Evaluating
BECA Ltd: Akaroa Wastewater Scheme

Design Flow Basis Update Report

Report to Environment Canterbury

15 April 2024

Executive Summary

Christchurch City Council submitted the resource consent application for its Akaroa Treated Wastewater Irrigation Scheme to ECAN in June 2023.

Friends of Banks Peninsula has been involved with the wastewater proposals since 2007, on working parties, keeping abreast of all technical developments and making substantive submissions. We obtained a copy of the application and carried out an analysis of the wastewater daily flow modelling, concerned that the proposed storage requirement was so much less than that presented to the public during the last round of consultation in 2020. Our analysis identified that the wastewater flows had been underestimated and the storage undersized. Both ECAN and Christchurch City Council were provided with a copy of our report in September 2023.

Christchurch City Council commissioned consultants Beca Ltd to review the flow modelling. Their Design Flow Basis Update Report was released on 8 April 2024 and made available to Friends of Banks Peninsula. We have now conducted an analysis of the Beca Update Report and compared it to the consent application to identify differences, and assess their implications for the proposed system design. The Update Report:

- confirms that the wastewater flow modelling in the application had been underestimated and for the reasons identified in the Friends of Banks Peninsula report;
- identifies that even if the maximum spare storage capacity provided by the application is constructed and fully utilised, there would still be treated wastewater overflows into the harbour more frequently than 1 in 5 years, whereas the application had been predicated on there being no overflows;
- discusses several different ARI (Average Recurrence Intervals) when different components of the system would be unable to cope with wastewater flows. This has drawn to our attention the inconsistencies in different parts of the proposed new wastewater system and the lack of any ARI threshold for the irrigation system as overflows were not anticipated;
- identifies that additional raw wastewater buffering is needed at the Terminal Pump Station to meet the Council's 1 in 5 year ARI for raw sewage overflows into Grehan Stream;
- flags that the irrigation rates have increased from those previously adopted to avoid increasing the risk of land instability. Our analysis also identifies that some of the irrigation areas now included were formerly excluded due to having a history of saturation and have yet to be geo-technically assessed;
- advises that the Council should now consider providing appropriate margins when sizing the infrastructure for the wastewater system for flows above the level predicted by the updated modelling to cope with anomalies in the model and the weather; and,
- advises that extreme weather events are more likely as the climate changes.

Given the substantive issues raised, the Council will now need to decide whether it is going to provide extra storage and/or irrigation capacity, accept more frequent overflows, or further reduce the high levels of infiltration into Akaroa's ageing pipe network. This infiltration during and following rainfall is the cause of the high wastewater flows and the resulting capacity issues.

We conclude that installing a fixed capacity land disposal system is incompatible with the current network infrastructure with its badly leaking pipes. These must be repaired or replaced to the fullest extent possible, in line with the recommendation made by the Council when it approved the irrigation scheme proposal in 2020. The current application should be withdrawn and reconsidered once all possible steps have been taken to reduce infiltration and the remaining extent of it is known. The system can then be properly sized with a consistent ARI that has been determined through an assessment of environmental effects, cost/benefit analysis and appropriate public consultation. This will provide Akaroa and the ratepayers with a system that is sustainable and resilient for the conditions expected in the years ahead.

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1 Summary of findings in the Beca Update Report

Christchurch City Council has supplied Friends of Banks Peninsula with a new report produced by Beca Ltd[1] re-assessing the design flows of the Akaroa Wastewater Scheme. This report released in April 2024 identifies substantive differences in the design flows, sizing of infrastructure and anticipated overflows from those in the Consent Application CRC235038 lodged with ECAN in June 2023, and from the responses given to ECAN in their subsequent requests for further information.

We summarise the differences it the table below, and then in the following sections discuss each in more detail.

Table 1 Summary of differences between consent application and updated modelling

Difference	Consent application including RFI	New Modelling Report
Storage requirement	12,000m3 would suffice with no overflows	20,000m3- 24,000m3, which still results in overflows
Extent of overflows	No overflows of treated wastewater	Overflow events could last weeks or months
Managing overflows	Overflows not anticipated	Identifies need to determine a management approach to overflows
Irrigation rate	Two different irrigation rates used in different appendices –original rates and new higher rates	Higher irrigation rates applied
Irrigation field size and use	Different field sizes used in different appendices, 35.7ha and 40ha	Consider use of 5ha previously earmarked as less suitable
Stand-down period after heavy rain	Inconsistency between management principle and storage modelling	Acknowledgement of long tail of increased groundwater after heavy rain but inconsistency remains
Raw sewage overflows	No mention of raw sewage overflows	Acknowledged that Terminal Pump Station capacity of 65l/s means raw overflows expected more frequently than 1 in 5 years
Raw sewage buffer tank at Terminal Pump Station	Not considered in application	Suggests a 330m3 raw buffer storage needed at the TPS to cope with inflows to meet 1 in 5 year overflow design criteria.
Bypass Flows	Committed to “no bypass” approach	Consultants understand Council is exploring Treatment Bypass for High Flows
Increase in extreme storms due to climate change	Acknowledged increased likelihood of extreme rain events but no provision made to cope with them.	Acknowledged increase in unpredictable “black swan” events around NZ but excluded them from modelling.
Capacity Margins	Storage margin 8,000m^3	Margin now exceeded, revised margins needed.
Forecast Population	Modelling based on Akaroa winter population of 840 and summer peak of 4557 Excluded Takamatua and Ōnuku from system	Revised to winter population of 882 and peak summer of 3706. Consideration of including the Takamatua and Ōnuku populations in the system
Environmental effects of overflows and unexpected events	No ARI (average recurrence interval) mentioned in application. No consideration of effects of overflows, as not anticipated	Various ARI scenarios (2 year, 5 year, 10 year) used for different parts of the system
Drinking water retentate reduction	Storage modelling based on 75% reduction in drinking water retentate	Acknowledges some retentate reductions achieved and assumes no further

[1] Beca Ltd, Akaroa Wastewater Scheme Design Flow Basis Update Report, April 8 2023

Difference	Consent application including RFI	New Modelling Report
I&I reductions	Storage sizing predicated on reducing I&I by 20%	I&I reductions considered achieved and no further repairs planned

2 Storage requirements and overflows

A critical component of the ATWIS system are large storage tanks designed to hold treated wastewater when there is more coming through the system than can be safely irrigated. If the storage is insufficient then treated wastewater will have to overflow somewhere – either by being drawn down and over-applied at the irrigation field or disposed of to a water body.

