Combined Akaroa & Duvauchelle Treated Wastewater Storage Exceedance Discharges – Short-List Options Assessment

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Prepared for

Christchurch City Council

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Limitations:

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Executive Summary

Christchurch City Council (CCC) is currently undertaking a project to replace the wastewater treatment plant (WWTP) servicing the Akaroa township to a new location and irrigate treated wastewater from both Akaroa and Duvauchelle townships to land.

The planned upgrade will combine the treatment of wastewater from both locations, disposal via discharge to irrigation fields, and storage tanks capable of holding 24,000 m^3 to hold irrigation water when conditions are not favourable for irrigation. Some emergency storage is also available within the scheme in the form of a subsurface wetland at Old Coach Road (OCR) located adjacent to the new WWTP site. In the infrequent circumstances the combined storage tank and wetland storage capacity is exceeded, an overflow discharge of treated wastewater will occur.

CCC acknowledges that resource consents for the discharge of treated wastewater during storage exceedance events at the Akaroa Treated Wastewater Irrigation Scheme (ATWIS) storage facility may be required. This is because the modelled frequency of storage capacity exceedance events is such that it may be inappropriate to rely on s.330 emergency provisions of the Resource Management Act.

This options assessment investigates potential discharge methods and locations for these exceedance discharge events with a view to progressing a best practicable option (BPO) to form the basis of a resource consent application.

Previous work was undertaken to assess a long list of discharge methods and locations, and from an initial list of 16 options four were selected for the short list to be assessed in more detail. These options were:

- Option 1 - Increase irrigation rates at Hammond Point irrigation area;
- Option 2 – Discharge from the WWTP via the OCR wetland to the boat park seawall at Childrens Bay;
- Option 3 – Discharge from the WWTP via the OCR wetland and additional constructed land passage to the boat park seawall at Childrens Bay; and
- Option 4 – Discharge to harbour via the existing Duvauchelle outfall pipe.

Short-listed options were refined to assess technical feasibility and compared using a traffic light assessment (TLA) against ten criteria agreed upon during the long-list workshop:

- Environmental;
- Technical;

- Social;
- Climate change adaptation;
- Climate change mitigation;
- Cultural setting – Mātauranga Māori;
- Legal / consenting considerations;
- Resilience;
- Intergenerational equity; and
- Timeliness.

A comparison of high-level cost estimates was also undertaken to help advise the process.

TLA scoring was agreed collaboratively during a short-list options workshop comprising attendees from CCC, Ōnuku rūnanga, and PDP. At the conclusion of the workshop, it was agreed that Option 1 and Option 4 should not be developed further, and that the best option to carry forward would be a variation somewhere between Option 2 and Option 3.

The extent of any additional constructed land passage and / or land contact processes required for inclusion will be determined after optimisation of the OCR wetland has been completed and the extent of treatment achievable within that wetland is fully defined. The workshop group agreed that it would be preferable to focus resources on optimising the proposed wetland when viable as opposed to creating additional standalone infrastructure for occasional storage exceedance discharges which would have associated maintenance requirements and costs above those of the wetland.

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1.0 Introduction

Pattle Delamore Partners (PDP) has been engaged by Christchurch City Council (CCC) to assist with identification of the best practicable option for management and discharge of intermittent overflows from treated wastewater storage tanks in the Akaroa Treated Wastewater Irrigation Scheme (ATWIS) prior to seeking resource consent for the discharges.

1.1 Project Background

CCC is currently undertaking a project to replace the wastewater treatment plant (WWTP) servicing the Akaroa township to a new location and irrigate treated wastewater from both Akaroa and Duvauchelle townships to land.

The planned WWTP upgrade will combine the treatment of wastewater from both locations and store this at the ATWIS storage site above Robinsons Bay to be piped back to irrigation fields. The total irrigation area is approximately 42.1 ha across Robinsons Bay, Hammond Point, Jubilee Park in Akaroa and at the Duvauchelle Showground Recreational Reserve (DSRR).

The ATWIS storage area is proposed to be located at the Robinsons Bay irrigation site and consist of 24,000 m^3 of storage. When irrigation to the disposal fields is not possible, due to excessive rainfall, and the tanked storage at Robinsons Bay is full or unavailable, treated wastewater is proposed to be diverted to a subsurface wetland at Old Coach Road (OCR), located adjacent to the new WWTP site. After these rainfall events have subsided, the treated wastewater stored in the subsurface wetland will be pumped back into the WWTP. In the infrequent circumstances that the wetland storage capacity is exceeded, an overflow discharge of treated wastewater will occur. This options assessment investigates potential discharge methods and locations for these exceedance discharge events.

On 18 April 2024, CCC and PDP met to discuss the Duvauchelle wastewater land treatment resource consents. CCC acknowledged that resource consents for the discharge of treated wastewater during storage exceedance events at the ATWIS treated wastewater storage facility may be required. This is because the modelled frequency of storage capacity exceedance events is such that it may be inappropriate to rely on s.330 emergency provisions of the Resource Management Act.

1.2 Project Aim

The aim of this project is to identify the most suitable discharge method and location for storage exceedance discharges, which could progress into a resource consent application for the discharges.

1.3 Long-List Options Workshop Outcomes

A workshop was held between stakeholders from CCC, Ōnuku rūnanga and PDP on 1 July 2024 during which a long list of 16 possible options, shown in Table 1, were presented and discussed.

Table 1: Long-List Options Assessed

Option		Receiving Environment
1	Increase the ATWIS storage capacity to remove overflows	None
2	Pipe from ATWIS to Akaroa terminal pump station (TPS) and discharge via increased irrigation of Akaroa Recreation Ground	Land
3	Pipe from ATWIS to Hammond Point and discharge via increased irrigation of Hammond Point irrigation site	Land
4	Pipe from ATWIS to Robinsons Bay and discharge via increased irrigation of Robinsons Bay irrigation site	Land
5	Pipe from ATWIS to Robinsons Bay and discharge direct to Robinsons Bay Valley Stream	Fresh water
6	Pipe from ATWIS to Takamatua and discharge direct to Takamatua Stream	Fresh water
7	Pipe from ATWIS to Akaroa TPS and discharge direct to Grehan Stream	Fresh water
8	Pipe and overland flow path from ATWIS to Children's Bay Stream and discharge into Children's Bay Stream	Fresh water
9	Pipe from ATWIS to Takamatua and discharge to wetland established on site between foreshore and SH 75	Wetland
10	Pipe from ATWIS to Robinsons Bay and discharge to wetland established on flats adjacent to SH 75	Wetland
11	Pipe from ATWIS to Akaroa TPS and discharge via Children's Bay / Ōtāhuahua Harbour at the boat park seawall.	Harbour intertidal zone
12	Pipe and overland flow path from ATWIS to Children's Bay via constructed overland flow path on CCC land and discharge into Children's Bay via a short outfall	Harbour intertidal zone
13	Pipe from ATWIS to Duvauchelle WWTP site and discharge via the existing Duvauchelle outfall	Harbour

Table 1: Long-List Options Assessed

Option		Receiving Environment
14	Pipe from ATWIS to Akaroa TPS and discharge via Children's Bay / Ōtāhuahua Harbour offshore at a distance beyond intertidal zone	Harbour
15	Pipe from ATWIS to Takapūneke WWTP site and discharge via the existing Takapūneke outfall	Harbour
16	Pipe from ATWIS to Harbour heads outfall (13km marine pipeline)	Ocean

The Long List Options Report can be found in Appendix A.

A summary of the discussion and recommendations resulting from this workshop is provided below.

In general,

- It was agreed that continued efforts to reduce inflow and infiltration (I&I) to the wastewater network should be undertaken by CCC alongside the preferred option. This work will help to reduce WWTP flows and therefore reduce the volume of treated wastewater disposal that is required; and subsequently the frequency and magnitude of discharges caused by exceedance of available storage.
- To gain support from Ōnuku rūnanga as tāngata whenua, any discharges of treated wastewater must have land contact to allow for transformation and naturalisation of the water to restore its mauri (life force). Ōnuku rūnanga indicated that 2-3 days of contact within a wetland or similar system should be used as an initial guide.
- It was agreed that any effects on water quality of the treated wastewater discharge before and after entering the wetland should be better understood.

The options discussed for potential progression in the long list workshop include those outlined in Table 2. Of the above options discussed, long list options 1 and 4 listed in Table 2 were considered not to accommodate all possible exceedance volumes or provide a discharge location for all events. For these reasons, these options have not been assessed as stand-alone options for this short list assessment. However, these are considered as supplementary measures which may be considered in design, should they optimise any of the other short list options. Short listed options which will accommodate exceedance volumes and provide a discharge location to meet the intended outcome for this assessment are listed below:

1. Increase irrigation at the Hammond Point irrigation block to discharge any storage exceedance volumes;
2. Discharge the exceedances via the proposed OCR wetland and purple pipe system to Childrens Bay; and
3. Discharge the exceedances via the OCR Wetland and an additional land passage system to Childrens Bay.

Table 2: Long-List Options to Short-List Options

Long List Option		Revised Option from Long List Workshop Discussion	Provides Discharge Location for Exceedances?	Short List Option	
1	Increase the ATWIS storage capacity to remove overflows	Some increased storage was viewed as beneficial, however increasing storage to mitigate all exceedances was viewed as not possible.	No, only reduces exceedances	N/A	Supplementary measure
3	Pipe from ATWIS to Hammond Point and discharge via increased irrigation of Hammond Point irrigation site	No	Yes	1	Increased irrigation at Hammond Point
4	Pipe from ATWIS to Robinsons Bay and discharge via increased irrigation of Robinsons Bay irrigation site	Unsuitable score ruled this option out. Instead, reconsidering irrigating the 'Less suitable' irrigable areas under normal operation was suggested.	No, only reduces exceedances	N/A	Supplementary measure
11	Pipe from ATWIS to Akaroa TPS and discharge via Children's Bay at the boat park seawall.	This option was altered to be more culturally acceptable by allowing for treated wastewater from the WWTP to run through the OCR wetland prior to discharge.	Yes	2	OCR Wetland to Childrens Bay
12	Pipe and overland flow path from ATWIS to Children's Bay via constructed overland flow path on CCC land and discharge into Children's Bay via a short outfall	This option was altered by allowing for treated wastewater from the WWTP to run through the OCR wetland then additional land passage to discharge at the boat park seawall.	Yes	3	OCR Wetland via a new land passage system to Childrens Bay

Following the long-list options workshop, PDP met with CCC on 2 October 2024. At this meeting CCC further requested that using the existing Duvauchelle outfall (long list option 13, Table 1) was included in this short list assessment for consideration. This proposed option 4 is as follows:

4. Discharge the exceedances via the OCR Wetland and through the ATWIS to Duvauchelle TPS site and discharge via the existing Duvauchelle outfall.

It is recognised that this option was initially rejected in the short list workshop by Ōnuku rūnanga due to the proximity of the existing Duvauchelle discharge location to the culturally significant site at Ōnawe Peninsula. While the sensitivity of this site is recognised and acknowledged, CCC felt that this option was worthy of assessment with respect to the other criteria. It was noted that the location of the Hammond Point disposal area, which was a recommended short list option, was not a dissimilar distance to that of the Duvauchelle harbour outfall with respect to Ōnawe Peninsula.

1.4 Purpose of this Report

The purpose of the short-list options assessment is to complete a more detailed evaluation to enable an informed decision for the best practicable option (BPO) for discharging treated wastewater when the ATWIS storage capacity is exceeded.

The purpose of this report is to:

- Further develop the short-list options in terms of feasibility and preliminary design considerations;
- Present a relative comparison of the options through a Traffic Light Assessment (TLA) of environmental, technical, social, climate change, cultural, consenting, resilience, intergenerational equity, and timeliness considerations;
- Provide a rough order of cost (ROC) estimate of capital costs for each option to allow for a financial comparison; and
- Incorporate non-cost TLA criteria and costs to identify the BPO.

2.0 Scheme Overview

2.1 Description

There have been multiple iterations of proposed designs for the Akaroa and Duvauchelle wastewater treatment and irrigation schemes. The current proposed scheme incorporates the following:

- Wastewater from the existing sewage networks in Akaroa and Duvauchelle townships will be piped to a single, new, WWTP located on OCR;
- Treated wastewater will be piped to areas for surface drip irrigation of trees at Hammond Point (3.8 ha), Robinsons Bay Valley (31.9 ha), and the DSRR in Duvauchelle (6.52 ha), a total irrigation area of 42.2 ha. Additional subsurface drip irrigation will be installed at Jubilee Park, but this area will only be irrigated to replace evapotranspiration losses and reduce reliance on potable water for irrigation during dry periods;
- If treated wastewater exceeds the amount that can be irrigated, it will be stored in covered tanks located at the Robinsons Bay irrigation area until it can be irrigated at a later date. The total available volume of these storage tanks will be 24,000 m³;
- If treated wastewater cannot be irrigated and there is no available storage remaining at Robinsons Bay, additional storage of 2,100 m³ is available in the proposed subsurface wetland located across the road from the new WWTP on OCR; and
- If Robinsons Bay storage tanks and OCR wetland storage are at full capacity and treated wastewater volumes still exceed available irrigation, treated wastewater will need to be discharged from the system. For the purposes of this report, this occurrence has been labelled a storage exceedance discharge.

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2.2 Nature of discharges

2.2.1 Model Assumptions

Modelling completed for the scheme in December 2023 has been used to provide characterisation of the magnitude and frequency of storage exceedance discharges anticipated. Previous modelling for the combined Akaroa and Duvauchelle schemes used 4 different model scenarios. For clarity, work completed for this short-list options assessment has used the model outputs from the following scenario[1]:

- Akaroa flows – 50 yr synthetic flow series (excl. Takamatua)[2];
- Duvauchelle flows – 50 yr synthetic flow series (including soil store);
- Duvauchelle irrigation site – 6.4 ha;

[1] Model scenario '001_No_Takamatua_35.7ha', dated 13/12/2023

[2] Future population dataset including climate change adjustment for Rainfall Derived inflow and infiltration. Detailed in *Akaroa Recycled Water Scheme – Irrigation Model Results for Recycled Water Disposal at Robinsons Bay with Supplementary Wetland,* PDP letter to Beca dated 5 April 2024.

- Akaroa irrigation site – 35.7 ha; and
- Storage area (for rainfall interception) – 3,200 m² (corresponds to wetland surface area).

The model was run to report the volume of water that was unable to be irrigated and require storage (i.e. with 'unlimited' storage). Work completed for this short list options assessment has used these storage volumes to calculate predicted exceedances of available storage within the ATWIS scheme.

The irrigation rates incorporated in the model are shown in Table 3.

Table 3: Modelled Irrigation Rates

Location	Area (ha)	Irrigation Rate (mm/d)				Rainfall Cutoff [a] (mm/d)
		Spring	Summer	Autumn	Winter	
Akaroa	35.7	2.41	3.08	2.41	1.68	50
Duvauchelle	6.4	1.50	2.80	1.50	1.00	30

Notes:
a) No irrigation is modelled if rainfall exceeds the cutoff threshold until the next day with no rainfall.
b) All irrigation is modelled as drip irrigation to trees

Notably improved I&I, design optimisation of irrigation or storage, and lesser actual effects of climate change or population growth than modelled, all have potential to reduce the future storage discharge exceedances frequency and volumes that have been used in this assessment.

The Akaroa flow series is a synthetic flow series developed by applying the relationship between flow and rainfall from Beca's Integrated Catchment Model of the Akaroa township wastewater network to historical climate data adjusted for future climate change. The key components which form this flow series are:

- Baseflow (permanent groundwater infiltration into the network);
- Trade flow (composed of commercial flows and retentate from the L'Aube hill water treatment plant);
- Rainfall Derived inflow and infiltration (RDII);
- Soil storage derived inflow and infiltration (soil store); and
- Foul flow (composed of residential wastewater flow and portions from accommodation catchments).

The Duvauchelle flow series is also a synthetic flow series and was developed from pump station and WWTP flow data using a relationship between RDII and soil storage with a historical rainfall data set adjusted for future climate change[3]. The historical rainfall and evapotranspiration data sets used are a compilation of data from the Akaroa electronic weather station, Ōnawe Duvauchelle rainfall gauge, NIWA Virtual Climate Station Network stations 20116 and 20249, and Duvauchelle compact weather station at Akaroa Golf Course. These data have been adjusted using Canterbury climate change seasonal rainfall data as suggested by Ministry for the Environment (MfE)[4].

2.2.2 Discharge Volumes

The model outputs cover a period of time between the start of 1972 and the end of July 2023 (adjusted for future climate change impacts). This includes values from 52 calendar years. The model outputs include a value for the volume of water that is unable to be irrigated and requires storage which can be compared to the proposed available storage to indicate when discharges due to storage exceedance will occur. Total available storage at Robinsons Bay and in the wetland indicates that storage exceedances may occur in 21 of the 52 calendar years modelled. The number of days with modelled exceedances is 368 from a total of 18,840 days modelled, a proportion of 2.0%.

This assessment works on a daily timestep,

- Taking daily storage volumes from the model and allocating them to Robinsons Bay storage followed by the subsurface wetland if the Robinsons Bay storage capacity is exceeded.
- If the combined storage capacity of Robinsons Bay and the wetland is exceeded, a discharge from the wetland occurs.
- When wetland discharges occur, the hydraulic residence time in the wetland is calculated using the average of the wetland inflow and discharge volumes for that day.

A discharge event is defined as one or more consecutive days of wetland discharges following at least one day with no wetland discharges.

To better understand the nature of the discharge events, their magnitude has been reported based on the event total discharge volume and duration (Table 4). Results are reported against multiple recurrence intervals to provide an indication of the frequency of discharge events of each size.

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[3] Duvauchelle WWTP Land Disposal Modelling – Updated WWTP Flow Series, letter from PDP to Beca, dated 18 December 2023.
4 Duvauchelle Wastewater Scheme Design Flow Basis Update Report, Rev 2, Beca, 19 December 2023.

Table 4: Modelled Wetland Discharge Events – Total Volume (Magnitude)

Annual Recurrence Interval (ARI) (1-in-n years)	Total Discharge Volume During ARI Exceedance Event [a] (m^3)	Duration (days)	Year Modelled
50	32,000	32	1978
25	17,100	11	1986
20	15,200	17	2010
10	13,000	16	1992
5	8,600	12	2017

Notes:

a) To nearest 100 m^3

b) Calculations used model outputs from flow series 001_No_Takamatua_35.7ha and assumed wetland available storage as 1,800 m^3 (working volume minus minimum water level) and Robinsons Bay storage as 24,000 m^3.

The model is based upon a daily timestep and, due to total discharge volumes being cumulative over the duration of each event, the peak daily discharge will not necessarily correlate with the largest total discharge volume for the event. The modelled peak daily discharge recurrence intervals based on the highest daily discharge regardless of event size or duration are presented in Table 5.

Table 5: Modelled Wetland Discharge Events – Peak Daily Discharge (per event)

Recurrence Interval (1-in-n years)	Maximum Daily Discharge (per event) (m^3/d)	Year
50	4,698	1986
25	4,190	2010
20	4,072	1974
10	3,173	1992
5	2,121	2012

Notes:

a) Calculations used model outputs from flow series 001_No_Takamatua_35.7ha and assumed wetland available storage as 1,800 m^3 (working volume minus minimum water level) and Robinsons Bay storage as 24,000 m^3.

