl. Redundancy and climate change and seismic vulnerability	15%	No redundancy (i.e., single critical asset), high vulnerability	Partial redundancy of asset, single asset but low risk of failure, potential for higher vulnerability	Either full redundancy or low risk of failure, neutral vulnerability	Full redundancy of critical assets and lower risk of damage, low vulnerability
		Change in flows/demand and meeting future demand	15%	Does not meet current demand	Potential for unrealised investment or not able to meet demand or flow basis	Meets predicted demand and flow basis	Flexibility between design capacity and predicted demand growth or flow changes
Construction and operation	30%	Health and safety	5%	Significant H&S risks	Some H&S risks	Some H&S risks, able to be managed	Minimal H&S risks
		Ease of operation	15%	Highly involved, multiple sites, significant operator involvement	Partially automated, some operator intervention needed	Largely automated, some operator intervention needed	fully automated, remote monitoring, minimal operator intervention, fewer sites
		Environmental compliance	10%	high risk of non-compliance	significant risk of non-compliance	moderate risk of non-compliance	low risk of non-compliance
Social Acceptance	10%	Social Acceptance	10%	Stakeholder opposition could compromise scheme viability	Stakeholder opposition but not fatal to scheme success	Accepted by most stakeholders and opposition is minor	Broad social acceptance
Total	*100%*		*100%*				

3.2 Multi-Criteria Assessment Results

MCA scoring has been split into two assessments: the first being the core options that exclude golf course irrigation (Options 1 - 4). MCA scoring for "excluding golf course irrigation" options is shown in Table 5 overleaf. This comparison demonstrates the relative benefits and disbenefits of the various treatment and conveyance options considered (i.e. separate or combined treatment and irrigation).

MCA scoring for "including golf course irrigation" options is shown in (Options 5, 6 and 7). In other respects Options 5, 6 and 7 are the same as Options 1, 2 and 3 respectively.

"Including golf course irrigation" options scored similarly to "excluding golf course irrigation" options except the social acceptance is higher for "including" options. Higher social acceptance is due to providing for social wellbeing through increased irrigation of the golf course in summer.

Table 5 – MCA Scoring for "Excluding Golf Course Irrigation" Options

MCA Assessment Criteria	Criteria weighting	Objective	Objective weighting	Option 1: SEPARATE SCHEMES	Option 2: SEPARATE TREATMENT BUT COMBINED IRRIGATION	Option 3: COMBINED TREATMENT & COMBINED IRRIGATION	Option 4: COMBINED TREATMENT & IRRIGATION TO AKAROA ONLY
Economic	30%	30-year NPV	30%	1.3	1.2	2.2	3.0
Reliability and resilience	30%	Infrastructure resilience, incl. Redundancy and climate change and seismic vulnerability	15%	2	2	2	2
		Change in flows/demand and meeting future demand	15%	2	3	3	2
Construction and operability	30%	Health and safety	5%	2	2	2	2
		Ease of operation	15%	1	1	2	3
		Environmental compliance	10%	2	2	3	2
Social Acceptance	10%	Social Acceptance / Public Perception	10%	1	2	2	0
Total	*100%*		*100%*				
		Total (unweighted)		11	13	16	14
		Rank (unweighted)		4	3	1	2
		Total (weighted)		**1.53**	**1.75**	**2.31**	**2.25**
		Rank (weighted)		**4**	**3**	**1**	**2**

Scoring Guide: **0** = Does not meet, **1** = Partially meets, **2** = Meets, **3** = Exceeds

Economic scoring based on quantitative scale from 1 – 3. Score = 1 + 2*[1 – ((cost of option – minimum cost option) / range of option costs)]