2.1 Storage requirement

The consent application stated that

There are no direct discharges from the ATWIS to water (fresh or coastal) – all treated wastewater will be irrigated to land.[2]

It identified that 12,000m^3 would provide sufficient storage to preclude treated wastewater overflows stating:

"modelling determined that storage capacity of approximately ***11,250 m^3 would be needed so the scheme can irrigate and / or store all wastewater treated at the WWTP without requiring any bypass discharges of treated or untreated wastewater from the scheme to an alternative receiving environment****.* ***Initial storage capacity of at least 12,000 m3*** *will be developed, but consent is sought in respect of all ten tanks, which would provide a cumulative total potential storage capacity of up to 20,000 m3. The additional capacity would provide substantial storage above the modelled volume to account for unforeseen events.*[3]

The storage is to be provided on two platforms on the Upper Robinsons Bay irrigation field, at an elevation of approximately 150m. Extensive earthworks over approximately 2ha are required to construct the platforms.

The modelling in the Update Report, tested on various scenarios, now informs that there would insufficient capacity to preclude all overflows. Even if the storage is increased to 24,000m^3 overflows could be reasonably expected every few years. At, 20,000m^3, as applied for, overflows are expected between 11-21 years over the 51year period analysed.[4]

This confirms the conclusions reached by Friends of Banks Peninsula in its report supplied to CCC and ECAN in September 2023 that the storage provided in the application had been grossly undersized. The cause identified was that the original flow modelling had not taken into account the long tail of elevated infiltration into the wastewater network that occurs after prolonged rain in the Akaroa catchment.[5]

2.2 Extent of the overflows

The Update report does not attempt to define what an overflow event is, but makes clear it could last for several days or even months. In the 1978 example given in the report the 20,000m^3 storage limit would have reached capacity, separate overflows would have occurred four times, the longest lasting for over a month.

Based on actual flow data from 2022 and 2023, overflows would have totalled 8,446m^3 in 2022 and

[2] CRC235038 consent application p7
[3] CRC235038 consent application p17
[4] Beca Design Flow Basis Update Report Table 6-2 p34
[5] Friends of Banks Peninsula, Evaluating Water Storage Requirements for Akaroa Treated Wastewater System Using Actual Flow Data, p 5

15,433m^{3}in 2023.

This is very different from the occasional temporary network overflows currently experienced which may last for a few hours or a day. The prolonged overflows occur because large volumes of treated wastewater are coming through from the plant, but cannot be irrigated out, so overflow.

2.3 Dealing with the overflows

Because the consent application assumes the storage will be sufficient it does not anticipate overflows of the treated wastewater, and therefore does not describe any mechanism through which they will be handled or provide any conditions to manage them.

The report advices that this matter does need to be addressed stating:

Further operational and planning considerations are needed to determine a management approach for overflows in terms of storage drawdowns, discharge rates, how overflows will be reported and discharge locations etc[6]

What is meant by "storage drawdowns" is not made clear – but could potentially mean irrigating outside of the permitted irrigation parameters or disposing to a nearby waterbody.

2.4 Increasing storage

Although the Update Report includes scenarios with 24,000m3 of storage, it does not give consideration as to whether this could be provided on the sites currently acquired by the Council for the wastewater project.

As noted above, the consent application indicated that that 12,000m^3 of storage would be constructed initially, and includes a proposed condition that between 8,000m3 to 12,000m3 of tank storage be constructed in the Robinsons Bay Valley Irrigation site. The application included provision for up to 10 tanks providing 20,000m3 of storage on large platforms to be excavated on a ridgeline at approximately 150m altitude on the site.

Later in response to ECAN's RFI, the Council stated that:

Up to 20,000m3 of storage will be provided depending on the results of I&I reduction measures, but it should be assumed that the full 20,000m3 of storage capacity will be available.[7]

It is not apparent where additional storage could be placed on the Robinsons Bay site, as all the potential storage locations assessed in 2020[8] are now allocated as irrigation areas, and the Geotechnical assessment warns not to overload the upper current tank platform due to instability concerns.[9]

3 Irrigation field and rates

Irrigation is to be provided on two sites at Robinsons Bay, the larger in the Upper Robinsons Bay valley and the smaller on Hammond Point – the headland between Takamatua and Robinsons Bay.

The application identifies 35.7ha of areas considered suitable for irrigation – 31.9 on the Upper Robinsons Bay land and 3.8 on Hammond Point. An additional 5.0ha are identified on the Upper Robinsons Bay land as possible irrigation areas but less suitable.

The application was based on irrigating to the 35.7ha of more suitable land.

3.1 Irrigation rates

It was unclear in the original application what set of irrigation rates was to be used. The rates given

[6] Beca Design Flow Basis Update Report p34
[7] RFI, p4
[8] CH2M Beca Ltd, Akaroa Wastewater Summary of Disposal and Reuse Options 17 July 2020, Appendix L
[9] CRC235038 consent application Appendix Q p 14

in Appendix F and used by PDP to calculate the storage requirement were the same as those published in 2020 when the Inner Bays Scheme was approved by Council. These rates appear to have been set in conjunction with the Technical Experts group (a body of engineers drawn from Council, consultants, Ngāi Tahu and the community) which met several times in 2017.[10] Three sets of rates were used (2.75mm/day in mid-summer, 2.1mm/day in spring and autumn and 1.5mm/day in winter). The Update Report states that:

Based on site conditions (soil type, slope and hill facing direction) a minimum winter application rate of 1.5mm/day (increasing in the shoulder and summer season) was originally adopted as appropriate to not heighten the risk of land instability.