Finally, the total volume of discharges in each calendar year for which discharges are modelled is shown as a proportion of total treated wastewater flows in Table 6.

Table 6: Modelled Annual Discharges as Proportion of Total Flows

Year Modelled	Total Annual Exceedance Discharge Volumes [a] (m^3)	Exceedance Discharges as a Proportion of Total Annual Treated Wastewater Volume
1974	17,900	6%
1975	12,500	4%
1976	7,300	3%
1977	17,500	6%
1978	40,000	13%
1981	3,400	1%
1983	4,800	2%
1986	19,800	6%
1992	13,000	5%
1994	6,100	2%
1999	900	0.3%
2000	1,400	0.5%
2008	900	0.3%
2010	23,500	9%
2012	12,800	5%
2013	9,500	3%
2014	4,500	2%
2017	10,300	4%
2021	3,900	2%
2022	11,100	4%
2023[2.]	6,100	3%

Notes:

a) To nearest 100 m^3

b) 2023 data only available to 01/08/2023.

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2.3 Proposed OCR wetland

The subsurface wetland located adjacent to the Akaroa WWTP on OCR is proposed to be operated as an emergency storage facility for treated wastewater[5]. The wetland is seen to support the aspirations and values of Ōnuku rūnanga as tāngata whenua by restoring mauri to the water through contact with the land, wind, sunlight, and plants.

Use of the subsurface wetland is proposed for situations when irrigation is not viable and storage, such as at Robinsons Bay, reaches its maximum limit. A constructed overtopping with discharge south towards Childrens Bay Creek is included in the design brief for the wetland. This will be required as it will allow safe emergency discharge of water from the wetland in case the usual outlet fails and inflows, such as rainfall, cannot be diverted.

The proposed working liquid volume is 2,100 m^3. Under normal operation, a small flow of treated wastewater, equivalent to evaporative losses, will be diverted from the WWTP into the gravel media to keep the wetland plants in good condition. A permanent water depth of 300 mm within a 600 mm deep gravel bed has been proposed with a 400 mm freeboard above the gravel surface[8]. This permanent water depth reduces the capacity of 2,100 m^3 to 1,800 m^3 for the purposes of additional storage capacity available in the wetland.

When the wetland is at capacity, the top 400 mm depth of water (freeboard) will be above the surface of the gravels. This freeboard could be increased during detailed design.

3.0 Short List Options

The short-listed options have been assessed based on the assumption that the ATWIS will be installed and notes any additional changes required to allow for discharge of the exceedances.

Each option is described in more detail in Sections 3.1 to 3.3.

3.1 Option 1 – Increased Irrigation rates at Hammond Point

This option involves irrigating higher volumes of treated wastewater to the proposed irrigation site at Hammond Point, which is part of the ATWIS, during a storage exceedance discharge. The discharge process would include:

- Conveyance of water to the Hammond Point irrigation site; and
- Irrigation to the site at higher rates than those proposed in the ATWIS until storage capacity is available again.

[5] Basis of Design Report Akaroa WWTP and Reuse, Rev 1, Aecom, 16 February 2024.

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Figure 1 demonstrates the irrigation area which would be irrigated at higher volumes during exceedance events, and Figure 2 shows the land area proposed, which would be planted in kānuka for implementation of the ATWIS .

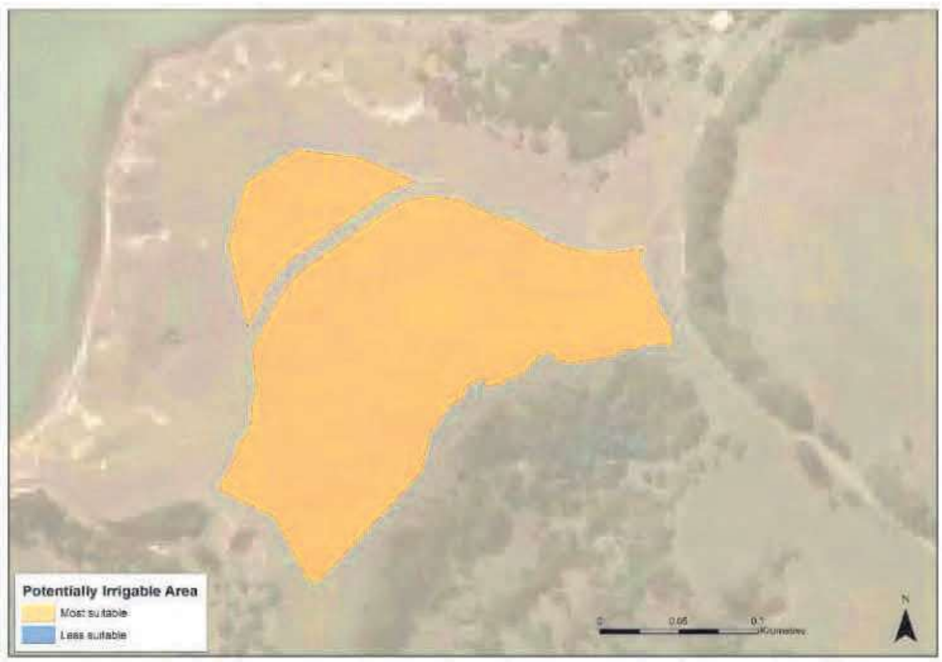

Figure 1: Irrigable land on the Hammond Point Irrigation Site[6]

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[6] Aqualinc 2022, as cited in Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, Rev 1, Stantec, May 2023.

Figure 2: Hammond Point Irrigation Area[7]

This option was considered favourably by CCC during the long-list options assessment due to the anticipated ability to share existing infrastructure that will be installed for the ATWIS.

As soil would likely be at saturation capacity during exceedances events, increased irrigation would likely lead to overland flow and some runoff to the coastal environment.

For this assessment, Option 1 has considered the scenario of increased irrigation at Hammond Point with all treated wastewater irrigated as part of the storage exceedance discharges having passed through the OCR wetland for transformation. In order for the conveyance and irrigation infrastructure to be able to be shared and still meet cultural outcomes, flows from the WWTP would have to be pre-emptively diverted through the wetland for at least the volume of water held in the irrigation main between the WWTP and the Hammond Point irrigation field take off point. This is to ensure that the pipeline contains wetland transformed wastewater at the start of exceedance discharges and that all water irrigated above that described within normal operation of the ATWIS has been wetland transformed prior to discharge (as detailed in Section 3.1.1).

7 Akaroa Treated Wastewater Irrigation Scheme - Preliminary Site Investigation, Rev 2, Stantec, June 2022.

Assessment of the alternative scenario, where increased irrigation at Hammond Point is undertaken without all WWTP flows diverted through the wetland first, could also be considered. Ōnuku Runanga will advise whether overland flow via the kānuka on Hammond Point is sufficient to meet cultural outcomes or whether wetland transformation would be required prior to irrigation.

3.1.1 Wetland capacity during storage exceedance discharges

3.1.1.1 Hydraulic residence time (HRT)

Ōnuku rūnanga have expressed that their support for any discharge option will rely on sufficient opportunity for the discharged water to have contact with the land and to allow for transformation by Papatūānuku. Two to three days of contact within a wetland or similar system was indicated by Ōnuku rūnanga as an initial guide for sufficiency of land contact during the long-list options workshop.

The functionality described for the proposed wetland indicates that water in exceedance of the storage capacity at Robinsons Bay will be diverted to, and therefore treated by, the subsurface wetland. The hydraulic residence time (HRT) figures shown in Figure 3 provide an indication of percentage of events that these residence times would be achieved over all modelled discharge flows associated with the storage exceedances. This contact time includes the freeboard volume of the wetland which will not be filled with the gravel substrate of the main body of the subsurface wetland. This is not a direct indication of the time that the water will be in close contact with the gravels. However, it is a good indicator for the time period that the water will spend, overall, within the naturalised wetland environment.

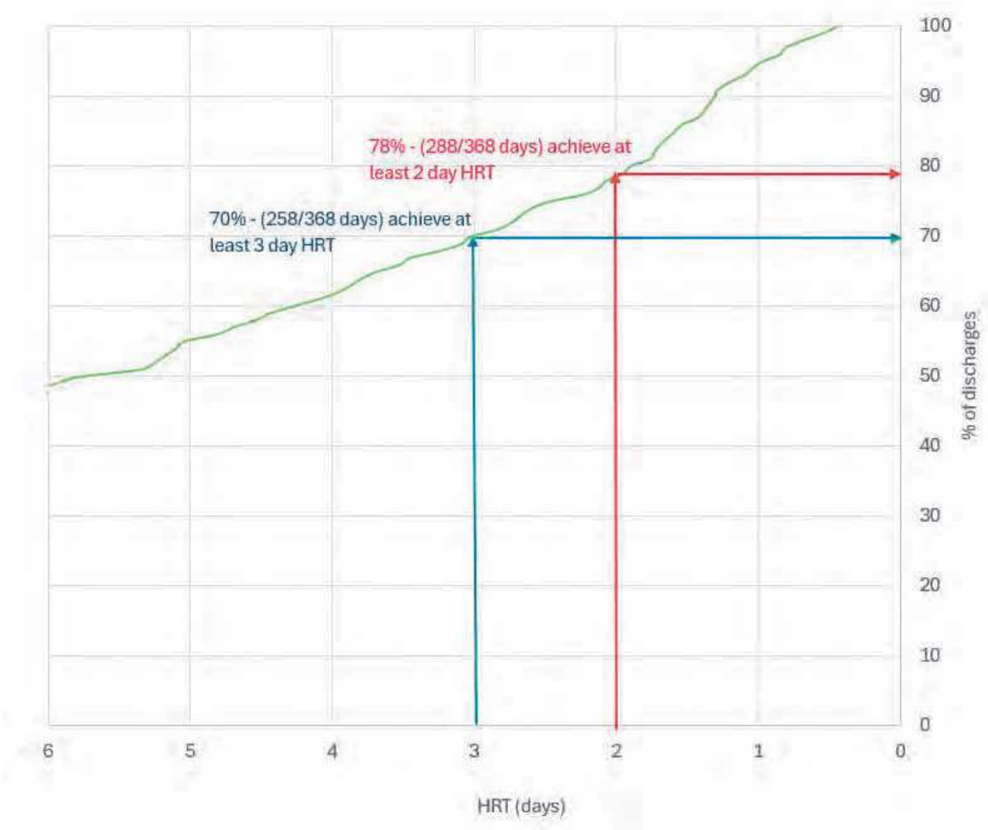

Figure 3: Percentage of exceedance discharge events from the wetland achieving varying hydraulic residence times (HRT)

This indicates that approximately 22% of the discharges from the wetland (0.4% of total days modelled) would have a residence time of less than 2 days; the minimum time indicated by Ōnuku rūnanga.

All storage exceedance discharges would pass through the wetland. Over three quarters of the exceedance discharges in this scenario would have a minimum residence time of two days in the wetland. Of those that have a lesser residence time, the lowest value modelled is 0.4 days (just under 11 hours). Notably, this is a single day in a data set of over 51 years (18,840 days), and storage exceedance discharges from the wetland are modelled on 368 days, or 2% of days modelled. There is potential for optimisation of the wetland operation during detailed design.

3.1.1.2 Wetland Treatment

The transformation of treated wastewater through wetlands can change the expected concentrations of contaminants in the treated effluent. Wetlands offer additional removal of contaminants, especially when influent contaminant loads are high. However, due to the natural characteristics of wetlands, background levels of these contaminants are always present. This limits the ability of wetlands to further reduce contaminant concentrations when the influent already has relatively low concentrations of contaminants.

The quality of the treated effluent anticipated, with the level of treatment proposed for the WWTP, and the discharge of treated wastewater for land irrigation is presented in Table 8.

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Table 7: Treated Effluent Concentration Limits[8]

Parameter	Unit	Mean Annual Limit
Carbonaceous five-day Biochemical Oxygen Demand (BOD_5)	mg/L	5
Total Suspended Solids (TSS)	mg/L	2
Total Phosphorus (TP)	mg/L	7
Total Nitrogen (TN)	mg/L	10
E. Coli	Cfu/100 mL	10
Enterococci	Cfu/100 mL	10

Studies by the USEPA shown in Table 9 demonstrate that background concentrations in a free water surface (FWS) wetland may be similar to that of the final treated wastewater quality when it enters the wetland for transformation. Values for a FWS wetland have been used as this represents the operation of the wetland when freeboard is used during exceedance events.

[8] Design Basis for Akaroa Wastewater Treatment and Reuse, AECOM - 16 February 2024 (Doc No. 60717466-BRD-RPT-001)

Table 8: Background Concentrations of Contaminants of Concern in FWS Wetland Treatment Systems[9]

Constituent	Unit	Range	Factors Governing Concentrations
BOD_5	mg/L	1 - 10	Plant types, coverage, climate, plant density
TSS	mg/L	1 - 6	Plant types, coverage, climate, wildlife
TP	mg/L	< 0.2	Plant types, coverage, climate, soil type
TN	mg/L	1 – 3	Plant types, coverage, climate, oxic/anoxic conditions
Faecal Coliforms	Cfu/100 mL	50 – 5,000	Plant types, coverage, climate, wildlife

It is likely no further treatment of BOD_5, TSS, TP, or TN will be achieved in the OCR wetland. Presence of faecal coliforms may increase through the wetland due to regrowth of microorganisms in the wetland or the addition of faecal matter from birds or other animals, which may result in effluent discharge concentrations in Table 8 being exceeded.

Due to the natural processes present in a wetland system, there is potential for increased *E.coli* and suspended solids in the wetland effluent, particularly if higher flow rates allow mobilisation of previously deposited solids. Figure 4 and Figure 5 show PFDs for a suggested configuration within the WWTP which will allow recirculation of wetland-treated water through filtration and UV treatment prior to discharge which will allow for solids removal and disinfection. The red lines represent wastewater or treated wastewater which have not passed through the wetland, and the green lines represent treated wastewater which has passed through the wetland.

Options for post wetland treatment should be considered in detailed design.

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[9] Wastewater Technology Fact Sheet, Free Water Surface Wetlands, USEPA (2000). *https://www3.epa.gov/npdes/pubs/free_water_surface_wetlands.pdf*

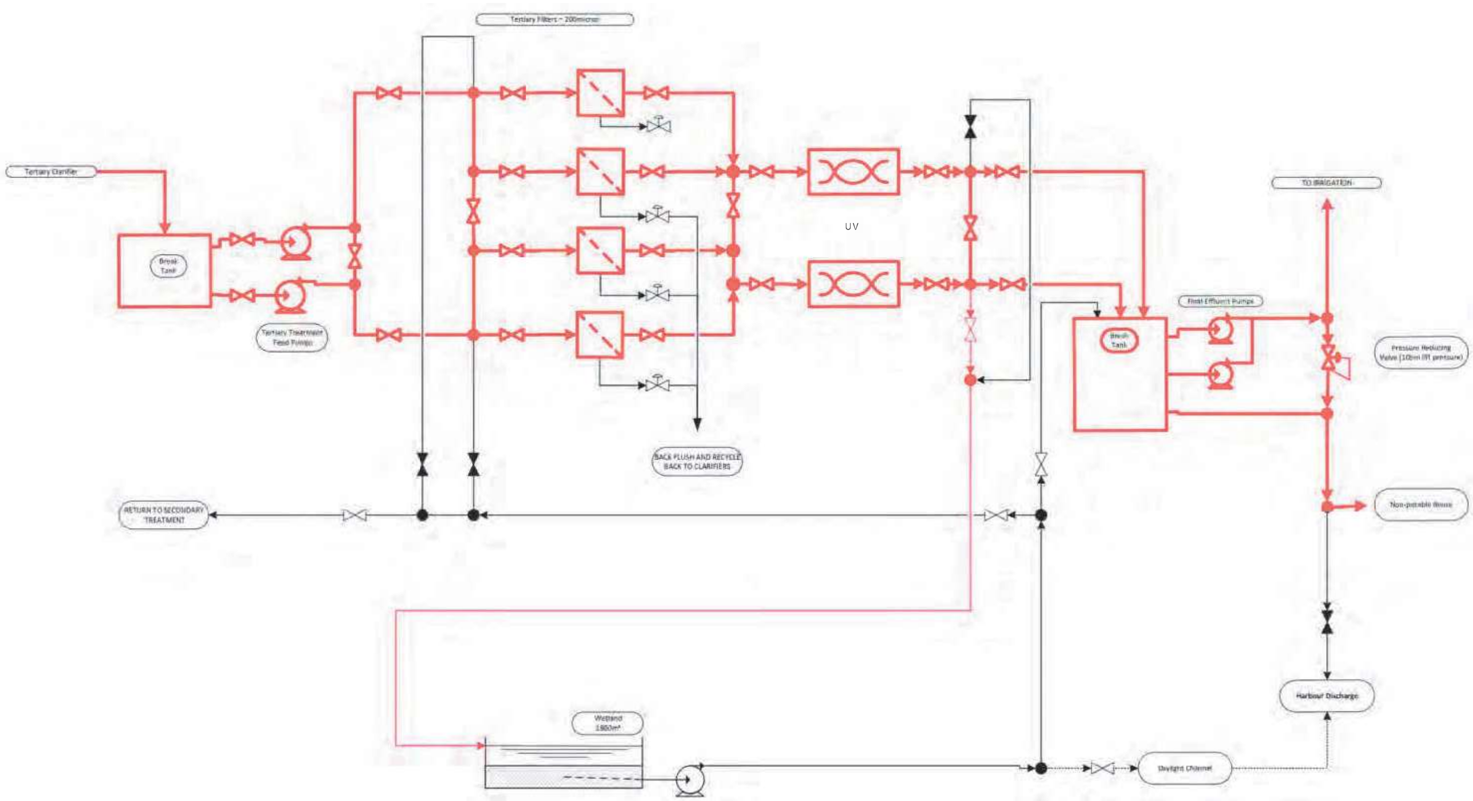

Figure 4: Proposed wetland configuration for normal operation for the WWTP[10]