Table 6 MCA Scoring for "Including Golf Course Irrigation" Options

MCA Assessment Criteria	Criteria weighting	Objective	Objective weighting	Option 5: SEPARATE SCHEMES (+ AGC COURSE IRRIGATION)	Option 6: SEPARATE TREATMENT BUT COMBINED IRRIGATION (+ AGC COURSE IRRIGATION)	Option 7: COMBINED TREATMENT & COMBINED IRRIGATION (+ AGC COURSE IRRIGATION)
Economic	30%	30-year NPV	30%	1.1	1.0	2.0
Reliability and resilience	30%	Infrastructure resilience, incl. Redundancy and climate change and seismic vulnerability	15%	2	2	2
		Change in flows/demand and meeting future demand	15%	2	3	3
Construction and operability	30%	Health and safety	5%	2	2	2
		Ease of operation	15%	1	1	2
		Environmental compliance	10%	2	2	3
Social Acceptance	10%	Social Acceptance / Public Perception	10%	2	3	3
Total	*100%*		*100%*			
		Total (unweighted)		12	14	17
		Rank (unweighted)		3	2	1
		Total (weighted)		**1.58**	**1.80**	**2.35**
		Rank (weighted)		**3**	**2**	**1**

Scoring Guide: **0** = Does not meet, **1** = Partially meets, **2** = Meets, **3** = Exceeds

Economic scoring based on quantitative scale from 1 – 3. Score = 1 + 2*[1 – ((cost of option – minimum cost option) / range of option costs)]

4 Conclusions

4.1 Summary of "No Golf Course Irrigation Options " MCA

"No golf course irrigation" options are described in Options 1 – 4. A summary evaluation of the MCA for these options is set out below.

- Option 3 (combined treatment + combined irrigation) is the highest scoring "golf course excluded" option. This option involves decommissioning Duvauchelle Wastewater Treatment Plant and conveying all wastewater for treatment at the new Akaroa WWTP, and then irrigating wastewater across both the Duvauchelle and Akaroa irrigation area. Option 3 scored highest due to the following key factors:
    - A single treatment plant at Akaroa will be comparatively easier to operate and, as a new plant, will provide reliable and compliant performance
    - Redistribution of wastewater to irrigation areas at both Duvauchelle and Robinsons Bay is considered more resilient as flows may be directed to different areas depending on local climatic and soil moisture conditions
    - Redistribution to both areas also addresses social concerns about wastewater from "other communities' being disposed in Robinsons Bay (it is intended that the annual irrigation to the different areas would roughly match the contribution from each community). This has been a very important theme in earlier community consultation and the reputational risks to council if this issue is not properly considered are significant
    - This option is moderately economically favourable compared to the average NPV for all schemes (30 year NPV is $5.4M less than average)
    - Some drawbacks of this option are the need for long runs of new rising mains (in both directions) and potential odour to be managed when pumping raw Duvauchelle wastewater to the new Akaroa WWTP
    - In summary, Option 3 provides optimal treatment performance and overall scheme resilience while also addressing important community concerns that wastewater from a community should be reused within that same community.
- Option 4 (combined treatment at Akaroa and irrigation only at Akaroa) is the second highest scoring option. This option involves abandoning the Duvauchelle WWTP, combining treatment at the new Akaroa WWTP, and then irrigating treated effluent from both schemes only at the Akaroa irrigation sites. Option 4 scored second highest due to the following key factors:
    - This option is the most economically favourable compared to the average NPV for all schemes (30 year NPV is $13.9M less than average)
    - A single treatment plant at Akaroa will be comparatively easier to operate and, as a new plant, will provide reliable and compliant performance
    - Option 4 has the disadvantage that 100% of the combined wastewater flows are applied to the Akaroa land irrigation sites. As a result, application volumes will be higher and the scheme will be less resilient to extreme weather events.
    - Another drawback of this option is the risk of community opposition to irrigating Duvauchelle wastewater on the Akaroa irrigation land. This opposition should not be underestimated, as the residents of Robinsons Bay have previously registered serious dis-satisfaction with the disposal of Akaroa wastewater in their local area. Adding the Duvauchelle wastewater may be seen as "adding insult to injury".

  - In summary, Option 4 provides optimal treatment performance and costs, but offers lower scheme resilience and exposes council to reputational risks due to community opposition to irrigating Duvauchelle wastewater at Robinsons Bay.