However, the PDP storage calculation had been based on having 40ha of irrigable land available (at the time that work was done there was expected to be 2.9ha in Takamatua).Later consultants Aqualinc, after walking over the Upper Robinsons site, made substantive changes to the proposed irrigable areas, removing some, adding others and taken together this reduced the total suitable irrigable area to 35.7ha. They circumvented the issue of a smaller total field size by increasing the irrigation rate 12% to enable the same volume of water to be disposed of into the reduced area.

This was clarified in response to ECANs RFI and these are the rates that have been used by Beca and PDP for the revised modelling in the Update Report, but there has been no discussion of how these higher rates may affect land stability.

3.2 Potential use of less suitable areas

The Update Report makes clear that

One of the key parameters for the irrigation modelling is the tree dripper irrigation area, which has been determined using guidance from the USEPA around land treatment of municipal wastewater – key recommendations being:

- *Exclude land with slope of greater than 19 degrees unless a site-specific geotechnical assessment confirms land as suitable.*
- *Exclude land with slope of greater than 15 degrees for land downslope to coastline*
- *Exclude land with identified instability within or downhill of area*
- *Exclude land that, if it became unstable, could pose risk to downslope residences and infrastructure.*

Assessments of the available irrigable land for the scheme have been made by various geotechnical and irrigation specialists with consideration of the above guidance, however the irrigable areas adopted (Table 6-1) have been taken from the recently lodged resource consent application for the scheme5[11].

In highlighting these matters, the Update Report does seem to cast some doubt on the increased irrigation rate and the suitability of irrigation areas identified in the consent application. The application does include in the 35.7ha several areas high on the upper eastern side of the Upper Robinsons Bay site that do not appear to have had any form of geotechnical assessment. These areas may have been ruled out in earlier versions of the scheme as prior to the purchase of the land, PDP had been informed by the land owner that

"land on the upper slopes gets saturated during winter and remains so, indicating poorly draining materials.".[12]

Also included in the 35.7ha are areas that have downslopes of greater than 19^{o}, irrigation between and around the two tank platforms and areas with existing slips below.

[10] Beca Report, November 2019 Appendix A
[11] Update Report P32
[12] Beca Report, 2017, Appendix N p2

Nonetheless, the Update Report also considers the extent to which irrigating on the additional 5ha of less suitable land would reduce the storage requirement. These areas have also not been ge-otechnically assessed.

3.3 Stand down period after heavy rain

In their response to ECAN's RFI, Council are unequivocal that:

Irrigation would be delayed following the end of extreme rain events and restart subject to the return of favourable conditions…a fundamental principle of the scheme is that no irrigation will occur where land conditions are likely to result in surface ponding.[13]

However, neither the storage modelling in the consent application nor the Update Report has taken this into account. In both cases, it is assumed that irrigation will only cease when there has been more than 50mm of rain on a single day, and will recommence on the next dry day.

This is despite the Update Report now recognising that:

The Akaroa network demonstrates a long "tail" of increased flow following rainfall events due to an elevated groundwater table and subsequent increased groundwater infiltration. This effect is pronounced in winter when rainfall is more frequent and the effect of multiple events in succession is cumulative.

The same effect applies to the drainage of the land in Robinsons Bay after prolonged rainfall.

For example in August 2023, 7 days after irrigation would have recommenced using the >50mm cut off and recommencing the next dry day rule, the ground on the Upper Robinsons Bay site was saturated with extensive surface ponding still evident in most of the areas identified for irrigation. Had irrigation not resumed over these 7 days, an additional 3,748m^3 would have built up in the storage (or overflowed in insufficient capacity) as the long tail from Akaroa drained through the wastewater network.

Figure 1 Irrigable Area 4 August 2023

No margin has as yet been incorporated into storage calculations to cope with the fundamental principle that no irrigation will occur where land conditions are likely to result in surface ponding.

This is a significant omission which needs to be addressed, as this situation will occur after prolonged wet weather when the storage is the most under pressure.

[13] ATWIS – ECan Request for Further Information and Applicant's Response, Qiii.,emailed to FOBP 16/01/2024

4 Raw sewage overflows

As well as Treated Wastewater overflows, the Update Report has drawn attention to the frequency with which raw sewage overflows will occur because of limits in the new system.

4.1 Terminal Pump Station capacity

The Terminal Pump Station (TPS) is designed with a maximum capacity of 65 L/s. The Update Report states that this is likely to result in overflows happening more frequently than 1 in every 5 years[14]. The 2015 consent for the TPS explains that such overflows will occur via an emergency overflow pipe into the Grehan Stream – which is between the TPS and the skatepark.

The application states that:

The pump station will convey raw wastewater to the WWTP at an approximate daily peak rate of 1,800 m3/day and an instantaneous peak rate of 62.5 L/s, via a pressure main to be built in Old Coach Road.[15]

This needs to be clarified as it is a critical constraint on the system[16]**.** If the daily limit is in fact 1,800m^3 per day, then this would be significantly less than the current network can deliver to the existing WWTP. On 16 occasions in 2022 and 2023 the PS616 flow meter (the final meter before the WWTP) measured greater flows that this.

A comparison of all network overflows recorded for Akaroa from 2022-23 with actual wastewater daily flows recorded during this period shows that the 1,800m^3 daily limit on the TPS would have more than doubled the total number of network overflows of raw sewage due to wet weather:

Table 2 Terminal Pump Station and Network overflows 2018-2023

Year	Wet weather network overflows recorded by CCC[17]	# of raw overflows that would have occurred with Terminal Pump Station daily limit of 1,800m^3	Additional volume spilled due to TPS 1800m3 limit
2022	3	7	5,257m^3
2023	3	9	8,285m^3
Total	6	16	13,442m^3

The additional raw sewage spill volume is equivalent to 5 Olympic swimming pools of raw sewage to be released at the Grehan Stream, near its mouth, where it flows out to the Childrens Bay shoreline. This is one of Akaroa's busiest recreational areas. Overflow spills due to capacity exceedance are likely to occur during times of high rainfall when this area is subject to flooding, and when storm surges on a rising tide could also push the overflowing sewage upstream towards the recreation ground and town.