[10] Christchurch City Council, Three Waters & Waste Team, July 2024

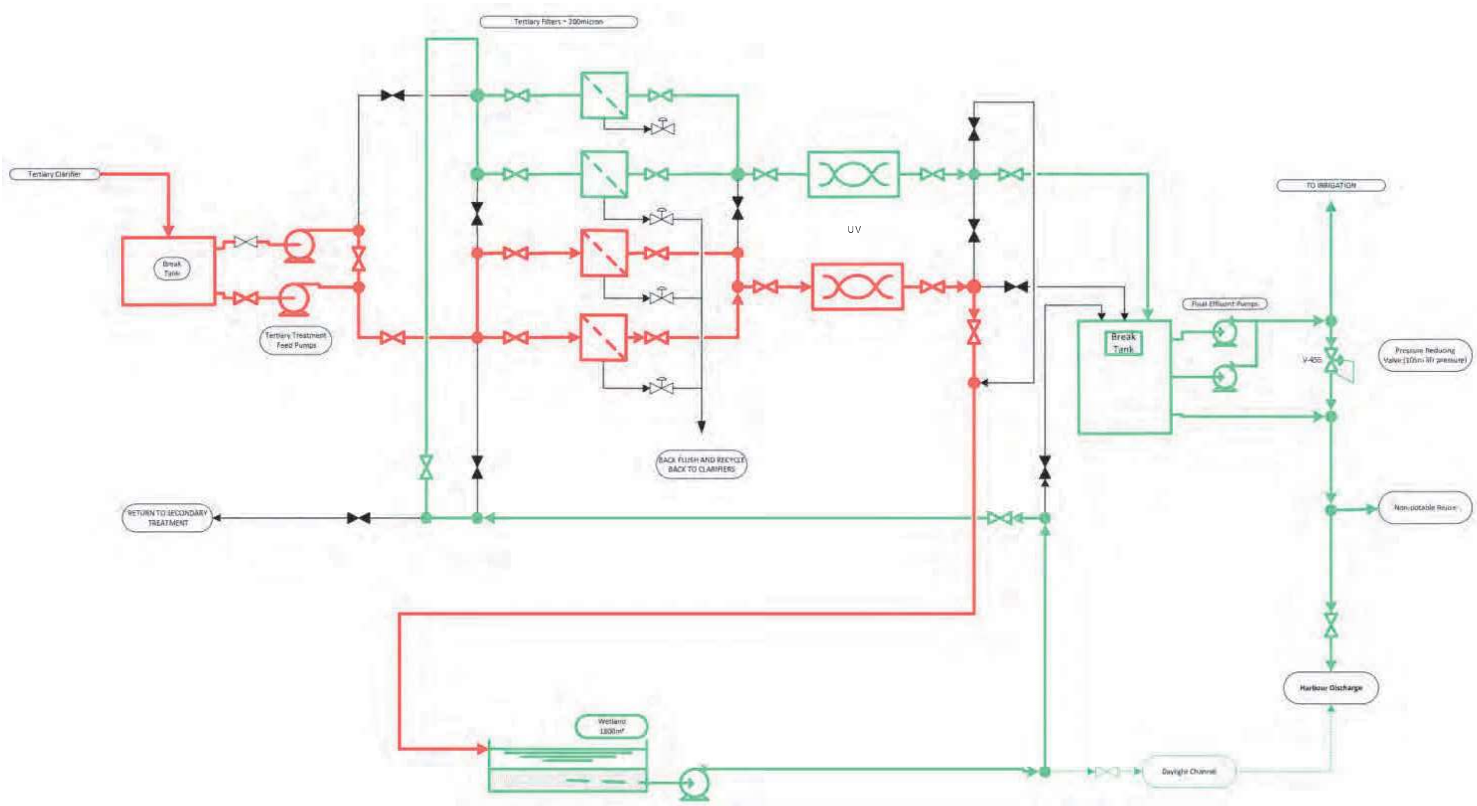

Figure 5: Proposed configuration for post-wetland treatment through the WWTP during storage exceedance discharges[11]

[11] Christchurch City Council, Three Waters & Waste Team, July 2024

3.1.2 Irrigation System

The proposed irrigation scheme for the ATWIS comprises surface dripline irrigation to native trees. Trees are to be planted in rows 2 metres apart with up to four driplines equally spaced between each tree row. Drippers will have a flow rate of up to 2 litres per hour (lph) and a spacing of 30-50 cm.[12] The treated wastewater from the WWTP will have a mean TN concentration of 10 g/m³.

The proposed ATWIS design specifies irrigation pipe sizes and pumping requirements based upon the maximum irrigation volume stated in Section 3.2.1 of the Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects (ATWIS AEE)[13]. The proposed ATWIS irrigation layout and sizing has been used as a baseline for this option, with increased pipe size requirements for management of exceedance discharges discussed further in Sections 4.4 and 5.0.

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3.2 Option 2 – Discharge from the WWTP via the OCR wetland to the boat park seawall at Childrens Bay

This option involves installation of a discharge pipeline from the proposed wetland to the boat park seawall at Childrens Bay. In the event that the scheme must discharge treated wastewater to Akaroa Harbour, the wetland is intended to offer an opportunity to provide restoration of the water's mauri prior to discharging into the harbour.

3.2.1 Wetland capacity during storage exceedance discharges

The same rationale for the wetland prior to the land passage system has been applied as that detailed in Section 3.1.1.

3.2.2 Outfall

Childrens Bay is comprised of recreational beach areas in the northern aspects which are accompanied by a public walkway. These areas are also marked as Department of Conversation (DOC) wetland area. The eastern aspects of Childrens Bay have an engineered seawall which protects boat and car parking areas. There is also a jetty and a boat ramp present. There are two altered outlets to Grehan Stream which discharge from the seawall via a culvert to the north and a channel to the south.

The discharge location for the outlet has been proposed to be along the boat park seawall for the following reasons:

- To avoid the wetland area to the north;

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[12] Basis of Design Report Akaroa WWTP and Reuse, Rev 1, Aecom, 16 February 2024.
13 Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, Rev 03, Stantec, May 2023.

- To leave the recreational beach areas unaltered by infrastructure and consolidate infrastructure into an area already altered by structures;
- To provide setback from existing seagrass in Childrens Bay as identified in aerial imagery;
- To remove maintenance issues with the infrastructure sanding up if it located across the beach in the tidal zone;
- To provide erosion protection and reinforcement to changing sea levels by installing the outlet within the existing seawall; and
- A short outfall reduces the amount of additional built infrastructure required to service the overflows.

For the purposes of this assessment, it has been assumed that the outlet will be placed between the north and south outlets of Grehan Stream to avoid crossing the stream. However, the outlet location could be further refined and optimised during design.

3.3 Option 3 - Discharge from the WWTP via the OCR wetland and additional constructed land passage to discharge at the boat park sea wall at Childrens Bay

This option builds on Option 2 with the addition of a constructed land passage system on the block of land down-gradient from the proposed OCR wetland. The outflow from this constructed flow path would then be piped to a discharge at Childrens Bay, again proposed to be adjacent to the boat park seawall.

3.3.1 Wetland capacity during storage exceedance discharges

The same rationale for the wetland prior to the land passage system has been applied as that detailed in Section 3.1.1.

3.3.2 Land Passage System

Incorporation of an additional land passage system can allow increased contact time with the land to allow for cultural transformation of the water. It is also viewed favourably by Ōnuku rūnanga as it provides a greater opportunity for education through additional landscaping and provision of information about the wastewater treatment and restoration process. It is anticipated that the land passage system would be constructed on land already owned by CCC between the wastewater utility site (the subsurface wetland) and Childrens Bay Road at the lower boundary of the site.

Figure 6 shows the OCR concept landscape plan, and Figure 7 shows the land parcel with 1 m contours to demonstrate the topography of the land passage site.

Figure 6: OCR Concept Landscape Plan[14]

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[14] Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, Rev 03, Stantec, May 2023.

Figure 7: CCC owned land (as indicated in Fig. 6) at Old Coach Road with 1 m contours

The topography of the land package is predominantly steep, with identified land instability concerns. Due to the requirement for discharges from the land passage system to only occur as a result of storage exceedances (i.e., very intermittent discharges), the design approach that has been considered for a land passage system is a bunded, rock-lined, naturalised channel with meandering sections on two gently sloping regions identified within the available land. The reasons for this selection and the capacity for it to achieve sufficient increases in HRT are discussed in more detail in the technical assessment in Section 4.4.3.

As the land passage system would only be utilised during infrequent exceedance discharge events, plantings for dry conditions that are also tolerant to temporary inundation would need to be considered in detailed design.

It is possible that some water quality parameters (e.g. TSS, *E.coli*) may be affected by the naturalised nature of this treatment stage. It will be pertinent to clearly address this and agree on the location for compliance testing of any discharges for which consent is sought. This is discussed further in Section 4.4.3.2.

3.3.3 Outfall

To avoid new infrastructure in the recreational beach and wetland areas of Childrens Bay, the same rationale for the outlet of the land passage system has been applied as that detailed in Section 3.2.2. A pipeline will be required to convey the treated wastewater from the bottom of the land passage to the outlet at Childrens Bay. It should be possible for this to be accommodated within the same alignment as the proposed purple pipeline route in the ATWIS and the raw sewage rising main from the Akaroa TPS to the WWTP.

3.4 Option 4 – Existing Duvauchelle Outfall

The Duvauchelle WWTP is located to the southeast of Duvauchelle, to the side of SH75. There is an existing harbour outfall as part of the current Duvauchelle WWTP and discharge. This outfall is recorded to be 150NB uPVC Class B and is laid from the Duvauchelle WWTP into the harbour and approximately 1,766 m[15] along the harbour floor to its discharge location.

The ATWIS system proposes to develop a new TPS at the existing Duvauchelle WWTP site along Christchurch Akaroa Road which will pump raw wastewater from the Duvauchelle township back to the proposed new Akaroa WWTP for treatment. The existing Duvauchelle WWTP will be decommissioned. A return pipeline from the Akaroa WWTP to the proposed DSRR irrigation site is proposed to be laid past the new Duvauchelle TPS location. This pipe could potentially be used for the conveyance of exceedance discharges to the Duvauchelle outfall if its diameter is increased to provide capacity for the additional flows. A new connection would be required from this treated wastewater pipeline into the existing Duvauchelle outfall.

3.4.1 Wetland capacity during storage exceedance discharges

The same rationale for the wetland has been applied as that detailed in Section 3.1.1.

To allow for treated wastewater which has passed through the wetland to be discharged via shared ATWIS infrastructure, purging of the pipe is proposed. This would empty the contents of ATWIS main between the WWTP and Duvauchelle

[15] https://mapviewer.canterburymaps.govt.nz/ - 'Wastewater Pipelines' Open Data (extracted 4 October 2024)

TPS into a purge tank to allow for only treated wastewater which has been wetland transformed to be discharged via the existing outfall.

3.4.2 Existing Outfall

The existing Duvauchelle outfall structure and location proposed for use in this option is fixed. Figure 8 shows the location of this pipeline.

Figure 8: Existing Duvauchelle Outfall Location[15]

4.0 Traffic Light Assessment Criteria

4.1 Overview of Traffic Light Assessment

The short-listed options have been assessed using a Traffic Light Assessment (TLA) to rank the potential suitability of the discharge options against ten priority considerations, which were agreed upon during the long-list options workshop on 1 July 2024.

As part of this assessment, a TLA of the short-listed options has been undertaken to further analyse and assess each option against a range of specific, and to some extent, measurable criteria. The criteria include environmental, technical, social, climate change adaptation, climate change mitigation, cultural, consenting, resilience, intergenerational equity and timeliness.

This assessment is subjective as the criteria that are used, as well as the scores which are assigned, are open to personal interpretation (and therefore could be open to debate). Nonetheless, a TLA provides a means of obtaining a ranking for each option, giving an indication of its viability, which promotes further discussion and further evaluation of the promising options.

For each criterion, each option has been scored against the others using a scoring system whereby the lowest score ('red') is the least favourable, the middle score ('orange') is neutral, and the highest score ('green') is the most favourable.

For the purpose of this report, criteria are as follows:

1. Environmental: The potential impact of the solution on the receiving environment, this includes surface watercourses, groundwater, flora and fauna, and other environmental considerations;
2. Technical feasibility: The technical requirements of the solution and how it meets the needs of the project;
3. Social: The potential impact on the local community and social perception of the solution;
4. Climate change adaptation: The exposure of the solution to future climate change hazards, impacts and whether risks are effectively mitigated;
5. Climate change mitigation: The greenhouse gas (GHG) footprint of the solution and whether any GHG reduction is achieved;
6. Cultural: The potential impact of the solution on cultural and tāngata whenua values;
7. Consenting Considerations: The consent requirements for each solution and any foreseeable associated risks to gain resource consent;

8. Resilience: The overall resilience of the solution with respect to exposure to natural disasters, hazards, and general wear and tear with time;
9. Intergenerational equity: The concept or idea of fairness or justice in relationships between children, youth, adults and seniors, particularly in terms of treatment and interactions; and
10. Timeliness: The potential for the solution to be implemented in a favourable or useful timeframe.

4.2 Information and Methodologies Applied

Key information, observations, or methodologies regarding each criterion applied in the TLA is documented below for context. This information has been identified via either:

- desktop assessment of relevant information made available;
- the site visit undertaken by PDP on 14 August 2024; or
- available good practice guidance.

Sections 4.3 to 4.12 outline key information considered for each criterion and score each option as per Section 4.1.

The summary tables for each section indicate the colour assigned to each option and include comments made during the short list workshop where they directly related to a specific option and assessment criterion. A full summary of discussion at the short-list options workshop is included in Section 6.0.

4.3 Environmental

The environmental assessment has considered the applicable areas of geology, marine environment and terrestrial ecology for each of the three key locations.

4.3.1 Hammond Point

4.3.1.1 Geology

The site slopes downwards in all directions from the eastern road boundary - approximately 20-25° to the south in the area of the native vegetation (outside the identified irrigation area), approximately 10-15° to the southwest, and approximately 15-20° to the northwest. The site consists of approximately 300mm of topsoil, underlain by loess, which is consistent with the mapped geology of the area. Loess can be extremely susceptible to changes in moisture content, with minimal increases sufficient to significantly reduce shear strength properties[16].

[16] Stantec. (2023). Akaroa Treated Wastewater Irrigation Scheme Geotechnical Desktop Study and Preliminary Investigations. Christchurch: Stantec.

Evidence of ongoing slope instability was observed throughout the sea cliffs to the north and west of the site, with limited smaller erosion and slump features (<5 m width/length) observed further back within the site itself. A small number of tunnel gully exit holes (piping) were observed in the loess at the top of the sea cliffs. The holes observed were in the order of <200 mm diameter and in the top 1 m of the sea cliffs. No tunnel gullies were observed further up the hill within the site itself, however the presence of exit holes at the sea cliffs suggests they are likely present.

A near-vertical cliff is present on the southwest boundary of the site approximately 20 to 25 m from the edge of the irrigation zone, located along the private property boundary.

The geotechnical report states that there is evidence of historical landslides on the private property on the southwest boundary and the area of native vegetation on the southern boundary. It also recommends that infiltration is monitored, and any runoff is strictly controlled to prevent reactivation of areas of slope instability and reduce the likelihood of tunnel gully (piping) formation. The report further states that to prevent surface ponding, runoff and associated erosion, and tunnel gullying, irrigation application rates should be controlled.

A preliminary assessment of the land at Hammond Point described a site visit which took place two days after a total of 16.2mm of rain had fallen over a period of three days[17]. The assessment notes that, at the time of the site visit, water was clearly exiting cuttings at the base of the crumbly loess sub-soil layer which was assumed to be from the recent rainfall.

4.3.1.2 Marine Environment

Hammond Point is subject to low levels of existing contamination sources predominantly from rural activities. The marine environment of Hammond Point is between Takamatua Bay and Robinsons Bay, with Takamatua Bay having lower tested water quality than Robinsons Bay.

Takamatua Bay area has been tested to have:

- high presence of Total Organic Carbon (TOC);
- higher presence of metals (Cu, Hg, Pb, Ni, Zn) than some other bays[18] in Bank Peninsula, theorised to be due to tidal currents and wind driven water transporting metals from the Akaroa township area to Takamatua; and

[17] PDP. (2019). Preliminary Assessment of Hammond Point Land for Wastewater Irrigation.

[18] All metals compared were arsenic, cadmium, lead chromium, copper, nickel, zinc

- no occurrence of 16 tested polycyclic aromatic hydrocarbons (PAHs)[19].

There is presence of an 'at risk - declining' species of sea grass in Robinsons Bay. Although the proposed storage exceedance discharge would only indirectly enter the bay, secondary discharge may still have an effect on the wetlands of moderate significance/threat. Seagrasses are considered important ‘nursery habitats’ for fish and crustaceans, where early life stages can find ample food and escape predation[20].

Some saltmarsh wetlands have been documented on geospatial layers in Robinsons Bay and Takamatua Bay[21] however there were no wetland or biodiversity layers documented around Hammond Point itself during this desktop assessment.

There are no inanga spawning habitats identified around Hammond Point, the closest is 1 km away in the Takamatua stream mouth.

4.3.1.3 Terrestrial Ecology

A terrestrial ecology report was completed for the ATWIS AEE that included assessment of the irrigation area at Hammond Point[22]. The assessment noted that the entire proposed irrigation area comprised cultivated pasture of exotic species with a few rushes (facultative wetland species) near the stock yards at the roadside. The report states that irrigation will not affect any indigenous species or vegetation, however this is based on regular operation of the proposed ATWIS and does not account for the addition of exceedance discharges.

Figure 9 shows the CCC Concept Landscape Plan for Hammond Point (from Appendix C of the ATWIS AEE[23]). A range of species are recommended in the terrestrial ecology report for planting in the areas marked ‘land application planting’. The report notes that the native species regarded as most suitable for first stage planting are species desirous of continual soil moisture. This characteristic of species planted will be particularly important if there is increased irrigation at the site. Additionally, it will be important to ensure

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[19] Environment Canterbury Regional Council. (2012). Sediment quality at muddy intertidal sites in Canterbury Report No. R12/33. Christchurch: Environment Canterbury Regional Council.
[20] Thomsen, M. S., Moser, A., Pullen, M., Gerber, D., & Flanagan, S. (2020). Seagrass beds provide habitat for crabs, shrimps and fish in two estuaries on the South Island of New Zealand. Christchurch: University of Canterbury.
[21] Environment Canterbury . (2024, July 23). Canterbury Maps Viewer. Retrieved from Map viewer: https://mapviewer.canterburymaps.govt.nz/
22 Baseline and Terrestrial Ecology Effects Assessment: Akaroa Treated Wastewater Irrigation Scheme, Colin Meurk Consultancy CMC, October 2022.
23 Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, Rev 03, Stantec, May 2023.

inclusion of species with roots that improve soil stability to assist with mitigation of potential instability associated with application of high irrigation volumes.

Figure 9: Hammond Point Concept Landscape Plan[17]

4.3.2 OCR proposed wetland and surrounding land

4.3.2.1 Geology

The wetland site itself is within a relatively flat, grassed farm paddock that slopes gently (<5°) in all directions, with a notable slump in the southeast corner suggestive of historic slope instability. The gradient of the site becomes steeper at the southern boundary where it borders a gully (in the order of 45°), and western boundary (in the order of 25°) where the slope has been truncated by road cuttings for SH75. Loess outcrops in the order of 3 – 5 m thick are visible within the road cutting, underlain in areas by boulders and rock. Loess can be extremely susceptible to changes in moisture content, with minimal increases sufficient to significantly reduce shear strength properties[24].

The proposed WWTP site is at the base of a relatively steep slope (in the order of 2H:1V) which appears to be the head scarp of the historic slope instability that extends into the proposed wetland area.

[24] Stantec. (2023). Akaroa Treated Wastewater Irrigation Scheme Geotechnical Desktop Study and Preliminary Investigations. Christchurch: Stantec.

Retrolens and Google Earth imagery show no discernible change in the historic slope instability over the period that aerial imagery is available for (1940s to present) and it is considered likely that it is currently inactive.

From the site visit it was noted that the proposed wetland area has a mild gradient. However, the area to the immediate south of the proposed wetland was noted to be steep with areas of potentially historic slumping and land movement visible. There appeared to be two central gullies where overland flow would be channelled through established trees and bush.

4.3.2.2 Terrestrial Ecology

The terrestrial ecology report completed for the ATWIS AEE advises that the proposed wetland area is entirely exotic pasture with exotic shelter trees and some recent roadside plantings[25]. The slopes below the plateau where the proposed land passage will be located is an area of secondary bush including a variety of native species.