- Option 2 (separate treatment + combined irrigation) is the third highest scoring option. This option involves retaining and upgrading the Duvauchelle WWTP, provision of the new Akaroa Treatment Plant, and then constructing a connecting pipe between the two schemes through which wastewater can be distributed across the different irrigation areas. Option 2 scored third highest due to the following key factors:
  - Two treatment plants are more complex to operate than one (i.e. Option 3) and are considered to be less reliable overall as the Duvauchelle plant is aging and relies on a process that is less controllable than the new treatment process intended for Akaroa.
  - Option 2 also provides the advantage of redistribution of wastewater to irrigation areas at both Duvauchelle and Robinsons Bay is considered more resilient in terms of climate change (than Option 4) as flows may be directed to different areas depending on local climatic and soil moisture conditions
  - Redistribution to both areas also addresses social concerns about wastewater from “other communities’ being disposed in Robinsons Bay. It is intended that the annual irrigation to the different areas would roughly match the contribution from each community
  - This option is economically unfavourable compared to the average NPV for all schemes (30 year NPV is $5.2M more than average)
  - A further drawback of Option 2 is the retention of Duvauchelle Wastewater Treatment Plant, with attendant risks of lower and less consistent treatment performance, reliability risks and more complex operations due to two treatment plants operating rather than one.
  - In summary, Option 2 provides similar benefits to Option 3 including moderate costs, optimal scheme resilience and recognition of community concerns, but with the disadvantage that two treatment plants must be kept in operation
- Option 1 (separate treatment and disposal) is the lowest scoring option. This option involves building separate schemes with localised treatment and irrigation. Option 1 scored lowest due to the following key factors:
  - This option is economically unfavourable compared to the average NPV for all schemes (30 year NPV is $4.4M more than average)
  - Requires operation of two treatment plants (complexity and higher risk of non-compliance),
  - The Duvauchelle Wastewater Treatment plant after upgrading and slope stabilisation, remains vulnerable to long term climate change risk, residual H&S risk to operators and lower ease of operation being an older treatment plant
  - Less adaptability to change in flows/demand as each scheme has a prescribed irrigation site
  - Without connectivity to the Akaroa flows this option offers less flexibility around flow distribution and hence is considered to be less resilient

4.2 Summary of " Golf Course Irrigation Options" MCA

- Option 7 (combined treatment + combined irrigation) is the highest scoring "golf course included" option. This scheme involves decommissioning the Duvauchelle plant and conveying all wastewater for treatment at the new Akaroa WWTP, and then irrigating wastewater across both the Duvauchelle and Akaroa irrigation areas including the Akaroa Golf Course. Option 7 scored highest due to the favourable performance already outlined for Option 3, but with the following additional features:
    - Combining Akaroa with Duvauchelle will allow additional golf course irrigation in the summer (from the Akaroa catchment). This would respond to a key golf club concern around inadequate summertime irrigation and optimise the social benefits of the scheme overall
    - Modelling results show no reduction in overflow frequency if the golf course is irrigated. In other words, while social benefits are considered optimal there are no improvements in overall scheme resilience and performance over Option 3.
    - This option is moderately economically favourable compared to the average NPV for all schemes (30 year NPV is $3.5M less than average)
- Option 6 (separate treatment + combined irrigation) is the second highest scoring option. This scheme involves retaining and upgrading the Duvauchelle WWTP, separate treatment at Akaroa, and then distributing wastewater from both communities across both the Duvauchelle and Akaroa irrigation sites. Option 6 scored second highest due to the favourable performance already outlined for Option 2, but with the following additional features:
    - Similar to Option 7, inter-connecting Akaroa and Duvauchelle systems will allow additional golf course irrigation in the summer (from the Akaroa catchment). This would respond to a key golf club concern around inadequate summertime irrigation and optimise the social benefits of the scheme overall
    - Modelling results show no reduction in overflow frequency if the golf course is irrigated. In other words, while social benefits are considered optimal there are no improvements in overall scheme resilience and performance over Option 2.
    - This option is economically unfavourable compared to the average NPV for all schemes (30 year NPV is $7.1M more than average)
- Option 5 (separate treatment and disposal) is the lowest scoring "golf course included" option. This scheme involves building separate treatment systems with localised treatment and irrigation. Option 5 scored lowest due to the unfavourable performance already outlined for Option 1, but with the following additional features:
    - This option fails to achieve summertime improvements in the golf course irrigation as available water from Akaroa cannot be used at Duvauchelle (as the schemes are not connected).
    - This option is economically unfavourable compared to the average NPV for all schemes (30 year NPV is $6.2M more than average)