4.2 Terminal Pump Station buffer tank

The Update Report suggests that if the pumping capacity is not increased, then an additional raw sewage buffer storage tank will be required to meet the 1 in 5 year threshold, and this will need to hold 330m^3. This is a significant structure equating in size to a 100sqm 1 storey house.

Beca had identified to the Council that the total capacity of the wastewater network when designing

[14] Update Report P26
[15] CRC235038 consent application p13
[16] We have an outstanding query with CCC project manager Tim Ure to clarify this
[17] https://ccc.govt.nz/services/water-and-drainage/wastewater/wastewater-overflows/recent-wastewater-overflows/

for a 1 in 10 year event is 3,562m^3 per day.[18] We are unclear why the pipe network upgrades are being designed to a 1 in 10 year ARI but the Terminal Pump Station to a 1 in 5 ARI.

4.3 Treatment Bypass for High Flows

Bypassing treatment during times of heavy flow was an extremely controversial issue in the community when first mooted in 2016. By the time it formally consulted with the community in 2017, the Council committed that all wastewater passing through to the irrigation fields would be fully treated. This commitment is re-iterated in the current consent application:

The applicant has committed to a 'no bypass' approach to wastewater treatment, meaning that all wastewater conveyed to the WWTP will either be treated as it arrives, or if inflows exceed 14 L/s (equivalent to the peak summer mean daily flow) raw wastewater will be stored in the wet weather flow storage tank (~2,000 m3) for future treatment.[19]

The Update Report suggests that this commitment may be dispensed with stating:

It is also understood that Council will explore a high flow bypass for the treatment train which will pass higher daily volumes to the irrigation system and storage when required.[20]

This indicates that the raw wastewater storage buffer tank that forms part of the consent application is too small to contain all the incoming wastewater. The Council has not explained in the application how it arrived at the 2,000m^3 sizing for the raw buffer tank. In 2022 it had been advised by GHD in an Options Analysis report for the new WWTP that this buffer tank would need to be at least 4,500m^3.[21]

5 Climate Change

Both the consent application and the Update Report acknowledge that more extreme rainfall events are likely due to climate change, but neither provide information on how the system can be designed to cope with them. All of the risks associated with insufficient capacity and the associated overflows are exacerbated by extreme rainfall events.

5.1 Increased extreme events

The consent application states that:

In general terms it is expected that the Banks Peninsula climate will be warmer with more frequent extreme rainfall events.[22],

but did not consider that these would add any increased risk or affect the ability of the storage and irrigation system to cope.

The Update Report acknowledges that extreme storm events are expected to occur with increased frequency and can strike randomly at any time, and that the probabilistic approach taken to model wastewater flows cannot forecast these extreme "black swan" events. They have classified the storm in July 2023 as a "black swan" event, and appear to have terminated their model validation on 22 June 2023, thereby excluding the prolonged wet weather in July and this event from their model validation.

In our view the July storm was not a black swan event. Whilst on the 22 July 2023 the 24 hour rainfall was a record, the total rainfall for the 8 day rain event of 268mm is significantly lower than in 1978 when 366mm fell in a 9 day event in April. July 2023 was not an extreme outlier. Within the 51

[18] Beca, Water Balance Model Summary Letter, 27 Jan 2022, p1
[19] CRC235038 consent application p13
[20] Beca Update Report, p33
[21] GHD, Preliminary Process Design of Akaroa WWTP Options Analysis Report, 27 June 2022, p4
[22] CRC235038 consent application p85

year sequence considered by PDP, three other years (1973, 1978, 2012 and 2013) all had events that exceeded the total rainfall of the July 2023 event, so July 2023 provides useful information for contributing to the probabilistic approach. Leaving it out means that Beca has failed to consider the most significant data point in the measured wastewater flow data available since the working meter was installed in 2017. For example, in assessing the storage requirement, the actual flows for 2023 show that over 30,000m^3 would be needed to avoid overflows.

6 Capacity margins

The Update Report recommends that an appropriate margin above that predicted by the revised modelling should be now be considered when sizing the infrastructure for the wastewater system[23], to cover weather and usage anomalies that the modelling does not account for, but it does not suggest how large this margin should be.

6.1.1 Storage margin

The Consent Application originally provided an 8,000m3 (66%) capacity margin for the storage, because although 12,000m^3 was considered sufficient with no overflows anticipated, the consent applied for up to 20,000m^3. That 20,000m^3 capacity has been shown to be insufficient, so there is no margin on the storage.

Friends of Banks Peninsula recommends that in terms of the storage capacity, at least 40,000m^3 is required. The graph below from the Update Report compares storage requirement using the modelled flows (in orange) with the storage requirement based on the measured flows (in blue). This shows that in 2023, approximately 32,000m^2 of storage would have been required. In addition as noted above, the storage modelling in the Update Report does not take into account ***the fundamental principle that no irrigation will occur where land conditions are likely to result in surface ponding.*** It appears that as yet no data has been collected on how long the land remains saturated after prolonged winter rain. On the basis of the photographs taken 7 days after the July 2023 event had ceased, at least another 4,000m^3 of storage would have been needed. If a further margin matching the original 8,000m3 is added on top of this, it suggests that storage of close to 44,000m^3 would be needed to cope with the actual wastewater flows measured over the past 6 years. We note this calculation still uses the higher irrigation rates which Beca seems to imply may affect land stability.