From the site visit it was noted that the proposed WWTP and wetland areas are mostly pasture and grass species. The area to the immediate south of the proposed wetland appeared to be steep with areas of established natives and some introduced species. The established plantings potentially provide good habitat for native birdlife in the area, with noted bird activity present. There are additional areas of pasture further down the slope within the land parcel.

4.3.3 Childrens Bay

4.3.3.1 Geology

The Childrens Bay area west of the Christchurch to Akaroa Road predominantly consists of reclaimed land. The proposed Akaroa TPS area is a G3 landfill site where historic testing has encountered domestic refuse and asbestos in nearby samples[26].

4.3.3.2 Marine Environment

Childrens Bay has existing contamination sources such as road runoff, stormwater, activities in the catchment and boating activities. Cumulative effects therefore should be managed.

Childrens Bay area has been tested to have:

- low presence of TOC;

[25] Baseline and Terrestrial Ecology Effects Assessment: Akaroa Treated Wastewater Irrigation Scheme, Colin Meurk Consultancy CMC, October 2022.
[26] Stantec. (2022). Akaroa Treated Wastewater Irrigation Scheme - Preliminary Site Investigation. Christchurch: Stantec.

- higher presence of metals (Cd, Cr, Cu, Pb, Ni, Zn) than some other bays in Bank Peninsula, likely due to human influences; and
- occurrence of 11 of 16 PAHs, likely due to human influences[27].

There is presence of an 'at risk - declining' species of sea grass in Childrens Bay. Occasional discharge of storage exceedances to the bay would provide an improvement on the current situation, but discharge will still be into wetlands of moderate significance/threat. Seagrasses are considered important 'nursery habitats' for fish and crustaceans, where early life stages can find ample food and escape predation[28]. Potential sea grass areas are shown in Figure 10.

Figure 10: Childrens Bay at low tide (left)(December 2021), and high tide (right)(March 2023) with potential seagrass viewed as darker patches underwater[29]

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[27] Environment Canterbury Regional Council. (2012). Sediment quality at muddy intertidal sites in Canterbury Report No. R12/33. Christchurch: Environment Canterbury Regional Council.
[28] Thomsen, M. S., Moser, A., Pullen, M., Gerber, D., & Flanagan, S. (2020). Seagrass beds provide habitat for crabs, shrimps and fish in two estuaries on the South Island of New Zealand. Christchurch: University of Canterbury.
[29] Google Earth Pro, 2024

There is a wetland layer created by the Department of Conservation (DOC) present on the northern portion of Childrens Bay as shown in Figure 11.

Figure 11: Childrens Bay Wetland Area (DOC)[30].

There are no inanga spawning habitats identified around Childrens Bay.

4.3.4 Existing Duvauchelle Outfall

4.3.4.1 Geology

The existing outfall pipeline from the Duvauchelle WWTP is 150 NB uPVC and extends approximately 1.76 km into the Akaroa Harbour. The WWTP site consists of 2 m depth of clay overlying 0.59 m depth of large stones and rocks and 2.91 m depth of clay bound volcanic rock[31].

The outfall extends from the secondary clarifiers to a wastewater manhole. The discharge pipeline exits this manhole and crosses SH75 approximately 40 m from the site, entering the coastal estuarine wetland. From here, the pipeline is laid along the harbour floor[32].

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[30] Environment Canterbury . (2024, July 23). Canterbury Maps Viewer. Retrieved from Map viewer: https://mapviewer.canterburymaps.govt.nz/

[31] Environment Canterbury Regional Council. (2023). Bore log for well N36/0005. Christchurch: Environment Canterbury Regional Council.

[32] Royds Garden Consulting Engineers & Planners. (1988). Drawing 02080/4 Pipework Details, Duvauchelle Sewage Treatment Plant, for Akaroa County Council. Royds Garden Consulting Engineers & Planners.

The site is classed as high hazard seismic risk area [33]. There is a rock fall zone above the Duvauchelle TPS site[34].

4.3.4.2 Marine Environment

The Duvauchelle WWTP outfall discharges in between Duvauchelle Bay and Robinsons Bay marine areas. Akaroa harbour has existing contamination sources such as road runoff, stormwater discharges, activities in the catchment and boating activities. Cumulative effects therefore should be managed.

There is a wetland layer created by the DOC present across the entirety Duvauchelle harbour as shown in Figure 12.

Figure 12: Duvauchelle Bay Wetland Area (DOC)[29].

The sediment at the existing wastewater outfall has been sampled historically for monitoring purposes (total nitrogen, total phosphorus, chlorophylls-a, pheophytin-a, total copper, total lead, total zinc) and found to be similar to results from sites located outside the area of influence of the outfall. The sampling found that matching and lower concentrations of these contaminants were reported since previous surveys in 2010 and indicated no effect of the existing outfall discharge with respect to sediment composition (due to tested results being lower than the Australia New Zealand Guideline 2018 default

[33] Seismic Risk Areas (building.govt.nz)
[34] Christchurch City Council (2023, September 20), Duvauchelle Wastewater Treatment Plant – Life Safety Risk Assessment for Slope Instability Hazards, MEMO NO: 2023-01.

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guideline values). The homogenous lack of diversity and abundance in benthic biota suggested there was no effect from the existing outfall discharge during this monitoring. The limiting factor for biota composition in this environment was noted to likely be due to the high mud content of sediment and zero visibility at the bottom[35].

From sampling undertaken in Robinsons Bay, which is the closest sampled location to the Duvauchelle estuary area, the following was noted:

- low presence of TOC;
- low presence of metals (Cd, Cr, Cu, Pb, Ni, Zn) than some other bays in Bank Peninsula; and
- No occurrence of PAHs[36].

It is noted that there is presence of a sensitive species of sea grass in Duvauchelle Bay. Seagrasses are considered important 'nursery habitats' for fish and crustaceans, where early life stages can find ample food and escape predation[37].

Fish species commonly harvested in the area are blue cod (*Parapercis colias*), flatfish (*Rhombosoleo spp*.), rock lobster (*Jaus edwardsii*), and sea perch (*Helicolenus percoides*) [38].

4.3.5 Summary

The environmental considerations for each option have been summarised in Table 10 in terms of potential impacts and an TLA score has been applied to each site.

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[35] Bioresearches. (2023). Environmental monitoring of Duvauchelle outfall: sediment quality and benthic biota survey. December. 2023.
[36] Environment Canterbury Regional Council. (2012). Sediment quality at muddy intertidal sites in Canterbury Report No. R12/33. Christchurch: Environment Canterbury Regional Council.
[37] Thomsen, M. S., Moser, A., Pullen, M., Gerber, D., & Flanagan, S. (2020). Seagrass beds provide habitat for crabs, shrimps and fish in two estuaries on the South Island of New Zealand. Christchurch: University of Canterbury.
[38] Källqvist, E. M. L. A. Pirker, J. G. and Marsden, D. (2015). Assessment of Recreational Fishing with the Akaroa Harbour Taiāpure Management Area, South Island Te Waipounamu, New Zealand. New Zealand Natural Sciences. (2015). 40: 1-15.

Table 9: Potential Environmental Impacts

Option	Environmental Effects	Score
Option 1 – Increased irrigation at Hammond Point	Increased risk of land instability. Tunnel gullies (piping) may cause preferential flows affecting normal irrigation effectiveness and further increasing soil instability. Runoff flow over cliff faces may add to already quite eroded features and increase sediment load to the harbour. Over-irrigation will increase run-off risk (especially as exceedances are likely to correlate with high rainfall). Run-off will effectively bypass land treatment so nutrient uptake will be minimal/non-existent. Bunding should be considered to prevent runoff into the private property in the southwest corner[39]. Some runoff is likely to enter the surrounding coastal environment, coastal assessment may be required.	Red
Option 2- OCR Wetland to Childrens Bay	Some water quality parameters (e.g. TSS, *E.coli*) may be affected by the naturalised nature of the wetland, and the same performance outcomes of the WWTP may not be met unless the wetland transformed wastewater is passed back through the WWTP prior to discharge into Childrens Bay. Presence of 'at risk - declining' sea grass in Childrens Bay is a concern, however, the infrequent nature of the discharge is a mitigating factor. Outfall is set back from sea grass areas visible on aerial photos and will be timed to discharge around high tides to increase mixing and dilution and mitigate effects on sea grass. DoC wetland area (Canterbury Maps) has been avoided by proposing the discharge is along the seawall to the southwest of the bay. Childrens Bay has existing contamination sources such as road runoff, stormwater, activities in the catchment and boating activities. Cumulative effects should be managed.	Orange

[39] Stantec. (2023). Akaroa Treated Wastewater Irrigation Scheme Geotechnical Desktop Study and Preliminary Investigations. Christchurch: Stantec.

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Table 9: Potential Environmental Impacts

Option	Environmental Effects	Score
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Some water quality parameters (e.g. TSS, *E.coli*) may be affected by the naturalised nature of the land passage system, and the same performance outcomes of the WWTP may not be met following land passage into Childrens Bay. Presence of 'at risk - declining' sea grass in Childrens Bay is a concern, however the infrequent nature of the discharge is a mitigating factor. Outfall is set back as far as possible from sea grass areas visible on aerial photos and will be timed to discharge around high tides to increase mixing and dilution and mitigate effects on sea grass. DoC wetland area (Canterbury Maps) has been avoided by proposing the discharge is along the seawall to the southwest of the bay. Childrens Bay has existing contamination sources such as road runoff, stormwater, activities in the catchment and boating activities. Cumulative effects should be managed.	Orange
Option 4- OCR Wetland to Existing Duvauchelle Outfall	Some water quality parameters (e.g. TSS, *E.coli*) may be affected by the naturalised nature of the wetland, and the same performance outcomes of the WWTP may not be met unless the wetland transformed wastewater is passed back through the WWTP prior to discharge via the outfall. Presence of sensitive sea grass in Duvauchelle Bay may be a concern, however the infrequent nature of the discharge as well as the outfall discharge location bypassing sensitive areas is a mitigating factor. DoC wetland area (Canterbury Maps) has been avoided as the discharge is further out in the bay. The rockfall zone above the Duvauchelle TPS may result in damage to purge tank assets, resulting in leaks, if not sited out of fall zones. CCC advised during the short-list options workshop that it should be possible to locate both the Duvauchelle TPS and proposed purge tank within the available footprint that avoids rockfall zones and risk of inundation due to sea level rise.	Green

4.4 Technical

The technical feasibility of each option has been assessed in terms of the anticipated ease or complexity of installation, operation and maintenance for each option. Comments have also been made on the potential additional treatment achieved as a result of each option.

4.4.1 Option 1 – Increased irrigation at Hammond Point

4.4.1.1 Feasibility

The technical feasibility assessment focusses on the adjustments required to the proposed ATWIS irrigation scheme to enable conveyance and irrigation of the storage exceedance discharge flows, the potential capacity of the site to accept and treat the additional flows, and the change from the baseline to nitrogen loading rates that would occur as a result of the additional discharges.

It is proposed that the Hammond Point irrigation zone will be fed directly from the same pipeline that feeds the Robinsons Bay area[40]. A direct supply connection of OD110 PE100 SDR11 with 10.91 L/s to the treated wastewater rising main has been specified for consideration by the Basis of Design Report.

Depending on the final dripper and dripline spacing, and the irrigation area of 3.8 ha, it may be possible to discharge the maximum daily exceedance discharge modelled (4,698 m^3/d) by increasing the irrigation duration and irrigating to all areas concurrently. This should be confirmed with the system designers if this option is chosen for progression to ensure that the irrigation network pipes within the site are adequately sized.

To discharge the maximum modelled daily exceedance evenly across a 24-hour period, the average flow rate into the site would be 54 L/s. Based upon a target velocity of 1.5 m/s, this would require an increase in the size of the Hammond Point main (connecting the irrigation main between the WWTP and Robinsons Bay storage with the Hammond Point irrigation field) to an OD250 pipeline.

If this option is progressed, it will be important that the maximum anticipated discharge flows are considered when the design of the irrigation conveyance pipes within the site is completed. For the purpose of this technical assessment, assumptions have been made about the likely design approach based upon that observed in the preliminary design for Robinsons Bay irrigation area[41], namely:

- The 3.8 ha irrigation area will be split into at least 5 zones, each with a similar capacity as the 10.91 L/s specified for the whole Hammond Point irrigation area (to allow rotational application); and

[40] Basis of Design Report Akaroa WWTP and Reuse, Rev 1, Aecom, 16 February 2024.
[41] Waterforce, 30 May 2024. Robinsons Bay – Irrigation Prelim (received 13 August 2024)

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- It will be possible to irrigate to all sub-zones concurrently when over irrigation is required for discharge of a storage exceedance. This will allow an approximate discharge rate of 5 zones x 10.91 L/s per zone = 54.6 L/s.

It is understood that no soakage testing has been reported on at the Hammond Point irrigation site to date. It will be important that this is completed to better inform the potential infiltration rates (and therefore likely runoff as a result of irrigation of storage exceedance discharges) prior to confirmation of the technical feasibility of this option.

The geology of the site has been discussed in the environmental assessment (Section 4.3.1.1). The presence of tunnel gullies (piping) and historical instability on the site indicates that the loess soils are not ideally suited to high irrigation rates. Further site investigations are recommended to fully describe the risks associated with occasional high irrigation application rates to the specific soils and topography of the site.

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4.4.1.2 Treatment

Irrigation of treated wastewater to land can offer reduction of BOD_5, TSS, TN, and faecal coliforms[42]. However, this is based upon slow-rate irrigation which assumes interactions between the irrigated wastewater and the soils. It is likely that increased irrigation at the scale implied in this option could result in runoff and overland flow of irrigated water if the soil reaches saturation and irrigation continues. If water bypasses infiltration into the soils, the potential for treatment via soil interactions will be lost.

With regard to land contact achieved through this discharge option, irrigated discharges resulting in overland flow or runoff will have some contact with the land surface prior to eventual discharge into the harbour surrounding Hammond Point. It is difficult to quantify the duration of this flow path as it will be dependent upon location of ponding/runoff within the irrigation block, weather conditions, soil saturation prior to irrigation, and discharge volumes amongst other variables.

4.4.1.3 Operation & Maintenance

Implementation of this option would require increasing of the pipe size for the Hammond Point irrigation main (between the WWTP to Robinsons Bay Storage main and the Hammond Point irrigation field) and addition of a larger pressure relief valve than that required for flows described in the ATWIS. This could be installed in parallel with the pressure reducing valve for normal operations, with

[42] U.S Environmental Protection Agency (USEPA). (September 2006). Process Design Manual for Land Treatment of Municipal Wastewater Effluents.

flow through the larger valve being controlled to only periods when storage exceedance discharges are required.

Confirmation would be needed on the suitability of proposed planting species in the Hammond Point irrigation block for occasional periods of soil saturation. Planting plans may need to be adjusted to ensure that plants which are susceptible to damage from short periods of 'wet feet' are not included in the area intended for increased irrigation. Confirmation of plant maturation required to ensure stability prior to application of high irrigation rates will also be required.

4.4.2 Option 2- OCR Wetland to Childrens Bay

4.4.2.1 Feasibility

The technical feasibility assessment for this option focusses on the ability of the proposed ATWIS irrigation scheme infrastructure to enable conveyance and discharge of the storage exceedance flows, additional infrastructure required for the proposed discharge location, and the modelled land contact that can be achieved through use of the OCR wetland.

A gravity-fed treated wastewater pipeline is proposed between the WWTP and the Akaroa TPS along the same route as the new rising main between the TPS and the WWTP. The proposed ATWIS irrigation scheme will use this pipeline for conveyance of irrigation water to the Jubilee Park subsurface irrigation and provision for a future purple pipe water reuse scheme in the Akaroa township. The basis of design[43] indicates an estimated 200 mm diameter pipe size with pressure reduction is required. The proposed ATWIS purple pipe will have capacity to convey modelled storage exceedance discharge flows from the WWTP to the Akaroa TPS.

Pre-emptive discharges of treated wastewater to the OCR wetland could be used to optimise wetland HRT or provide for timed exceedance discharges around high tide in Children's Bay to achieve improved mixing in the receiving environment. Overall, the volume of discharges would increase slightly (0.2%) as a result of pre-emptive or timed discharges. The total number of discharges modelled increases from 368 days to 401 days (from 2.0% to 2.1%) of the 18,840 days modelled.

The tidal discharge model used to calculate the change in discharge volumes incorporates the following assumptions:

- High tide occurs with a 12-hour, 25-minute interval;
- Discharge occurs for three hours either side of high tide;

[43] Basis of Design Report Akaroa WWTP and Reuse, Rev 1, Aecom, 16 February 2024.

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- Wetland inflows (from WWTP) will be constant (i.e., buffered over the 24-hour period recorded); and
- Discharge will occur during permitted periods as soon as the trigger volume is reached.

It is recommended that the purple pipeline is increased in diameter from 200 mm to 250 mm to accommodate the higher discharge flow rate required for timed tidal discharges. The additional infrastructure required for this option may include a discharge pipe from the Akaroa TPS to the sea wall, a control valve at the TPS, a backflow device / non-return valve near the discharge point to protect the system from sea level rise, a concrete outlet structure and provisional rock protection at the exit of the seawall. Pressure reduction should have been addressed according to the existing basis of design.

The land contact and associated HRT within the wetland is detailed in Section 3.2 and represented graphically in Figure 13 (with and without the pre-emptive discharge for timed discharges around tides).

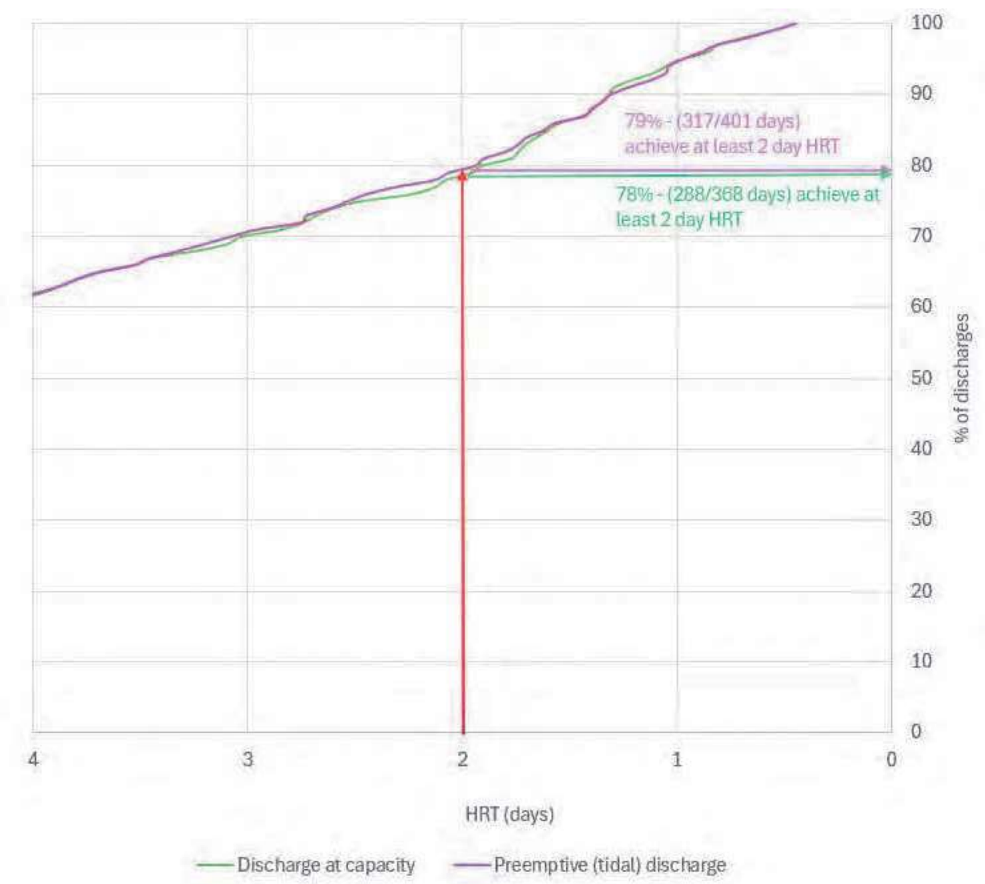

Figure 13: HRT for treatment of storage exceedance discharges in proposed wetland

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As the pipeline from the WWTP to the Akaroa TPS will also convey Jubilee Park irrigation flows and future purple pipe water, detailed design will need to consider purging of the regular treated wastewater pipe back up to the WWTP prior to starting exceedances discharges of wetland treated wastewater.

4.4.2.2 Proposed Wetland Treatment

Subsurface wetlands can achieve sediment removal and tend to favour anaerobic treatment processes, such as denitrification, when influent water quality is poor. Due to the nature of wetlands, there is some potential for increased sediment loads and microbial contamination in the wetland-treated water. When wetlands are used for flows with high variation as is proposed for this option, sediment that settles into the media during periods of low flow may be remobilised when higher flows occur. The sediment load in the wetland influent will be low due to upstream filtration, but there may still be some sediments present due to plantings and deposition on the surface of the wetland.

Risk for microbial increase is due to bird and wildlife activity around the wetland. Although this is more common for free-surface wetlands, higher wetland flows associated with discharges will occasionally use the freeboard capacity of the wetland, resulting in a water surface above the level of the wetland gravels.

Figure 4 and Figure 5 in Section 3.1.1 show a suggested configuration within the WWTP which will allow recirculation of wetland-treated water through existing filtration and UV treatment prior to discharge which will allow for solids removal and disinfection. However, if this configuration is approved, the capacity of the treatment units identified to manage the required flows for storage exceedance discharges (up to 4,698 m³/d) will need to be confirmed.

4.4.2.3 Operation & Maintenance

The only additional infrastructure required for this option would be an increase in the size of the proposed purple pipeline, a discharge pipeline between the Akaroa TPS and boat park seawall, and associated fittings and erosion protection. The proposed operation of the wetland fits within the operational strategy of the ATWIS.

4.4.3 Option 3- OCR Wetland via a new constructed land passage system to Childrens Bay

4.4.3.1 Feasibility

The technical feasibility assessment focusses on the potential for the identified land package to provide a suitable land passage system with sufficient HRT for cultural restoration of the treated wastewater. The proposed discharge of the storage exceedance flows will be the same as Option 2, so consideration of the discharge location and infrastructure has been discussed in Section 4.4.2.1.

The geology of the site is detailed in Section 4.3.2.1, and includes 3-5 metres depth of loess outcrops which is described as extremely susceptible to changes in moisture content, with minimal increases sufficient to significantly reduce shear strength properties. This, in combination with a site that is also steep in places, indicates a substantial risk for instability, particularly if additional water is added during or following periods of high rainfall. This introduces significant challenges when considering a design approach for overland flow within the site.

Detailed geotechnical assessment would be needed to further develop a design. This would need to include consideration of landslip risks, potential for tunnelling (subsurface erosion of preferential flow paths which can occur in unpredictable directions), and confirmation of optimal flow path to reduce the risk of slips occurring into the constructed channel during rainfall events which could reduce functionality. Other considerations required due to the underlying geology of the site will include:

- confirmation of the required stabilisation around the constructed channel;
- catchment assessment to quantify additional flows that the constructed channel will need to handle due to rainfall runoff; and
- selection of appropriate lining material for the land passage structure(s).

4.4.3.1.1 Design Approach

To accommodate the slopes on site, a rock-lined channel would offer a suitable land passage conveyance alternative to a closed pipe. The bottom of the channel would be rock-lined for erosion protection and, if a lime-stabilised base was considered acceptable following detailed geotechnical assessment, this would offer a more natural appearance than a plastic-lined channel. Side slopes would need to be created at a 1:3 gradient and could be planted. The design would need to ensure sufficient scour protection for combined storage exceedance discharges and stormwater run-off following catchment assessment. It may be necessary to pipe short sections of the flow if it is found to intersect a significant overland flow path, and the channel may need to incorporate stepped sections to allow dissipation of energy in the steeper sections. To avoid disturbance of the steep area of established vegetation immediately downslope of the proposed wetland, it has been considered preferable to pipe the wetland discharges along Old Coach Road. The same route proposed for the rising main from the Akaroa TPS would be used. The rock-lined channel would then begin from the point where the proposed pipeline diverges from the existing road into the paper road within the land parcel.

Due to the significant slopes on site, velocities are likely to be high which will result in small residence times within a basic constructed channel.

The addition of wetlands or ponds could increase the holding volume of the land passage system and, thus, retention times. However, due to the very intermittent nature of the discharge flows and the requirement for a base flow for wetland or pond operation, a preferred approach would be to include one or more basins or swales with strategic planting (which is tolerant to occasional flooding for two or more weeks). Two flatter areas have been identified within the site which have potential for this development, and for the purposes of assessment they have been assumed to be planted areas with (lined) low flow meandering channels. These areas could then be linked by a rock-lined channel as described above. A potential layout for this land passage system is shown in Figure 14. The residence time achievable within this type of system is likely to be in the range of 2-8 hours depending upon the final channel surface required for the shallower sloped channel sections within the basins (to be confirmed by geotechnical assessment).

Figure 14: Conceptual land passage system

There is significant potential within this option for optimisation of the land passage system. Challenges for all channel options will include the topography and stability of the site, and the intermittent nature of the required discharges.

It is anticipated that the proposed purple pipeline which is included in the ATWIS will still need to be installed for conveyance of water for irrigation of Jubilee Park. This water will have been tertiary treated (filtration and disinfection) prior to use for irrigation which is important to prevent clogging of the drippers.

The option described has not included filtration and / or disinfection of the treated wastewater after the land passage treatment. This may be an additional requirement, initially depending upon consent requirements and particularly in the future if the purple pipe reuse network is installed.

4.4.3.2 Proposed Wetland and Land Passage Treatment

The land passage system is expected to cause increased sediment loads and microbial contamination in the treated wastewater quality when compared to the upstream quality, of the WWTP effluent. This is for similar reasons to those described in Section 4.4.2.2 for Option 2.

There is also a risk of increased sedimentation due to bank erosion during higher flows, but this may be avoided through good design and inclusion of elements for energy dissipation and scour protection. As previously mentioned, the option described has not included additional filtration or disinfection at the end of the land passage treatment. The channel will be designed to finish with a lower gradient (and thus lower energy) section to allow some settlement of sediments . A grille will be installed on the inlet to the final piped section to the Akaroa TPS to prevent larger debris entering the pipeline. However, if higher level treatment for removal of natural contaminants introduced by the land passage treatment was required for consenting the discharges, this may need to be added to the design at a later stage.

4.4.3.3 Operation & Maintenance

Additional infrastructure required for this option would include sections of secondary ‘purple pipeline’ to be installed alongside the proposed purple pipeline in the ATWIS between the WWTP outlet and the start of the land passage system, and between the end of the land passage system and the Akaroa TPS (as shown in Figure 14). The land passage system itself will include two basins with low gradient meandering rock-lined channels, connected by steeper sections of an armoured rock-lined channel.

The banks of all channels will be planted and bunded to exclude stormwater from the surrounding catchments. Stormwater would need to be carefully managed in detailed design.

The approximate grade of the meandering channels is low enough that standard design approaches would recommend inclusion of a perforated collection pipe in the channel base to ensure complete drainage of the channel. This has not been included in the design assumptions as it would have potential for bypassing parts of the land contact, which is the desired outcome of the system. Ongoing maintenance of the system would include routine checks of the channel and surroundings and plant maintenance.

A discharge pipeline between the Akaroa TPS and boat park seawall, associated fittings and erosion protection will also be required, as described for Option 2. However, due to the absence of available storage area at the base of the land passage system, a tidally timed discharge to achieve improved mixing could not be achieved with implementation of this option as described for Option 2.

4.4.4 Option 4 - OCR Wetland to the Existing Duvauchelle Outfall

4.4.4.1 Feasibility

The technical feasibility assessment focusses on the potential challenges for repurposing the existing outfall infrastructure to discharge occasional but higher flow rates than its current design operation. Adjustments and additional infrastructure required to the proposed ATWIS irrigation scheme are also assessed to enable conveyance and discharge of the storage exceedance flows.

The existing outfall pipe is 150NB uPVC Class B which infers a pressure rating of 6 bar (61.2 m head). The outfall has been in use for around 35 years, although uPVC has an expected lifetime of up to 100 years[44]. A complete assessment of the condition and functionality of the outfall pipe has not been completed. Due to significant unknown factors regarding the current condition and operability of the outfall pipeline, the effect of average outfall discharge rate on the capacity of the outfall to discharge storage exceedances has been assessed. If this option is chosen for further development, it will be important to a complete a detailed condition and capacity assessment of the pipe .

The pipe is currently gravity fed from a manhole at the WWTP site and is reported to achieve a flow rate of approximately 4 L/s from a driving head of 2.15 m.[45] It has been suggested that the pipe may be able to achieve flows of up to 20 L/s[46], however, an upper pressure limit of around 1 bar (10.2 m head) has also been suggested to account for the age of the pipe.

[44] Water Works, (2021). PVC Pipes Explained. Retrieved from PVC pipes explained | High quality pipe systems NZ (waterworksnz.co.nz) 10 October 2024

[45] Email from CCC (Kylie Hills) to PDP (Alida van Vugt), *Duvauchelle outfall information email 1,* dated 02 October 2024.

[46] Verbal discussion at meeting with CCC and PDP, 02 October 2024.

A range of average outfall discharge rates between 4 L/s and 20 L/s has been assessed in order to capture all of the suggested flow rates provided. Notably, the estimated driving head requirement for the outfall pipeline exceeds the suggested upper pressure limit of 1 bar at around 9.5 L/s.

A high-level design based upon the above assumptions would require the irrigation pipeline from the main between the Akaroa WWTP and Robinsons Bay storage to the Duvauchelle TPS/outfall connection point to be increased to OD160 PE100 SDR11. During normal operation of the ATWIS, this pipeline will convey treated wastewater to the irrigation area at the DSRR. The outfall pipeline has been assumed to be connected to the proposed irrigation pipeline at around the SH75 road corridor where their respective paths intersect.

As irrigation water in the pipeline will not have received wetland transformation under normal operation, the design has included a purge tank at the Duvauchelle TPS site. The operational intent will be to divert the water already within the irrigation pipework between the WWTP and the outfall connection into the purge tank when an exceedance discharge via the existing outfall is triggered. This is to ensure that all the treated wastewater discharged to the harbour has received wetland transformation. The purge tank could then be drained back into the irrigation main or into the wet well within the TPS to be recycled to the WWTP depending upon when capacity becomes available within the system following cessation of the exceedances.

The assessed range of outfall flow rates operated consistently over a 24-hour period would achieve a maximum outfall discharge of 345 – 1,728 m³/d, which is less than the maximum daily storage exceedance modelled for a 5-year ARI (2,121 m³/d).

Figure 15 shows the relationship between outfall flow rate and storage exceedances that are above the discharge capacity of the existing outfall pipe as a proportion of the total storage exceedances volume and of the number of discharge days. This is the percentage proportion of storage exceedances that would be in excess of the capacity of the system, so would likely result in an overflow elsewhere in the ATWIS.

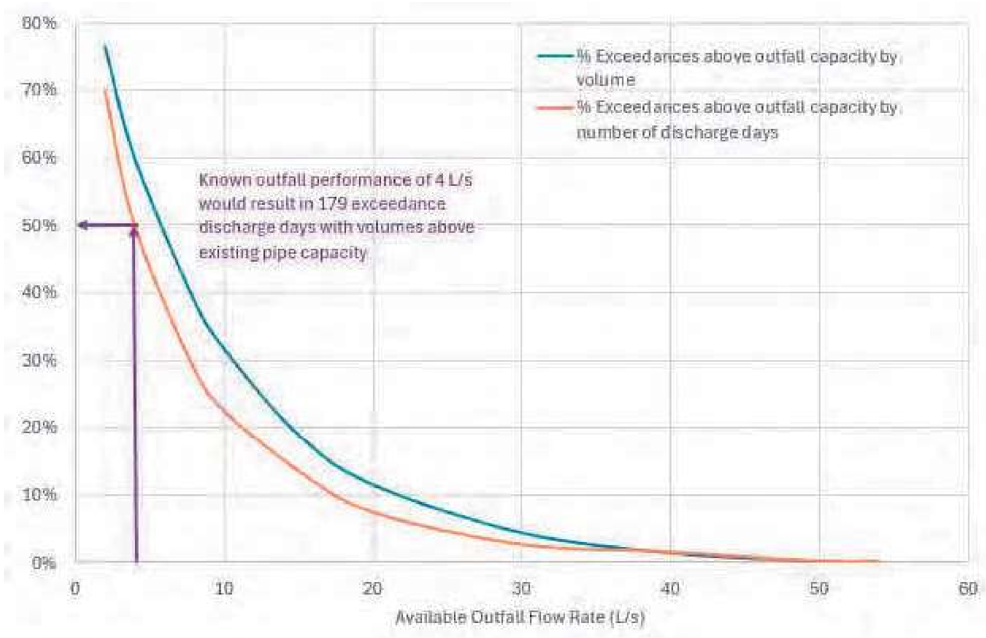

Figure 15: Effect of outfall flow rate on % storage exceedances above outfall capacity (by volume and number of discharge days)

The volumes and discharge days for key flow rates within this data set are included in Table 11.

Table 10: Outfall Capacity to Discharge Storage Exceedance Volumes

Outfall Flow Rate (L/s)	Total volume above outfall discharge capacity (for modelled period) (m^3)	Number of discharge days above outfall capacity	Number of exceedance events above outfall discharge capacity
4	132,864	179	43
8	85,959	103	31
10	70,252	81	25
20	25,451	27	15

Notes:
a) Values shown are for entire modelled data set (51 years).

There is an opportunity to pre-emptively run treated wastewater via the wetland and drawdown associated storage of wetland treated wastewater when using the existing outfall. This may positively impact future discharges and reduce the number of days the outfall would not have sufficient capacity to discharge.

However, due to the unpredictable nature of rainfall events and subsequent wastewater volume fluctuations, this may still not add sufficient capacity into the system to allow for discharge of all exceedance events.

4.4.4.2 Proposed Wetland Treatment

Potential wetland treatment and considerations about wetland functionality will be the same as those described in Section 4.4.2.2 for Option 2.

4.4.4.3 Operation & Maintenance

Additional infrastructure required for this option would include:

- an increase in the size of the proposed irrigation pipeline between the offtake to the ATWIS storage at Robinsons Bay and the site of the future Duvauchelle TPS;
- a purge tank of approximately 200 m^3 volume on the site adjacent to the proposed Duvauchelle TPS; and
- connections and associated fittings between the irrigation pipeline, the outfall pipe, and the purge tank.

Routine flushing of the outfall pipe would be required to prevent/reduce silting and biological growth (including shellfish) within the outfall which have potential to block the pipeline. Operational approach and flushing frequency of the outfall pipeline and purge tank would be confirmed during further design.

The proposed operation of the wetland fits within the operational strategy of the ATWIS.

4.4.5 Summary

The technical feasibility for each option has been commented on in Table 12 in terms of viability for each option.

Table 11: Technical Feasibility

Option	Feasibility Considerations	Score
Option 1 – Increased irrigation at Hammond Point	Overloading the loess soils is likely to cause geotechnical problems and an increased likelihood of slips on the irrigation field which would affect normal operation of the system. Excessive dosage rates have the potential to result in runoff, erosion, tunnel gullying and landsliding[47].	Red

[47] Stantec. (2023). Akaroa Treated Wastewater Irrigation Scheme Geotechnical Desktop Study and Preliminary Investigations. Christchurch: Stantec.

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Table 11: Technical Feasibility		
Option	**Feasibility Considerations**	**Score**
	Loess deposits are generally of a low permeability, although there are likely to be fractures or more permeable zones within the loess that water will be able to flow more freely along. These zones are difficult to identify and treat, however potential for this flow should be considered if this site is carried through to detailed design as it has the potential to increase tunnel gullying and erosion observed on cliff faces. Possible effects of additional nutrient loading are unclear as proportion of discharge likely to run off is currently unknown.	
Option 2- OCR Wetland to Childrens Bay	The additional infrastructure required above what is already included in the ATWIS has good feasibility. Timed discharges to occur either side of high tides are feasible but require increase in purple pipe size to accommodate increased flows. Tidally timed discharges will also require pre-emptive discharge of the proposed wetland which will result in a small increase in the number of discharges modelled.	Green
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Land passage system design will be very geotechnically challenging due to topography, soils, and evidence of historical slope instability. Good engineering design will minimise risks, but chances of system failure are still considered significant. There is potential for optimising land passage system to include wetland or pond areas to increase retention times and incorporate some additional emergency storage capacity. Risk of initiating movement and instability in the area above the State Highway. Any land passage system will need to be lined to prevent water from infiltrating into the soil and the historic landslide to the southeast and west of the site; and potentially increasing instability.	Orange

Table 11: Technical Feasibility

Option	Feasibility Considerations	Score
Option 4- OCR Wetland to Existing Duvauchelle Outfall	As the outfall has only been known to perform up to a rate of approximately 4 L/s, it is unknown what level of fluctuations or pressure the pipeline could tolerate above this. This means the existing pipeline may not have capacity for up to 179 of modelled exceedance discharge days. Therefore, this option is likely to have insufficient capacity to achieve the purpose of this assessment. There is an opportunity to pre-emptively run treated wastewater via the wetland and drawdown associated storage of wetland treated wastewater when using the existing outfall. This may reduce the number of days the outfall would not have sufficient capacity to discharge, however, is unlikely to add sufficient capacity into the system to allow for discharge of all exceedance events.	Red

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4.5 Social

Key social considerations for proposed option locations have been outlined from available community reference group material and property files.

4.5.1 Hammond Point

4.5.1.1 Neighbouring properties

Access on the existing Hammond Point track appears to be used by some members of the community for small private baches situated below Hammond Point to the south at Sandy Bay.

Most immediately surrounding landowners are down slope from the irrigation area and some appear to rely on the CCC owned land for access to their properties. Immediate down slope and surrounding neighbouring properties are summarised in Table 13.

Table 12: Neighbours immediately adjacent to Hammond Point.

Plan	Owner(s)	Direction/Location
Lot 2 Deposited Plan 563448	Fabiola Johnstone Hamish Hogan Johnstone Harriet Farrar Cowie	Southwest of Hammond Point below irrigation area (appears to be

Table 12: Neighbours immediately adjacent to Hammond Point.