[23] Beca Update Report, p36

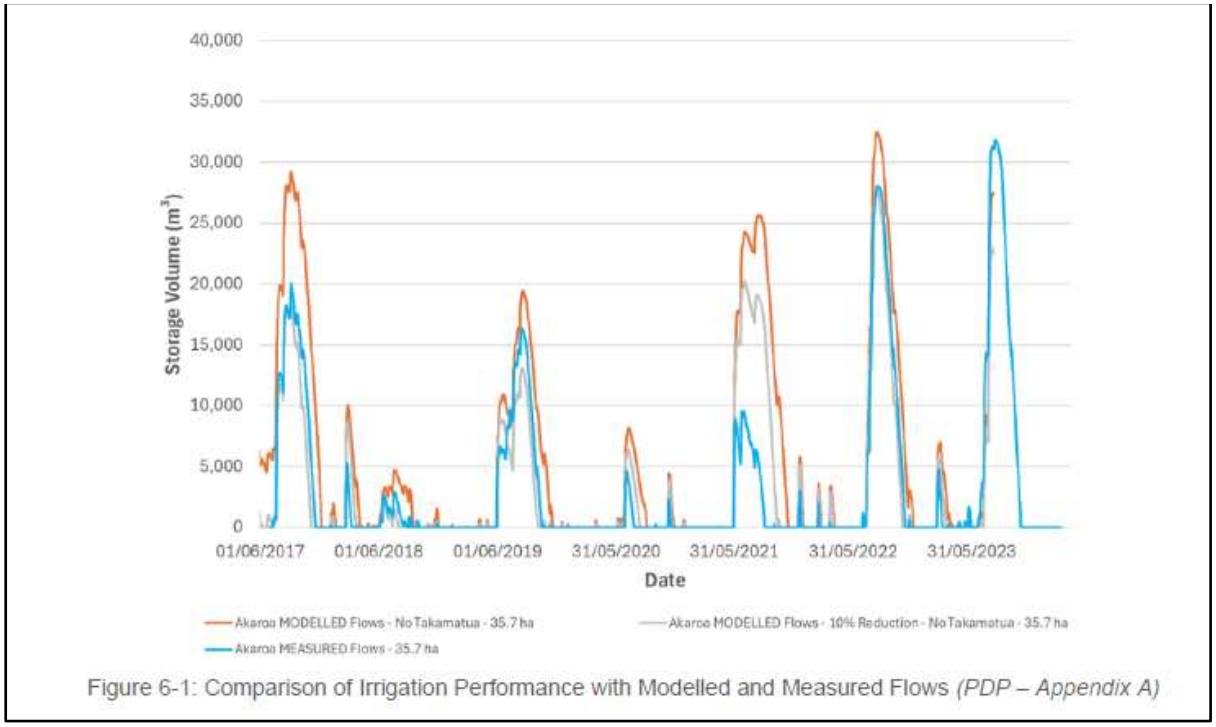

Figure 2 Modelled versus Measured flow graph from Update Report

6.1.2 Irrigation field margin

The Consent Application was based on irrigating 35.7ha of land classified as "suitable" and had as a margin 5ha of additional land identified as "less suitable".

The Update Report has now considered the use of this 5ha of "less suitable" land and found that even with irrigating to these areas, the storage capacity of 20,000m3 would result in overflows more frequently than 1 in 5 years. (No evidence has been provided that irrigating areas already identified as "less suitable" at times when the land is wettest, and potentially saturated and using the higher irrigation rates is feasible without causing run-off and/or increasing land instability).

7 Forecast population changes

The Update Report has made significant adjustments to the current and forecast populations for Akaroa. However, as it acknowledges, population does not have a great impact on the system capacity, and wet weather flows from rainfall are multiples of peak day population flows.[24]

In other words, the system capacity is being driven by the infiltration levels, not by the population levels, and as the infiltration peaks in winter and the population peaks in summer, at this stage of the system design, population levels are largely irrelevant to capacity design.

8 Environmental effects of overflows

The Update Report makes clear that both Raw and Treated wastewater overflows must be planned for and managed. The current consent application does not provide either management or conditions for overflows, so this is new assessment work that now needs to be added to the application.

8.1 ARI design

The consent application is silent on the overall ARI (average recurrence interval) for the system design. Essentially it has assumed an infinite ARI as it does not countenance any aspects of the

[24] Beca, Update Report, P36

system being overloaded by an extreme event.

The Update Report mentions various different ARIs for different aspects of the system. It states that the network capacity is designed for a 1 in 10 rainfall event.[25] For the Terminal Pump Station it states that the Council aiming to achieve a 1 in 5 ARI.

Earlier documents, such as BECA's Water Balance Summary letter[26] suggest that CCC's selected design storm was a 1 in 10 year ARI. This applied to the network and all the components in the train, including pumping capacity and raw wastewater storage prior to the WWTP. Deciding this is critical to the sizing of all the components of the system and where and what type of overflows will occur. There is no point in sizing facilities for the treated wastewater that exceeds what the network can deliver, when it will already have overflowed as raw wastewater. In order for the system to cope with an overall design criteria of 1 in 10 ARI, the Terminal Pump Station would need to increase from 65L/s to 91L/s and the raw wastewater buffer storage at the WWTP would need to increase from 2,000m^3 to at least 4,500m^3.

The treated wastewater storage volume also needs to be addressed to determine what would fit with the 1 in 10 ARI if this is the design criteria chosen.

The ARI threshold chosen is one of the most critical elements of the system, underpinning all aspects of design, and the cost/benefit choices that must be made by the Council. There has as yet never been any consultation or discussion with the community enabling their views on this matter to be ascertained.

8.2 Effects of Raw Wastewater overflows

The effects of raw wastewater overflows are set out in the Water NZ Good Practice Guide.

Discharge of untreated wastewater into a receiving environment poses a public health risk. This is because untreated wastewater contains elevated levels of contaminants, pathogens, viruses, bacteria, and protozoa that can cause serious diseases and health problems (Beca et al. 2020)… WWO events can also have negative environmental effects, through the potential to impact receiving water quality, habitat quality and aquatic communities.[27]

As noted above, the discharge point into the Grehan Stream adjacent to the Terminal Pump Station is approximately 50 meters from where this stream flows across the beach and enters the shallow bay, but it is tidal at this point, so could also flow upstream on an incoming tide. Facilities in the immediate area include the Akaroa Playcentre, the SkatePark, BMX track, the mini golf, the Akaroa Boat Ramp slipway, kayak launching, the Boat Store, the Freedom Camping area, the Akaroa main car and bus park, the recreation ground and the tennis and croquet club. All of these facilities are heavily used by local residents and visitors in both summer and winter.

8.3 Effects of Treated Wastewater overflows

The consent application states:

Treated wastewater has the potential to significantly affect public health where there is a risk of public exposure to and contact with the wastewater. Exposure to contaminants of concern to human health including pathogens can result in significant illness in the community, and in extreme cases public health emergencies. Wastewater networks, treatment and disposal is therefore critical to maintain public health and avoid the potential for serious adverse effects on the public from contacting wastewater, or from wastewater contaminants in the receiving environment.

Due to the risks with exposure to treated wastewater, Christchurch City Council has opted not to put

[25] Beca, Update Report p36
[26] Beca, Water Balance Model Summary Letter, 27 Jan 2022, p1
[27] Water NZ, Good Practice Guide: Addressing Wet Weather Wastewater Network Overflow Performance, p7

a general purple pipe re-use system into commercial and domestic premises in Akaroa, or even to use the treated water for flushing public toilets. It is only prepared to provide a purple pipe for sub-surface irrigation of the recreation ground.

If the treated wastewater includes bypass flows it will be of a lower quality and is more likely to contain pathogens such as e coli and viruses.

Because the consent application stated that the system was sized to eliminate the need for any ***bypass discharges of treated or untreated wastewater from the scheme to an alternative receiving environment*** there is no description of where and how the treated wastewater is to be overflowed. In its response to the ECAN RFI, the Council has indicated that the discharge would to the harbour via the purple pipe supplying treated wastewater to Akaroa and discharged via Terminal Pump Station. Potentially this also changes the status of the application.

Such overflows in the heavily used recreational area of the Childrens Bay foreshore and recreation ground do therefore pose a risk to human health, and over time and with large quantities of overflow it is likely to negatively impact on waterways and coastal marine areas.

The purpose of the land irrigation system is to preclude treated wastewater from entering Akaroa Harbour, however, under the current design there is a very high potential for frequent and large overflows of both and treated and *additional raw* sewage entering waterways and the harbour, meaning this objective is not being met.

9 Inflow and Infiltration

All of the issues set out above are a direct result of the very high level of infiltration of storm water and groundwater into the Akaroa sewer pipe network.

The amount of infiltration in the network is already the driving the need for raw sewage and treated wastewater storage tanks and the need to use overly steep and saturated land for irrigation.

The Update Report has now identified that frequent raw and treated wastewater flows are to be expected and will still occur (with a lower frequency) if the proposed system is augmented with:

- a large raw sewage buffer tank at the Terminal Pump Station;
- a large increase in the treated wastewater storage at Robinsons Bay (and the earthworks to create the platforms); and,
- treatment bypass flows at the WWTP.

It is not at all clear that the Council has sufficient land to provide additional storage or more buffering tanks, meaning the environmental effects if this system proceeds as per the application will be much more than minor.

9.1 I&I reductions

The Consent application states:

Reducing I&I directly influences the volume of raw wastewater storage and the treatment capacity, storage volume and irrigation area needed. I&I reduction will also help to reduce the risk and frequency of network overflows in Akaroa.[28]

It goes on to state that a $3.2million programme to substantially reduce I&I commenced in 2019.

The flow modelling underpinning the storage and irrigation field sizing in the consent application was based on the assumption that storm and ground water infiltration would be reduced by 20%.[29]

The Update Report states:

[28] CRC235038 consent application p24
[29] CRC235038 consent application, Appendix F, p7

The proposed I&I network improvement work began in 2020 and is now complete.[30]

It reports that a review of recent flow meter data has shown a significant reduction in baseflow in the order of 20-25%.

Regardless of whether this is the case, the flow figures show that the level of Rain Derived Infiltration remains a critical problem for the Akaroa wastewater system. In recent communications with the media, the Council has confirmed that I&I levels in June 2022 and July 2023 (after the I&I work was completed) were 70% and 69% respectively. Such high levels of Rain Derived I&I present a double problem for the land-based irrigation disposal system, because wastewater volumes increase massively exactly when the land is the wettest and irrigation not possible, driving the peak capacity storage volumes. It is also likely that infiltration levels are higher than stated. Council have calculated the I&I levels by deducting estimated monthly population, commercial and retentate flows from the measured wastewater flows. These estimates include annual average flows for commercial properties that do not take into account the seasonal variations in Akaroa and therefore likely to be inflated during winter.

The current high levels of infiltration mean that the system proposed by the consent application needs to be overhauled to provide much more storage for both raw and treated wastewater and probably more land for storage and irrigation to avoid triggering large and frequent overflows of raw and treated wastewater in times of heavy or prolonged rain.

9.2 Retentate

A component of the I&I that has been identified more recently is retentate from the filtering at the drinking water plant that is disposed of to the wastewater network. This contributes to the baseflow of wastewater, and is not the cause of the huge rainfall induced spikes.

The Consent Application flow modelling was based on this being reduced by 75%[31]

However in their updated modelling, Beca have decided not to include potential reductions *due to uncertainty of the level of reduction that can be achieved*[32]*,* but do identify this as an area that could still be optimised.

Some work has been done to fix overflows in the drinking water processing system, which will have in turn reduced the amount of water being processed and therefore the retentate, and this will have contributed to the base-flow reductions noted above.

9.3 Why has infiltration not been dealt with

There is no explanation given in the Consent Application or the Update Report as to how the proposed infiltration reductions were decided upon, or why reductions in line with both the Council's decision to proceed with the application and the ECAN consent giving approval to the continued operation of the current system have not been included.

9.3.1 Council decision to reduce infiltration to 20%

In December 2020 the Council resolved to proceed with the Inner Harbour option[33]. It recommended that inflow and infiltration be reduced to *less than* 20%.However, as noted above, the Consent Application is predicated upon reducing the I&I *by 20%* and the retentate by 75%.

This is a substantial difference as shown in the diagram below.