Plan	Owner(s)	Direction/Location
	Mark Anthony Cowie Nicholas James Cowdy Prudence Kate Johnstone	accessed by road via CCC land)
Lot 1 Deposited Plan 329727	Belinda Jane Gilroy Ben Wellton McMaster David Gordon Coull Elizabeth Letitia Martha Coull Hamish Cameron Taylor Simon William David Gilroy	Southeast of Hammond Point below irrigation area.
Lot 1 Deposited Plan 76144	Colin Andrew Megaw Kerry Anne Megaw Lyall Matthew David Smith	Northeast of Hammond Point below irrigation area
RS 41166 RS41167	His Majesty the King (Department of Conservation)	West of Hammond Point (accessed by road via CCC land)

4.5.1.2 Other key stakeholders

Akaroa Area School access the site via the track through the proposed irrigation area for a conservation project on Te Uwu Te Rehua (Hammond Point) headland (RS41166 and RS 411667) where they are establishing native plantings.

4.5.2 OCR proposed wetland and surrounding land

4.5.2.1 Neighbouring properties

The site for the proposed wetland is bound by SH75 and Old Coach Road on three sides, with the southern boundary shared with another CCC-owned land parcel. CCC own four adjoining land parcels here which are bound by SH75, Old Coach Road, and the paper road 'Old German Bay Road' (Lot 7 Deposited Plan 7273, also CCC-owned). The paper road is the location of the proposed wastewater rising main and the Jubilee Park irrigation and purple pipeline treated wastewater pipeline between the new WWTP and the Akaroa TPS. Landowners of the parcels adjoining this paper road are shown in Table 14.

Table 13: Neighbours immediately adjacent to paper road

Plan	Owner(s)	Direction/Location
Section 1 Survey Office Plan 16495	Orion New Zealand Limited	East of CCC-owned land, between boundary and Old Coach Road
RS 41028	Josef Herman Gerhardus Mensen Katrina Ann Mensen	
Lot 2 Deposited Plan 524133	Marilyn Kaye Masefield Robert Valentine Masefield	
Lot 1 Deposited Plan 524133	Lianna Merie Hagaman FJB Trustees Limited Gibraltar Trust Limited	Southeast of CCC-owned land, between boundary, Old Coach Road, and SH75.

4.5.2.2 Other key stakeholders

Previous community engagement between CCC and the Banks Peninsula Community Reference Group[48] has indicated wider community interest for the OCR wetland and surrounding CCC land parcel to:

- Develop walking tracks accessible from Akaroa, linking with Old French Road and beyond; and
- Create a community garden and orchard for the Akaroa community, connecting to the purple pipe network.

It was proposed in 2022 that this area becomes a wetland reserve and acts as both a place of education and amenity for the local community and visitors. It was intended that a small carpark and bus pull in area be included to accommodate school groups. This area would showcase Māori values associated with water and the how the ATWIS is protecting and enhancing those values. This area would include walkways, boardwalks, extensive native revegetation planting, shelter structure, and interpretation panels. Community indicated the design be developed by Ōnuku rūnanga to reflect te ao Māori. It is understood that Ōnuku rūnanga have had involvement with this proposed wetland as indicated by the 2022 notes by Creative Facilitation Network.

[48] Creative Facilitation Network. (2022). Akaroa Reclaimed Water and Reuse Scheme Community Reference Group Commentary - DRAFT REPORT . Christchurch .

4.5.3 Childrens Bay

4.5.3.1 Neighbouring properties

The site for the proposed discharge from the seawall to Childrens Bay is owned by CCC. CCC own some adjoining parcels on the other side of Rue Brittan and Rue Jolie. There are also many landowners of the parcels privately owned along Rue Jolie to the east of the reclaimed land which form the main township, as well as to the north of State Highway 75 near Childrens Bay. As there are many properties nearby this urban area, they have not been tabulated at this point in time. However, the land use activities are listed in Section 4.5.3.2.

4.5.3.2 Other key stakeholders

Public use the recreational walkway which runs along the top of the seawall and northwest along Childrens Bay. There are also many members of the public who utilise the nearby boat parking, boat ramp and public parking facilities. The land parcel owned by CCC where the pipeline would go comprises of freedom camping, mini golf, croquet, a skate park, a playcentre, recreation ground, and public toilet facilities.

4.5.4 Existing Duvauchelle Outfall

4.5.4.1 Neighbouring Properties

The Duvauchelle WWTP is owned by the Akaroa County Council. There are many landowners of the parcels privately owned to the north of the WWTP in the Duvauchelle township at the head of the bay as well as to the south in the between the WWTP and Robinsons Bay.

4.5.4.2 Other Key Stakeholders

Public use multiple recreational facilities surrounding the bay. These include the Duvauchelle Holiday Park, Duvauchelle Wharf, Robinsons Bay Wharf, Duvauchelle Boat Ramp, Ōnawe walking track and Ngaio Point walking track. The WWTP outflow, located in the middle of these facilities, interacts with the high recreational value of the bay. Additionally, there may be some interaction of the outfall with the recreational fishing use of the bays.

4.5.5 Summary

The social considerations for each option have been commented on in Table 15 in terms of potential impacts.

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Table 14: Potential Social Impacts

Option	Social Considerations	Score
Option 1 – Increased irrigation at Hammond Point	• Public are aware that irrigation fields should have fixed capacity and may scrutinise increased irrigation rates. Public push back on wanting more I&I reduction is likely. • Public have expressed a 'Plan B' in case land-based solutions cause issues, this option could be perceived to provide no Plan B if the design were not fully communicated, however it is assumed the emergency discharge to Childrens Bay from the wetland storage would be present as per the design documents. • Public are aware of escalating costs of the project and may favour reducing costs of additional infrastructure. • Primary school activities in Hammond Point Reserve and coastal residents may be affected if the Ministry of Health were to impose access restrictions following exceedance events, or if ground movement resulted in damage to roads. • Geotechnical report noted areas of recent land movement[49] – if this is already occurring at the site, public may assume future movements to be caused by over-irrigation regardless of whether the assumption is accurate. • Consideration is recommended for the use of protection measures such as bunding to prevent runoff into the private property in the southwest corner – this is a tangible indicator to the occupants of the private property that there is a risk of runoff towards their property. • Over-irrigation has been flagged by public as a concern regarding higher nutrient loading and odour issues.	Red
Option 2- OCR Wetland to Childrens Bay	• Public perception of treated wastewater entering the recreational beach area is likely to be negative. Timing discharges to occur around high tides may help to improve perception by avoiding obvious discharges onto the beach when the tide is out.	Orange

[49] Stantec. (2023). Akaroa Treated Wastewater Irrigation Scheme Geotechnical Desktop Study and Preliminary Investigations. Christchurch: Stantec.

Table 14: Potential Social Impacts

Option	Social Considerations	Score
	• The mouth of Grehan Stream and boat park area are noted to flood regularly by residents. Concerns may be present around adding further discharges during wet periods. Public push back on wanting more I&I likely. • Proposed discharge point will be adjacent to the proposed Akaroa TPS overflow discharge point for raw wastewater. It is possible that if this is known, discharges in the area may be assumed to be of raw wastewater with the associated negative effects regardless of their nature.	
Option 3- OCR Wetland via a new land passage system to Childrens Bay	• Public perception of treated wastewater entering the recreational beach area is likely to be negative. Timing discharges to occur around high tides may help to improve perception by avoiding obvious discharges onto the beach when the tide is out. • The mouth of Grehan Stream and boat park area are noted to flood regularly by residents. Concerns may be present around adding further discharges during wet periods. The rock-lined channel may be viewed to provide additional space for water and retention to mitigate this. Public push back on wanting more I&I likely. • Proposed discharge point will be adjacent to the proposed Akaroa TPS overflow discharge point for raw wastewater. It is possible that if this is known, discharges in the area may be assumed to be of raw wastewater with the associated negative effects regardless of their nature.	Orange
Option 4- OCR Wetland to Existing Duvauchelle Outfall	• Public have been concerned that the proposed inclusion of the Duvauchelle wastewater stream to the AWTIS may result in CCC again exploring options to include a high flow treatment bypass to manage increased flow volumes, this option may be viewed as poorly executed by public given the capacity issues with the existing outfall.	Orange

4.6 Climate Change Adaptation

There are a number of potential climate change hazards which could impact the efficacy of the proposed exceedances discharge options. Projections for the following physical climate related hazards have been assessed against the options for the following reasons:

- Sea level rise: sea level rise may result in increased coastal flooding or erosion in the proposed discharge areas;
- Rainfall intensity: increasing rainfall intensity could result in larger surges of stormwater ingress through the WWTP, as well as increased volumes of stormwater overtopping wetland storage and changes to irrigation area soil saturation capacity predictions. Increased rainfall intensities also have potential to increase instability of steeper slopes and create more geohazards;
- Total rainfall: decreasing seasonal annual rainfall totals could result in reduced exceedance events or change the seasons in which these occur; and
- Drought: increased drought periods could allow for more irrigation to occur over dry months, or more demand for purple pipe re-use, and reduce exceedance events. It may also result in changes to soil behaviour and damage to underground infrastructure.

Other climate change hazards or extreme weather events exacerbated by climate change such as increasing temperatures and high wind days may have some minor impacts on the proposed options but are considered unlikely to be material for the purposes of this options assessment.

The WWTP and irrigation upgrades are considered a major new infrastructure and therefore should be classed as Category A[50]. Therefore, the assessment for coastal hazards will use a timeframe out to 2130 (≥100 years) and apply the medium confidence SSP5-8.5 H+[51] based relative sea level rise (RSLR) projection, which includes the relevant vertical land movement (VLM) rate for the local and/or regional area.

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[50] MfE. (2024). Ngā pūmate takutai me te ārahitanga huringa āhuarangi - Coastal hazards and climate change guidance. Wellington: Ministry for the Environment.
[51] H+ refers to the 83rd percentile

To provide consistency and align with the recommended MfE scenario and timeframe for coastal hazards, as well as enable planning for long term infrastructure resilience, the other climate change hazards have also been assessed against available higher emissions scenario projections (SSP5 – 8.5 or RCP8.5 with 3.3 – 5.7 °C projected temperature rise by the end of the century [52] [53]). Changes have also been assessed against the long-term time frames where available.

4.6.1 Sea Level Rise Projections

4.6.1.1 Hammond Point

Predicted VLM is -2.0 ± 2.2 mm/year at Hammond Point. RLSR is therefore predicted at 2.14 m under SSP5-8.5 H+ in the Hammond Point area[54].

Coastal flood maps between the NIWA extreme coastal flood maps and Christchurch coastal hazards online portal for the 2130 medium confidence SSP5-8.5 H+ RSLR are roughly in agreement regarding flood extents for 2 m (the limit of modelled flood extents) of SLR in Hammond Point for this scenario. Figure 16 demonstrates that the extent of flooding is expected to be limited to low lying beach areas.

[52] MfE. (2023). Aotearoa New Zealand climate change projections. Publication number: INFO 1142: Ministry for the Environment – Manatū Mō Te Taiao.

[53] Bodeker, G., Cullen, N., Katurji, M., McDonald, A., Morgenstern, O., Noone, D., . . . Tait, A. (2022). Aotearoa New Zealand climate change projections guidance: Interpreting the latest IPCC WG1 report findings. Report number CR 501, 51p.: Ministry for the Environment.

[54] NZSeaRise. (2024, July 19). Maps. Retrieved from NZSeaRise: https://searise.takiwa.co/map/6233f47872b8190018373db9/embed

Figure 16: Hammond Point coastal flooding under 2 m RSLR in 2130

Coastal erosion projections are only available for 1.5 m of SLR at 2130, however outline a cliff instability setback which should be observed. No other probability of erosion at Hammond Point has been indicated as shown in Figure 17.

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Figure 17: Hammond Point coastal erosion under 1.5 m RSLR in 2130

4.6.1.1 Childrens Bay

Predicted VLM is -1.9 ± 2.3 mm/year in Childrens Bay. RLSR is therefore predicted at 2.12 m under SSP5-8.5 H+ in the Childrens Bay area[55].

Coastal flood maps between the NIWA extreme coastal flood maps and Christchurch coastal hazards online portal for the 2130 medium confidence SSP5-8.5 H+ RSLR are roughly in agreement regarding flood extents for 2 m (the limit of modelled flood extents) of SLR in Childrens Bay for this scenario. Figure 18 demonstrates that the extent of flooding may be expected up to the State Highway 75/Woodills Rd.

[55] NZSeaRise. (2024, July 19). Maps. Retrieved from NZSeaRise: https://searise.takiwa.co/map/6233f47872b8190018373db9/embed

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Figure 18: Childrens Bay coastal flooding under 2 m RSLR in 2130[56]

Coastal erosion projections are only available for 1.5 m of SLR at 2130, however indicate a high probability or erosion along Childrens Bay and potentially the boat park as shown in Figure 19. The Boat Park Seawall provides some protection to coastal erosion, however the design tolerances of this seawall are unknown.

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[56] Christchurch City Council. (2024, July 19). Christchurch coastal hazards online portal. Retrieved from https://gis.ccc.govt.nz/hazard-viewer/coastal-flooding

Figure 19: Childrens Bay coastal erosion under 1.5 m RSLR in 2130[57]

4.6.1.2 Duvauchelle

Predicted VLM is 1.7 ± 2.1 mm/year in Duvauchelle harbour. RLSR is therefore predicted at 2.09 m under SSP5-8.5 H+ in the Duvauchelle Bay[58].

Coastal flood maps between the NIWA extreme coastal flood maps and Christchurch coastal hazards online portal for the 2130 medium confidence SSP5-8.5 H+ RSLR are roughly in agreement regarding flood extents for 2 m (the limit of modelled flood extents) of SLR in Duvauchelle Bay for this scenario. Figure 20 demonstrates that the extent of flooding may be expected up to 6137 Akaroa Road, the Duvauchelle WWTP site.

[57] Christchurch City Council. (2024, July 19). Christchurch coastal hazards online portal. Retrieved from https://gis.ccc.govt.nz/hazard-viewer/coastal-flooding
[58] NZSeaRise. (2024, July 19). Maps. Retrieved from NZSeaRise: https://searise.takiwa.co/map/6233f47872b8190018373db9/embed

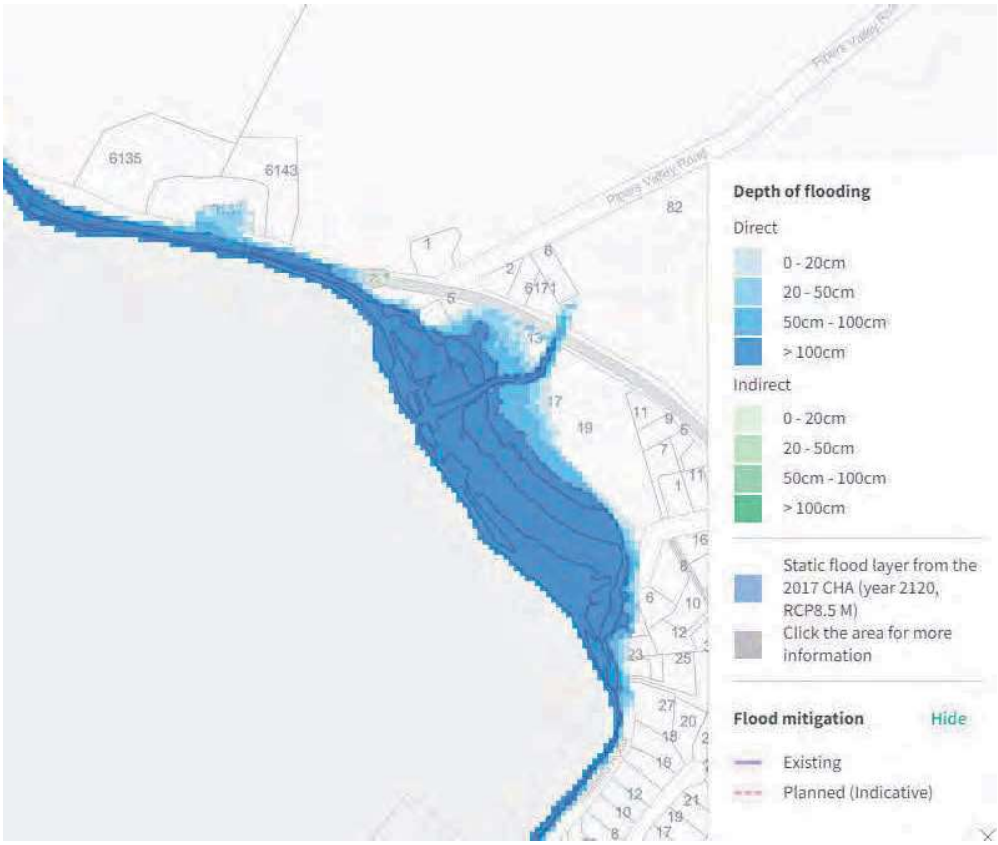

Figure 20: Duvauchelle Bay coastal flood under 2 m RSLR in 2130[59]

Coastal erosion projections are only available for 1.5 m of SLR at 2130, however indicate a high probability or erosion along Duvauchelle Bay shown in Figure 21. Coastal subsidence has potential to shift the ground structure beneath the pipe and cause structural deformation.

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[59] Christchurch City Council. (2024, July 19). Christchurch coastal hazards online portal. Retrieved from https://gis.ccc.govt.nz/hazard-viewer/coastal-flooding

Figure 21: Duvauchelle Bay coastal erosion under 1.5 m RSLR in 2130[60]

4.6.2 Rainfall intensity

Data from the High Intensity Rainfall Data Systems Version 4 (HIRDS V4)[61] indicates rainfall intensity increases under RCP8.5 for 2081 to 2100 in Akaroa could increase 31% - 35% for short duration events (10 – 30 minutes) and 12% to 16% for long duration events (≥ 120 hours). Where the historical 1% Annual Exceedance Probably (AEP) 24-hour duration rainfall event is statistical calculated to have an intensity of 7.29 mm/hour, under RCP8.5 (2081 – 2100) this may increase to 8.91 mm/hour. These projections apply to Hammond Point and Childrens Bay.

[60] Christchurch City Council. (2024, July 19). Christchurch coastal hazards online portal. Retrieved from https://gis.ccc.govt.nz/hazard-viewer/coastal-erosion
[61] NIWA. (2024, July 19). High Intensity Rainfall Design System V4. Retrieved from NIWA: https://hirds.niwa.co.nz/

4.6.3 Total rainfall

Projected annual mean rainfall changes under the RCP8.5 scenario for the 2081 – 2100 timeframe are expected to change by 0 to -5% in Banks Peninsula. A break down for seasonal mean rainfall changes for the same scenario and timeframe are shown in Table 16.

Table 15: Seasonal mean rainfall projected changes (RCP8.5, 2081 – 2100)

Season	Projected change
Summer	-15% to -10%
Autumn	-5% to 0%
Winter	0% to 5%
Spring	-5% to 0%

Notes:
a) Sourced from NIWA Canterbury projections, Table 5-7.

These projections apply to Hammond Point and Childrens Bay.

4.6.4 Drought

Notably Summer mean rainfall is expected to decrease by 10 – 15% (see Table 16). Reduced rainfall may lead to increased drought conditions and more need for irrigation.