[30] Beca, Update Report, p31
[31] CRC235038 consent application, Appendix F, p7
[32] Beca, Update Report, p12
[33] CNCL/2020/00176 Christchurch City Council minutes 10 December 2020, Item 33, p18

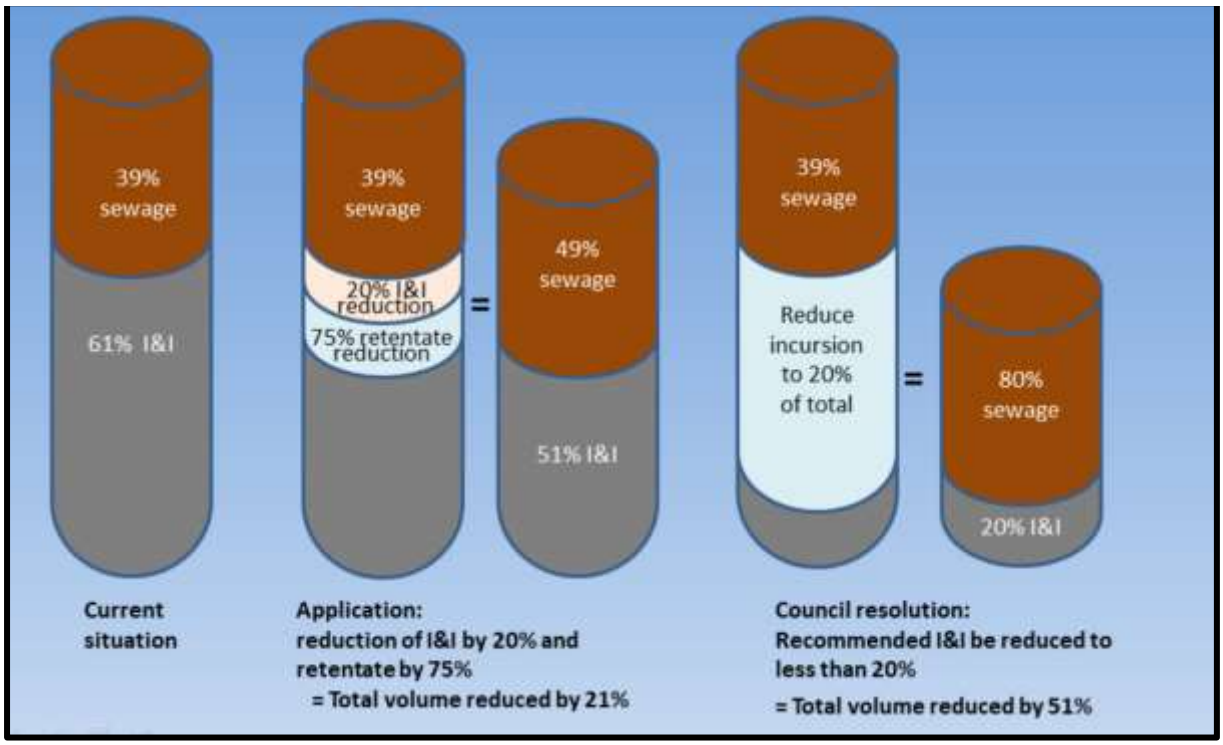

Figure 3 Difference from reducing I&I by 20% and to 20%

Had the Council recommendation been followed, the total volume of the wastewater would have been reduced by 51%. With the reductions set out in the consent application the total volume is only being reduced by 21%.

More critical however, is what is meant by the reduction. Is it an average over the whole year, or is it the amount that can infiltrate during the critical times of heavy rain? As already explained, annual averages are meaningless in the context of a wastewater system with fixed limits coping with flows, as the system needs to be sized to cope with the maximum flows, or at least the maximums to a set ARI level. Averaging in 0% infiltration over a dry summer with massive infiltration in a wet winter masks the system's vulnerability to large rain events.

Neither the Consent Application nor the Update Report discuss this point. Nor is any information available as to why, in preparing the Consent Application, the recommendation of the Council to reduce infiltration to 20% was not followed.

9.3.2 ECAN Consent decision CRC204086 extending current harbour outfall

Furthermore, the current consent issued by ECAN to Christchurch City Council extending the existing harbour outfall until May 2023 includes Condition 6 which states:

a. *The volume of inflow and infiltration from the Akaroa wastewater network exiting the Akaroa Wastewater Treatment Plant shall reduce to: Below 50 percent inflow and/or infiltration by 31 October 2022; and*

   i. *Below 40 percent inflow and/or infiltration by 31 October 2025.*

b. *The inflow and infiltration percentage shall be determined as follows:*

   % Inflow and Infiltration = 100 x (Inflow and Infiltration Flows/WWTP Flow)

   Where:

   - *Inflow and Infiltration Flows = WWTP Flow – Legitimate Wastewater Flow.*
   - *The WWTP Flow shall be as measured at the WWTP outfall flowmeter.*
   - *Legitimate Wastewater Flow = Commercial Flow + Residential Flow + Water*

Treatment Plant Backflush Flow.

- *The Commercial Flow shall be measured as the boundary water meter flow for commercial properties connected to the Akaroa wastewater network. Where the meter read dates do not align with the period of assessment, the average daily flows from the most recent meter reads must be used.*
- *The Residential Flow shall be calculated as the permanent Akaroa population (refer to Statistics New Zealand for the most recent census data) multiplied by a factor of 240 litres per person per day.*
- *The Water Treatment Plant Backflush Flow shall be calculated as 10% of the total water abstracted from streams and bores to supply the water treatment plant until permanent metering is commissioned at which point the flowmeter data shall be used.*[34]

The condition has clearly not been met, as even using its annual averages, Christchurch City Council has not achieved the requirement to reduce infiltration below 50% by 31 October 2022, and as the consent application makes clear, it never had the intention to do so.

In setting the condition, ECAN is silent on what is meant by "below 50%" and whether this means an annual average or a daily figure. The requirement to use daily flows for the Commercial and Residential Flows would imply a daily limit.

10 Risks that need to be addressed

The work to update the modelled flows has raised a large number of significant issues around the sizing of the system. These now present the need for an updated Assessment of Environmental Effects to determine how they will be dealt, which is likely to involved increased costs to provide additional capacity in the system, and conditions which may be difficult for the Council to meet if it does not carry out further I&I reduction work.

The issue of an increase in extreme events due to climate change has been flagged.

That so many issues have been raised with the consent application regarding the sizing of the system, raises the question as to whether there are other areas of the proposal that also require more critical scrutiny. We attempt to identify some of these below.