The future amount of accumulated potential evapotranspiration deficit (PED) is projected to increase across most of Canterbury, therefore drought potential is projected to increase. By 2081 to 2100 under RCP8.5, an increase in accumulated PED of 75-100 mm per year is projected for the Akaroa, Banks Peninsula area[62].

Soil moisture deficit (SMD) is calculated based on incoming daily rainfall (mm), outgoing daily potential evapotranspiration (PET), and a fixed available water capacity of 150 mm (the amount of water in the soil 'reservoir' that plants can use). A day of SMD is considered to be when soil moisture is below 75 mm of available soil water capacity.

In 2081 – 2100 under RCP8.5 the projected change in the annual number of SMD days is 10 to 20[63]. For this same scenario, there is no projected decrease in SMD days in any season (including winter), and the highest increase in SMD days may

[62] NIWA. (2020). Climate change projections for the Canterbury Region. Wellington: NIWA.

[63] NIWA. (2020). Climate change projections for the Canterbury Region. Wellington: NIWA.

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be up to 10 additional days in autumn. These projections apply to Hammond Point and Childrens Bay.

4.6.5 Summary

The exposure to the various climate change hazards identified for each option has been commented on in Table 17 in terms of potential impacts.

Table 16: Projected Climate Change Impacts

Option	Climate Change Impacts	Score
Option 1 – Increased irrigation at Hammond Point	The irrigation areas at Hammond Point and supporting infrastructure are unlikely to be exposed to coastal flooding or erosion. Increased rainfall intensities may reduce the OCR wetland storage capacity for exceedances reducing hydraulic residence time for cultural transformation during future extreme events. Increased rainfall intensities may increase slumping and tunnelling around the discharge area, in addition to increased irrigation rates, this needs to be confirmed via a geotechnical assessment. Increased mean rainfall in winter may also result in more exceedances during this wet season. This may be counteracted by more treated wastewater being able to be irrigated in Autumn with increased SMD.	Orange
Option 2- OCR Wetland to Childrens Bay	Childrens Bay and surrounding low lying areas is likely to inundated during future coastal flooding and exposed to coastal erosion, the discharge point will gain erosion protection by being located at the existing sea wall. Increased rainfall intensities may reduce the OCR wetland storage capacity for exceedances reducing hydraulic residence time for cultural transformation during future extreme events. Increased mean rainfall in winter may also result in more exceedances during this wet season. This may be counteracted by more treated wastewater being able to be irrigated in Autumn with increased SMD.	Orange

Table 16: Projected Climate Change Impacts

Option	Climate Change Impacts	Score
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Childrens Bay and surrounding low lying areas are likely to be inundated during future coastal flooding and exposed to coastal erosion, the discharge point will gain erosion protection by being located at the existing sea wall. Increased rainfall intensities may reduce the OCR wetland and land passage storage capacity for exceedances, reducing hydraulic residence time for cultural transformation. Increased rainfall intensities and more extreme weather events may increase slope instability around land passage channels. Slips may cause system failure if they block channels. Conservative geotechnical assessment and controls are required. Increased mean rainfall in winter may also result in more exceedances during this wet season. This may be counteracted by more treated wastewater being able to be irrigated in Autumn with increased SMD.	Orange
Option 4- OCR Wetland to Existing Duvauchelle Outfall	Part of the Duvauchelle TPS and surrounding low lying areas immediately adjacent to the coast are likely to be inundated during future coastal flooding and exposed to coastal erosion, the infrastructure would need to consider erosion protection. The site is exposed to land subsidence. Increased rainfall intensities may reduce the OCR wetland and land passage storage capacity for exceedances, reducing hydraulic residence time for cultural transformation. Increased rainfall intensities and more extreme weather events may exacerbate any instability or rockfall hazard from the cliffs above the Duvauchelle TPS. Slips may cause system failure if they damage infrastructure. Geotechnical assessment and controls are required. Increased mean rainfall in winter may also result in more exceedances during this wet season. This may be counteracted by more treated wastewater being able to be irrigated in Autumn with increased SMD.	Green

4.7 Climate Change Mitigation

Greenhouse gas (GHG) emissions associated with each option have been considered at a high level in terms of whole of life carbon emission. These stages where GHG emissions can occur are presented in Figure 22.

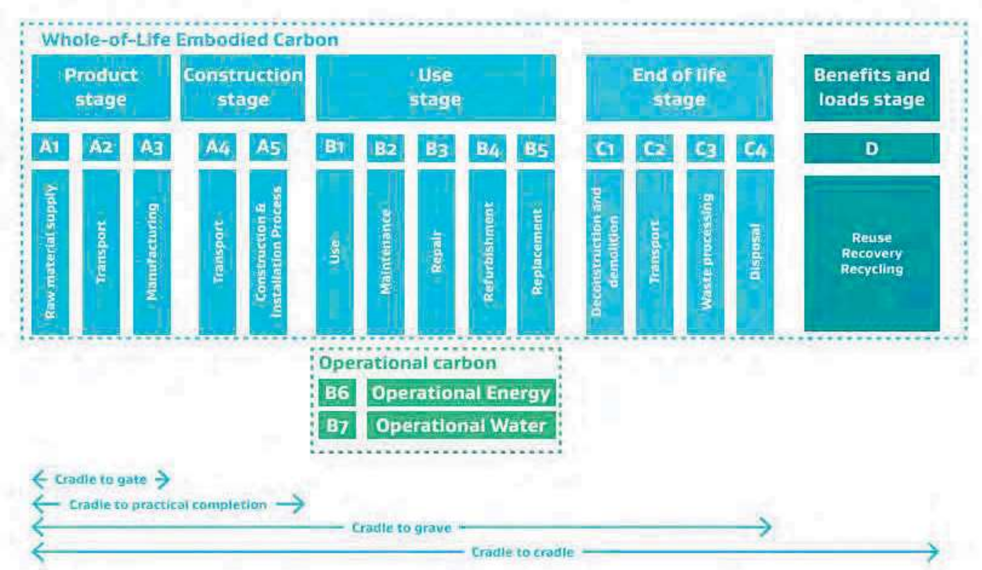

Figure 22: Module Framework for carbon life cycle assessment of a project[64]

As the use stage design parameters, end of life and any benefits and loads have not been confirmed, the assessment will compare at high level:

- the anticipated emissions from cradle to practical completion (A1 – A5); and
- operational energy (B6) which is likely to be materially impacted by the amount of pumping required.

It is recommended further design phases for the selected exceedances discharge option incorporate wider cradle to grave (or cradle) emissions reduction consideration.

Any GHG emissions which would result from the existing proposed WWTP, wetland, storage, pumping and pipelines have been excluded from this assessment. Only the additional greenhouse gas emissions associated with implementing the additional infrastructure or operations for each exceedance discharge option have been assessed. These estimates cover Scope 1, 2, and 3 emissions at high level and have been informed by Environmental Product

[64] MBIE. (2020). Whole-of-Life Embodied Carbon Emissions Reduction Framework. Wellington: Ministry of Business, Innovation and Employment.

Declarations. As the exact materials for use have not been designed yet, all GHG estimates have a moderate to high level of associated uncertainty.

A short description of the boundary of each GHG estimate is given in Sections 4.7.1 to 4.7.3 below. The GHG estimates can be found alongside the cost estimates for each option in Appendix B.

4.7.1 Option 1 – Increased irrigation at Hammond Point

The embodied carbon (A1 – A5) associated with upgraded pipe sizes from the Hammond Point take off to the irrigation network has been estimated to account for conveyance of larger volumes to driplines. The dripline infrastructure is expected to stay the same as presently proposed. Increased pump capacity is also considered as not required as pump sizes from the WWTP are not expected to increase and volumes are the same as if the treated wastewater were being pumped to the ATWIS and therefore no additional GHGs from pumping (B6) to the existing proposal are expected.

4.7.2 Option 2 - OCR Wetland to Childrens Bay

The embodied carbon (A1 – A5) associated with upgraded purple pipe size from the wetland to the Akaroa TPS and outfall valves and connections have been estimated to account for conveyance to an outfall. No additional infrastructure associated with GHGs from pumping (B6) are expected.

4.7.3 Option 3 - OCR Wetland via a new constructed land passage system to Childrens Bay

The embodied carbon (A1 – A5) associated with all additional infrastructure for the additional land passage, including bulk earthworks, rock materials, lining and the outlet have been estimated. No additional infrastructure associated with GHGs from pumping (B6) are expected.

4.7.4 Option 4 – OCR Wetland to the Existing Duvauchelle Outfall

The GHG estimate is an upper estimate assuming an outfall performance of 20 L/s. If the performance of the outfall is lower, smaller sizes of piping and tanks would be required, reducing the GHG estimate. The embodied carbon (A1 – A5) associated with all additional infrastructure for the upsized main and additional purge tank, including bulk earthworks, materials, and foundations have been estimated. No additional infrastructure associated with GHGs from pumping (B6) are expected.

4.7.5 Summary

The sources of greenhouse gas emissions were estimated for each option and have been commented on in Table 18 in terms of potential impacts.

During the short-list options workshop, climate change mitigation was discussed, and it was agreed that there was too much uncertainty around the implementation approach with regards to required infrastructure and the holistic effects of each option to confidently assign scores at this stage of development. Scores have been omitted from Table 18 accordingly.

Table 17: Projected Greenhouse Gas Impacts

Option	Greenhouse Gas Estimates
Option 1 – Increased irrigation at Hammond Point	Option 1 assumes minimal changes to the existing proposed design are required by using existing infrastructure as far as practicable. Therefore, the increase in associated GHGs from constructing the option are approximately 12,400 kg CO_2/e.
Option 2- OCR Wetland to Childrens Bay	Option 2 assumes minimal changes to the existing proposed design are required by using existing infrastructure as far as practicable. Therefore, the increase in associated GHGs from constructing the option are approximately 44,800 kg CO_2/e.
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Option 3 assumes significant new infrastructure added to the existing proposed design is required. Therefore, the increase in associated GHGs from constructing the option are approximately 96,000 kg CO_2/e. This estimate has the largest associated uncertainty regarding GHGs and would increase with increased protection measures in place.
Option 4- OCR Wetland to Existing Duvauchelle Outfall	Option 4 assumes long lengths of increased main sizes and purge tank infrastructure added to the existing proposed design is required. Therefore, the increase in associated GHGs from constructing the option are approximately 95,100 kg CO_2/e. This estimate has large associated uncertainty regarding GHGs and would decrease with lower performance of the existing outfall.

4.8 Cultural Setting – Mātauranga Māori

Akaroa Harbour is bordered by Te Rūnanga o Ōnuku and also Waiwera Rūnanga to the west. Taiapure (Ngai Tahu) Akaroa Harbour is designated as a coastal fishing zone of special significance to iwi or happy as source of kaimoana (food)[65].

[65] Environment Canterbury . (2024, July 23). Canterbury Maps Viewer. Retrieved from Map viewer: https://mapviewer.canterburymaps.govt.nz/ Taiapure (Ngai Tahu) - Overview (arcgis.com)

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Ōnuku Rūnanga represents the hapū of Ngāi Tārewa and Ngāti Irakehu who are the tāngata whenua of the takiwā which covers Akaroa Harbour, surrounding coastal environment and hills as defined by Ngāi Tahu Claims Settlement Act 1998. Ōnuku Rūnanga have the responsibility to act as kaitiaki over these lands, ensuring the area is passed down to future generations in a state which is as good or better than its current state[66].

In the Ngāi Tahu creation narrative, all life begins with wai (water), and the health of all things begins with water, making this taonga. The mixing of water from separate categories has been considered unacceptable to Māori, and therefore mixing of wastewater which could be classified as Wai-ki-no (Polluted water) should not be mixed with other categories of water, such as the life sustaining waters in the harbour.

Ōnuku rūnanga maintain that irrigation to land, re-use, and constructed wetlands for transformation using Papatūānuku prior to reaching other categories of water is the most resilient and culturally appropriate way forward for the Akaroa WWTP and discharges.

Ōnuku rūnanga indicated in the long-list options workshop that they:

- Would strongly prefer to have an option which incorporates naturalised overland flow or wetland transformation rather than direct discharge to the harbour or more piped infrastructure;
- Wish to ensure that CCC are doing all they can to reduce the treated wastewater exceedances by prioritising investment into I&I reduction (including overflows into gully traps on individual properties) and exploring whether some increased storage could provide benefit;
- Wish CCC to leave future provision for further purple pipe networks which can be used in periods of drought;
- Want to see solutions that are resilient to climate change and future proof for the next generations (therefore the OCR wetland is preferred over low-lying areas which may become inundated by sea level rise);
- Would like to see preliminary wetland hydraulic designs to see how the water will flow through the wetland and maximise residence times; and
- Would like to see preliminary wetland hydraulic designs to see how interactions with sunlight and air can be maximised.

[66] Ōnuku Rūnanga & Christchurch City Council . (2023). Akaroa Wastewater Wetland Reserve - cultural landscape and design report. Christchurch : Christchurch City Council .

4.8.1 Hammond Point

Te Umu-Te-Rehua is the name for Hammond Point between Kakakaiau (Robinsons Bay) and Takamatua Bay in Akaroa Harbour. It was formerly known as Bottle Point[67].

4.8.2 Childrens Bay

Ōtāhuahua is the traditional name for Childrens Bay situated on the eastern side of Akaroa Harbour. Childrens Bay is a silent file area created by Te Whakatau Kaupapa in 1990[68].

Akaroa (Ōtāhuahua) to Pigeon Bay is marked as 'Ka Ara Tupuna' or ara tawhito (traditional travel route).

Various Ngāi Tahu rangatira (chiefs) have claimed and fought over land on the peninsula. One of these chiefs was Tūtakakahikura who was travelling from Pōhatu (Flea Bay) to Te Ruahine, and then down Akaroa Harbour before he encountered and killed Ōinako at a stream within the harbour. Grehan Stream which feeds Ōtāhuahua has been known by his name, Ōinako, ever since (Ngāi Tahu, 2024).

4.8.3 Duvauchelle Harbour

Ōtokotoko is the headland between Duvauchelle and Kakakaiau (Robinsons Bay) in Akaroa Harbour. Te Ake was one of several Ngāi Tahu tūpuna (ancestors) who claimed land during the southern Ngāi Tūhaitara migration to Canterbury. After landing at the head of Akaroa Harbour, Te Ake attempted to make his way round to Wainui but was stopped by the nature of the country. He then went around the other side of the harbour and placed his tokotoko (walking stick) at the headland between Duvauchelle Bay and Kakakaiau, to claim ownership of the harbour [69].

To the west of the outfall is the Ōnawe pā which is situated on the small peninsula that extends into Whakaroa (Akaroa Harbour) between Barrys Bay and Duvauchelle Bay. In 1831, Ōnawe was the site of a massacre[69]. Duvauchelle Bay is a silent file area created by Te Whakatau Kaupapa in 1990[70].

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[67] Ngāi Tahu. (2024, July 24). Atlas. Retrieved from Kā Huru Manu: https://kahurumanu.co.nz/atlas
[68] Environment Canterbury . (2024, July 23). Canterbury Maps Viewer. Retrieved from Map viewer: https://mapviewer.canterburymaps.govt.nz/
[69] Ngāi Tahu. (2024, July 24). Atlas. Retrieved from Kā Huru Manu: https://kahurumanu.co.nz/atlas
[70] Environment Canterbury . (2024, July 23). Canterbury Maps Viewer. Retrieved from Map viewer: https://mapviewer.canterburymaps.govt.nz/

4.8.4 Summary

An indication of potential cultural acceptability based on literature is summarised in Table 19 alongside comments noted from Ōnuku rūnanga representation at the short-list options workshop.

Table 18: Cultural Considerations

Option	Cultural Considerations	Score
Option 1 – Increased irrigation at Hammond Point	This option achieves some land contact time within the OCR wetland prior to discharge. Ōnuku rūnanga has assisted with design of the wetland. During the short-list options workshop, it was acknowledged that Ōnuku rūnanga would not support this option as it had evolved to attempt irrigation of all discharges to Hammond Point which would cause runoff and associated environmental challenges.	Red
Option 2- OCR Wetland to Childrens Bay	This option achieves some land contact time within the OCR wetland prior to discharge. Ōnuku rūnanga has assisted with design of the wetland. Increasing the size of the purple pipe to Akaroa will provide greater capacity for future re-use initiatives.	Orange
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Ōnuku rūnanga favoured this option due to the associated opportunity to increase land contact prior to discharge, enhance natural values in the area, increase biodiversity and provide educational boards to teach members of the public about the wastewater treatment and disposal process. Cultural supervision will be required for any excavation required to construct this option due to excavation occurring in a silent file area and potential for cultural/archeological discovery.	Orange

Table 18: Cultural Considerations

Option	Cultural Considerations	Score
Option 4- OCR Wetland to Existing Duvauchelle Outfall	This option achieves some land contact time within the OCR wetland prior to discharge. Ōnuku rūnanga has assisted with design of the wetland. Increasing the size of the main to Duvauchelle TPS may provide opportunities for any future additional re-use initiatives in this area. During the short-list options workshop, this option was initially categorised as ‘red’ but following more detailed discussion about possible treatment capability of the OCR wetland it was agreed it may be possible to recategorize as ‘orange’ provided sufficient proof of mauri restoration within the wetland could be provided.	Red – possibly orange if sufficient proof of mauri restoration provided

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4.9 Legal / Consenting Considerations

Legal and consenting issues for each option are outlined below. The intermittent and temporary nature of the discharges may enable an easier consenting route than if the discharges were continuous in nature.

4.9.1 Hammond Point

The consenting viability of land application of the storage exceedances has been assessed in Table 20. Notably, while this is called discharge to land, discharge to soils which have exceeded their saturation capacity will result in ponding or overland flow to nearby waterbodies.

Table 19: Consenting viability of land discharge options

Consenting Viability	Hammond Point
Possible Consents Required	Discharge Permit under Rule 5.84 of LWRP as a **discretionary** activity.
Policy Direction	Both the LWRP (Policy 4.13 (d)) and Regional Environmental Coastal Plan (RCEP) encourage the discharge of wastewater to land, instead of discharges to surface water bodies or coastal environments. However, as the option is to 'over irrigate' the hydrological capacity of the soil, the ultimate receiving

Table 19: Consenting viability of land discharge options

Consenting Viability	Hammond Point
	environment may still be groundwater, fresh waterbodies or the coast. Policy 4.14 direct discharges to land to not exceed the natural capacity of soil to treat or remove contaminants, and the water storage capacity within soil. Where this is not practicable, discharges must meet the nutrient limits set within Schedule 8, utilise the BPO to minimise the contaminant plume, ensure sufficient distance between drinking water supplies and any other discharge, not result in the accumulation of pathogens, or raise groundwater levels so that land drainage is impeded.

4.9.2 Childrens Bay

The consenting viability for discharges to the Children Bay harbour intertidal zones is presented in Table 21.

Table 20: Consenting viability of intertidal zone discharge options

Consenting Viability	Childrens Bay
Possible Consents Required	Discharge Permit under Rule 7.3 of RCEP as a **discretionary** activity. If it can't meet water quality standards, then non-complying under Rule 7.6. Resource consent would also be required for a structure within the Coastal Marine Area (CMA).
Policy Direction	Policy 7.4 of the RCEP states that a point source discharge of a contaminant to land and water must after reasonable mixing meet the water quality standards for contact recreation in these locations. During low tide, there will be no mixing, therefore a comparison of the proposed Akaroa WWTP quality against the standards can be made. The treatment quality meets all standards except BOD_5, which requires 2mg/l, and the plant proposed to treat to a quality of 5mg/l. If any point source discharge cannot meet the water quality standards, Policy 7.4 provides exceptions to justify the granting of the consent, with b) the discharge is of a temporary nature could be justified if discharges are intended to only be short-term. Policy 7.2 also reflects the contact recreation standards and uses of the water.