10.1 Consenting risks

The Inner Bays system proposed in 2020 was classified as a non-complying activity because it included provision to overflow treated wastewater to a freshwater body when the storage capacity was exceeded. The Consent Application has suggested that it be classified discretionary because no overflows were anticipated. As the Update Report now identifies that overflows will occur unless the storage is massively increased, this may affect the consent classification.

10.1.1 Assessment of Environmental Effects and revised conditions

The Council now needs to make a decision on how it is going to address the undersizing, including the expectation of an increased frequency of extreme storms. Will it:

- provide additional pump capacity, raw sewage buffering at the TPS and WWTP, treated wastewater storage and/or a greater irrigation area?
- propose a shorter ARI threshold enabling more frequent overflows?
- undertake to achieve much more extensive I&I reductions, particularly in wet weather periods?

A new or updated Assessment of Environmental Effects is needed once these options have been

[34] https://www.ecan.govt.nz/data/consent-search/consentdetails/CRC204086/CRC204086

considered and costed.

Once the decision has been made on how to address the undersizing issue and the Assessment of Environmental Effects completed, then the Council will need to put forward appropriate conditions.

These conditions need to be meaningful and stipulate the ARI level for raw and treated wastewater overflows and the minimum specification for each component to ensure that stated ARI level is met. These would include:

- pump instantaneous and daily capacities
- WWTP instantaneous and daily capacities
- raw sewage buffer storage to ensure the full volumes can be met without overflows exceeding the stated ARI level for raw wastewater
- irrigable area
- irrigation management plan setting out how the field will be managed to avoid effects such as ponding, runoff and demonstrating how it is still able to irrigate the anticipated full volume of water
- consequent storage volumes for treated wastewater to meet the stated ARI level for treated wastewater.

10.2 Other potential risks that need to be re-examined

A new wastewater system requires a very substantial investment of funds and must be safe, efficient and sustainable well into the future. It must be as risk-free as possible because the need for sewage collection and treatment cannot be 'switched off' if a system fails.

In addition to the capacity matters above the following risks are also not addressed by the AEE supplied with the current application or through meaningful conditions to ensure there are capacity margins should problems be encountered in the future:

- Irrigation field areas damaged by slips caused by extreme weather
- Irrigable areas are less able to take up water than expected, or prove geotechnically unsuitable when further assessed
- The system fails to take up nutrients at the rate forecast and leaching of nutrients into the stream exceeds the permitted limits.

The application is also silent on the need for pumping stations at the irrigation field. The storage tanks are located approximately 50m higher than the WWTP, so cannot be gravity fed. A pump station of significant size will be needed at the Robinsons Bay Valley site to pump the water to the storage tanks.

Approximately ⅓ of the 35.7ha of land identified as suitable irrigation areas and almost all of the less suitable 5ha that may now be required, are above the storage tanks, and up to 150m higher. Another pumping station will be needed to pump the stored water up to these areas for irrigation.

Both pumping stations will require earthworks to excavate platforms, a power source and may have effects such as noise, odours and emergency discharges in case of failure, and will require landscaping.

10.3 Management risks

The system proposed is much more complex than Akaroa's current gravity fed wastewater system with its harbour outfall disposal. There are many more components that could fail including the many pumps, long distance pipes, wastewater storage tanks and the irrigation field with its many lines, drippers, and control systems.

The application provides for monitoring of the wastewater quality, irrigation, fresh, ground and harbour water quality and soil quality, but gives no information on the effort involved in carrying out the monitoring or the daily work and daily decisions involved in managing the irrigation fields.

We understand that the Council is now providing an adaptive management and mitigation strategy to support the ATWIS application.

The application states that:

If monitoring indicates an environmental effect that requires intervention to avoid, remedy or mitigate it, a range of options are available to the consent holder in response. These may include but are not limited to:

- *Further reducing inflows into the WWTP by reducing I&I into the wastewater network*
- *Introducing additional treatment steps to the WWTP process*
- *Extending the area of land irrigated on the Robinsons Bay Valley site to include the 'less suitable' land identified in site mapping*
- *Extending the area of land irrigated by purchasing additional land in the inner harbour area*
- *Adjusting the irrigation regime to, for example change the irrigation application rate, alter the scheme configuration, or change the dose / rest / dose pattern, duration or frequency.*

Most of these remedies or mitigations would require extensive costs and purchasing more land could prove very difficult. It has already taken the Council nearly 9 years since the harbour outfall was declined to develop the current proposal. Any mitigation proposed must address how issues such as overflows due to lack of storage or irrigation area would be managed in the intervening period when more land was being sought or the system expanded in other ways to prevent many years of ongoing environmental effects while solutions are sought.

11 Conclusion

The issues identified in the Beca Update Report indicate that substantial changes are necessary to the ATWIS design and identifies that overflows and the ARI must be considered in the system design.

Latest modelling work demonstrates that unless it is substantially modified, the proposed system will be demonstrably less resilient and prone to overflows (both raw and treated) than the current system, resulting in an increased impact on the environment and creating a public health risk.

It is hard to see how the Council can make decisions on how it will address these issues and prepare an AEE within the timeframe of the current consent, and allocate the necessary budgets through its LTP process to fund the increased infrastructure identified.

Friends of Banks Peninsula has previously recommended that the existing harbour outfall should be retained and used solely as the emergency overflow for treated wastewater. This would provide a mechanism for dealing with large overflows in times when it was too wet too irrigate, while minimising adverse effects on human health and the freshwater or coastal areas.

However, now that it appears the system may also be subject to large raw wastewater overflows at Childrens Bay, we conclude that the fixed capacity land disposal system proposed is incompatible with the current network infrastructure with its badly leaking pipes.

We therefore conclude that the current application should be withdrawn and reconsidered once all possible steps have been taken to reduce the infiltration and the remaining extent of it (properly measured and during peak infiltration times) is known.

Appropriately sized infrastructure and ARI conditions can be then be developed, in consultation with the community to provide Akaroa and the ratepayers with a system that is sustainable and resilient for the conditions expected in the years ahead, and not subject to ongoing failures.