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Table 20: Consenting viability of intertidal zone discharge options

Consenting Viability	Childrens Bay
	Policy 7.5 only allows the discharge of human sewage directly into the CMA (instead of passing through land or a specially constructed wetland outside of the CME), where (a) the discharge better meets the purpose of the Act than disposal through one of those methods, (b) there has been consultation with tāngata whenua, (c) consultation with the community and (d) the discharge is not within an Area of Significant natural value. Option 2 and 3 both involve discharge to wetland at minimum prior to the intertidal zone at Children's Bay, and provided that is located outside of the CMA, would be consistent with this policy. Discharge into the intertidal zone at Children's Bay is not an Area of Significant Natural Value but would have to still meet the purpose of the act (a), and consultation (b) and (c). Policy 7.7 is to avoid significant adverse effects on cultural and spiritual values. Mahaanui Karateka IMP Policy A1.2 seeks to eliminate all discharges to the harbour. Ngai Tahu submissions on Duvauchelle wastewater options is that a "discharge of treated wastewater to harbour is culturally offensive and incompatible with the harbour as mahinga kai". Clarification should be sought from mana whenua on whether this position also applies for infrequent, fully treated wastewater discharges of a high quality. Policy 7.8 (relatively consistent with s.107 RMA tests) states that after reasonable mixing, the discharge of a contaminant or water into water, or onto land in the CMA should not (a) give rise to any significant adverse effects on the existing habitats or feeding grounds of indigenous fauna or any significant adverse effects on aquatic ecosystems; and (b) acute or chronic toxic effects on fish, either directly or indirectly. Nitrate and ammonia toxicity may be an issue if there is no reasonable mixing. s.107(1) where matters such as the exceptional circumstances and temporary nature of discharge can be justified thereby providing a potential pathway to grant such discharge permits (s.107(2) RMA)).

Table 20: Consenting viability of intertidal zone discharge options	
Consenting Viability	**Childrens Bay**
	The New Zealand Coastal Policy Statement (NZCPS) Policy 23(2)(b) does not allow the discharge of treated human sewage to water in the coastal environment unless (i) there has been adequate consideration of alternative methods, sites and routes for undertaking the discharge. The long list of storage exceedance discharge options forms part of the alternatives assessment being undertaken by CCC to consider viable alternatives to a coastal discharge. Policy 23(2)(b)(ii) also requires the discharge of treated wastewater to the CMA to be informed by an understanding of tāngata whenua values and the effects on them. Policy 11 of the NZCPS is to protect indigenous biological diversity in the coastal environment by avoid adverse effects of activities on indigenous taxa that are listed as threatened or at risk in New Zealand. A coastal assessment would be required to determine whether the discharges would have any effects on any identified at-risk taxa in Childrens Bay.

Notably for Option 3 there will be additional consents required for construction. This includes potential excavation land use, dust, and construction phase stormwater discharge consents.

4.9.3 Summary

A summary of consenting considerations which differ for each option is given in Table 22. At the short-list options workshop, it was agreed that there were consenting challenges associated with all options but that, due to the additional unknown factors about technical challenges of increased irrigation at Hammond Point, Option 1 was likely to be relatively more challenging than the other options.

Table 21: Consenting Considerations		
Option	**Consenting Considerations**	**Score**
Option 1 – Increased irrigation at Hammond Point	There are affected or interested party risks associated with public relations and loss of confidence in CCC's proposal. Affected persons objecting to the proposal, may cause greater delays due to responding to challenges.	Red

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Table 21: Consenting Considerations

Option	Consenting Considerations	Score
	Likely for MoH to request restrictions on closing the area until risk of health to the public is acceptable. Potential effects of sedimentation and runoff nutrients affecting sea grass are unknown.	
Option 2- OCR Wetland to Childrens Bay	Even though wastewater will be fully treated and highly diluted, if the activity is considered by tāngata whenua to cause significant adverse effects on cultural values, the activity could be contrary to Policy 7.7, and for Option 11, Policy 7.5 as well. Childrens Bay is a contact recreational water quality area, even if water quality is treated at a level that does not cause unacceptable health risks, perceived health risks will still need to be managed. There are affected or interested party risks associated with public relations and loss of confidence in CCC's proposal. Affected persons objecting to the proposal, may cause greater delays due to responding to challenges. Coastal assessments will need to be undertaken to determine whether the discharges would contravene or align with Policy 11 of the NZCPS. The application may have difficulty in meeting the tests of s.107 of the RMA but could be proven to be an exceptional circumstance or of a temporary nature under s.107(2) RMA.	Orange
Option 3- OCR Wetland via a new land passage system to Childrens Bay	More consents may be required for this option with a greater detail of technical assessments required prior to lodgement. Even though wastewater will be fully treated and highly diluted, if the activity is considered by tāngata whenua to cause significant adverse effects on cultural values, the activity could be contrary to Policy 7.7, and for Option 11, Policy 7.5 as well. Children's Bay is a contact recreational water quality area, even if water quality is treated at a level that does not cause unacceptable health risks, perceived health risks will still need to be managed. There are affected or interested party risks associated with public relations and loss of confidence in CCC's	Orange

Table 21: Consenting Considerations

Option	Consenting Considerations	Score
	proposal. Affected persons objecting to the proposal, may cause greater delays due to responding to challenges. Coastal assessments will need to be undertaken to determine whether the discharges would contravene or align with Policy 11 of the NZCPS. The application may have difficulty in meeting the tests of s.107 of the RMA but could be proven to be an exceptional circumstance or of a temporary nature under s.107(2) RMA.	
Option 4- OCR Wetland to Existing Duvauchelle Outfall	Even though wastewater will be fully treated and highly diluted, if the activity is considered by tāngata whenua to cause significant adverse effects on cultural values, the activity could be contrary to Policy 7.7, and for Option 11, Policy 7.5 as well. There are affected or interested party risks associated with public relations and loss of confidence in CCC's proposal. Affected persons objecting to the proposal, may cause greater delays due to responding to challenges. Additional coastal assessments may need to be undertaken to determine whether the discharges would contravene or align with Policy 11 of the NZCPS. The application may have difficulty in meeting the tests of s.107 of the RMA but could be proven to be an exceptional circumstance or of a temporary nature under s.107(2) RMA.	Orange

4.10 Resilience

"Resilience" with regards to infrastructure is defined as the capacity of infrastructure, communities, and their related systems to mitigate, adapt, or positively respond to chronic and acute stresses, transforming in ways that restore, maintain and even improve their essential functions.

Stresses may include climate change impacts, natural disasters, and load fluctuations in treated wastewater volumes.

For this assessment, climate change impacts are considered in Section 4.6 and therefore have not been the focus of the resilience considerations for each option. General long-term performance and tolerance to natural disasters have been considered.

4.10.1 Long term performance

- Load fluctuations – Infrastructure will need to be tolerant to significant fluctuations in loads. This should be accounted for in detailed design and, for the purposes of this assessment, only repairs following extreme effects have been considered. The Option 4 outfall infrastructure may not be able to tolerate fluctuations in loads.
- Geotechnical stability – Long term degradation or behaviour of underlying loess or sea floor is a potential risk for all options.
- Maintenance:
  - Significant increased maintenance from the existing proposal is expected for Option 3 and the land passage system.
  - Option 4 will also have increased specialised maintenance for an aging asset under water. Flushing of the pipeline, or inspection for blockages, will be required regularly to ensure unpredictable exceedances can be serviced by the infrastructure.
  - Other options are expected to have minor increased maintenance.
- Capacity – Infrastructure requires sufficient capacity to discharge the varying exceedances volumes. Option 4 is unlikely to have sufficient capacity for all modelled exceedances events.
- Useable Life – All options are proposed to utilise new infrastructure proposed as part of the ATWIS and therefore will have longer useable life. The exception is Option 4, where understanding of the structural integrity of the existing outfall is important to estimate the remaining useable life of the uPVC pipe.

4.10.2 Natural disasters

- Earthquakes - There are no natural fault lines recorded in Banks Peninsula[71], however all sites are exposed to potential seismic activity.
- Extreme storm events – All sites are exposed to possible extreme weather events including high wind and rainfall.
- Storm surge – Hammond Point cliffs are exposed to storm surge from waves; however, the irrigation areas are likely set back such that this would not affect the irrigation. Any outlets in Childrens Bay or Duvauchelle harbour will also be exposed to tidal storm surges, however the sea wall will provide some protection.

[71] GNS Science. (2024). New Zealand Active Fault Datasets. Retrieved from https://data.gns.cri.nz/af/index.html

- Fire – Hammond Point, being planted in kanuka with driplines underneath, may be most subject to fire damage. Wetland and land passage options have lower fire risk.

4.10.3 Summary

A summary of key resilience considerations which differ for each option is given in Table 23.

Table 22: Resilience Considerations

Option	Resilience Considerations	Score
Option 1 – Hammond Point	Resilience of this option with time may be low. This is due to the expected behaviour of the onsite loess. Saturated and loaded loess is liable to collapse and slumping which may result in damage to irrigation infrastructure. This option has higher risk of fire damage due to being amongst established kanuka, and will have some seismic risk, however no greater than the existing proposed design.	Red
Option 2 – OCR wetland to Childrens Bay	This option may be subject to damage during seismic or storm events. Resilience of this option with time is likely to be higher than Options 1 and 3.	Green
Option 3 – Land passage to Childrens Bay	This option may be subject to significant damage during seismic or storm events. Resilience of this option with time may be low. This is due to the expected behaviour of the onsite loess. Highly loaded loess on slopes is liable to collapse and slumping which may result in damage to the infrastructure.	Orange
Option 4- OCR wetland to existing Duvauchelle outfall	The existing uPVC pipeline has been designed for Duvauchelle WWTP populations and not the projected exceedances. The outfall is unlikely to have sufficient capacity for all modelled exceedances events and infrastructure may not be able to tolerate fluctuations in loads. This option may be subject to deterioration as the current state of infrastructure performance is unknown. Blockages from sediment build up and	Orange

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Table 22: Resilience Considerations

Option	Resilience Considerations	Score
	marine species (mollusc) may decrease the capacity of the pipe to convey required exceedance volumes. Regular maintenance is required to ensure the exceedances can be serviced and is anticipated to be more challenging that other options. This option may be subject to damage during seismic events. Any additional infrastructure on the Duvauchelle TPS site would need to be placed away from the surrounding rock fall hazard as far as practicable. Resilience of this option is low.	

4.11 Intergenerational Equity

The basic concept of intergenerational equity is that all generations are partners caring for and using the Earth. Every generation needs to pass the Earth and our natural and cultural resources on in at least as good condition as we received them. This leads to three principles of intergenerational equity: options, quality, and access. The first, comparable options, means conserving the diversity of the natural resource base so that future generations can use it to satisfy their own values. The second principle, comparable quality, means ensuring the quality of the environment on balance is comparable between generations. The third one, comparable access, means non-discriminatory access among generations to the Earth and its resources.

4.11.1 Summary

Intergenerational equity was raised as of importance to Ōnuku rūnanga during the long-list options workshop and has been commented on at high level for each option in Table 24.

During discussion about intergenerational equity at the short-list options workshop, Ōnuku rūnanga indicated that it was important to consider the fact that the OCR wetland treatment gave opportunity for harvesting of treated wastewater for reuse, particularly as access to freshwater is likely to become more difficult with time. This opportunity is present for all options as they all incorporate use of the OCR wetland. It was also noted that there may be a future need for storage downstream of the wetland to maximise the potential for treated wastewater reuse.

Table 23: Intergenerational Equity Considerations

Option	Intergenerational Equity Considerations	Score
Option 1 – Increased irrigation at Hammond Point	Potential MoH concerns with over irrigation or damage to ground due to tunnelling and excess moisture on Hammond Point could cut off access for future generations to school planting area (conservation project) and raise considerations for those accessing baches. Kanuka will increase birdlife and biodiversity in area.	Red
Option 2- OCR Wetland to Childrens Bay	Outlet protected by seawall to provide more resilient solution less subject to erosion for next generation (saving costs of replacement) Converted sheep paddock to proposed wetland will result in enhanced planted wetland area for nearby birdlife to use and public to enjoy. Costs to future generations may be implemented should the outfall and infrastructure be placed in flood zone.	Green
Option 3- OCR Wetland via a new land passage system to Childrens Bay	Exacerbating flooding or landslide risk to access Akaroa via main highway (thoroughfare) in the future There could be future cost to protect the land passage from erosion, in order to maintain and upkeep it in the future. Costs to future generations may be implemented should the outfall and infrastructure be placed in flood zone. Temporary loss of established trees and birdlife in the immediate area due to removal for channel construction. May result in temporary reduced amenity values for public with estimated future gains once re-established and improved.	Orange
Option 4- OCR Wetland to Existing Duvauchelle Outfall	Using existing infrastructure may conserve the diversity of the natural resource base by avoiding additional construction for alternative option, or the impact of disposal, or redundancy, of the disused existing infrastructure. However, the existing outfall was designed for a different hydraulic service demand and may not have capacity to discharge the exceedance flows expected.	Orange

Table 23: Intergenerational Equity Considerations		
Option	**Intergenerational Equity Considerations**	**Score**
	Use of existing outfall infrastructure avoids disturbance of marine ecosystems, excluding scour and sedimentation. The quality of the existing outfall pipe infrastructure has not been determined. There may be structural limitations to existing pipeline material, deteriorations and/or leaks. The resultant estimated life cycle of the existing outfall pipeline is estimated to be 65 years, assuming PVC lasts 100 years and was installed in approximately 1988. Using existing infrastructure, avoiding construction that may interfere with existing infrastructure, improves access, compared to other options considered.	

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4.12 Timeliness

4.12.1 Consenting timelines

The actual timeframes for consent application lodgement will depend on any additional environmental monitoring or investigations which may be required for the preferred option, and time taken to prepare the corresponding technical assessments to support the application. Consultation, strategies and written approvals may also affect timeframes.

Below are some indicative timeframes for different options:

4.12.1.1 Hammond Point

Indicative timeframes for consenting a discharge to Hammond Point are as follows:

- CCC review final options assessment report & SoW for consent application – 1 month (November)
- Land based discharge consent application prepared – 5 months (November – March 2025)
- Iwi consultation only prior to lodgement – no extra time as it is assumed Ōnuku rūnanga will participate in selecting the best practicable option with CCC at the short-list workshop.

For Hammond Point there is a consent risk that coastal assessments may be required and delay these timeframes should the large amounts of overland flow be modelled to runoff to the coast and potentially effect the coastal environment. This may require further investigation.

4.12.1.2 Childrens Bay

Indicative timeframes for consenting a discharge to Children's Bay are as follows:

- CCC review final options assessment report & SoW for consent application – 1 month (November)
- Coastal discharge consent application prepared – 6 months (November – May 2025) (potential additional monitoring required which must be undertaken over Summer)
- Public consultation prior to lodgement – 9 months following conclusion of technical assessments (May - February 2026) (should CCC choose to undertake upfront consultation for the option chosen)

4.12.1.3 Duvauchelle Outfall

Indicative timeframes for consenting a discharge via the Duvauchelle outfall are as follows:

- CCC review final options assessment report & SoW for consent application – 1 month (November)
- Coastal discharge consent application prepared – 6 months (November – May 2025) (potential additional monitoring required which must be undertaken over Summer)
- Public consultation prior to lodgement – 9 months following conclusion of technical assessments (May - February 2026) (should CCC choose to undertake upfront consultation for the option chosen)

4.12.2 Goods and services

Additional materials and services have potential to delay implementation of the options and wider project timelines.

- Option 1 - As this option is assumed to only require upgraded PE100 pipe sizes for the take-off to Hammond Point, no additional delays are foreseen on project timelines to source and install these pipes to implement this option.
- Option 2 - As this option is assumed to only require upgraded PE100 pipe sizes for conveyance to the Akaroa TPS and outfall, no additional delays are foreseen on project timelines to source and install these pipes to implement this option.

- Option 3 - As this option will require significant further design, preparation and clearance of the land areas, cut and fill, and materials such rocks and lining materials. Implementation of this option is likely to cause wider project delays.
- Option 4 - As this option is assumed to only require upgraded PE100 pipe sizes for conveyance through the ATWIS, as well a small tank design, minimal additional delays are foreseen on project timelines to source and install these materials to implement this option.

4.12.3 Seasonal considerations

Seasonal restrictions have potential to delay projects should there be restrictions on when construction can be undertaken.

- Option 1 - Seasonal considerations for installation are assumed to be the same as the existing proposed design.
- Option 2 - Seasonal considerations for installation are assumed to be the same as the existing proposed design.
- Option 3 - This option is assumed to require installation to be staged and scheduled over summer periods to reduce installation occurring during rainfall periods.
- Option 4 - Seasonal considerations for installation are assumed to be the same as the existing proposed design.

4.12.4 Summary

The timeliness of each option is summarised in Table 25.

During discussion at the short-list options workshop, CCC indicated that all indicative timeframes were within acceptable project forecasts, so all options were categorised as ‘green’.

Table 24: Timeliness Considerations

Option	Timeliness Considerations	Score
Option 1 – Increased irrigation at Hammond Point	It is expected as a conservative estimate that a land discharge consent may be able to be lodged in 5 months dependent on modelling outcomes for the overland flow. Coastal assessments may be required which could delay consent lodgement. Implementation for construction purposes is unlikely to delay the existing schedule in any material way.	Green
Option 2- OCR Wetland to Childrens Bay	A conservative timeframe for a coastal consent is lodgement by February 2026 which accounts for coastal assessments and public consultation regarding the Children's Bay area. Implementation for construction purposes is unlikely to delay the existing schedule in any material way.	Green
Option 3- OCR Wetland via a new land passage system to Childrens Bay	A conservative timeframe for a coastal consent is lodgement by February 2026 which accounts for coastal assessments and public consultation regarding the Children's Bay area. Implementation for construction purposes likely to take additional time. Higher level of technical assessments required.	Green
Option 4- OCR Wetland to Existing Duvauchelle Outfall	A conservative timeframe for a coastal consent is lodgement by February 2026 which accounts for coastal assessments and public consultation regarding the Children's Bay area. Implementation for construction purposes likely to take a small amount of additional time. Higher level of technical assessments required.	Green

5.0 Cost Comparison

A rough order of cost (ROC) estimate for each option has been undertaken to allow for a financial comparison. These cost estimates are a pre-concept level estimate in the range of +/-40%.

Indicative capital cost estimates have been developed for the shortlisted options as detailed in Section 3.0. PDP understands that these cost estimates will be refined as part of the next stage of this project. All costs included in this report are exclusive of GST. These rough order cost estimates include CAPEX but excludes OPEX at this stage until further design is undertaken. Consenting costs have been excluded from these estimates however are common to all options.

Where available PDP has used costs from the 'Akaroa Wastewater Treatment Upgrade - Concept Estimate Whole Scheme High Level Summary'[72] with allowances for inflation to provide comparable cost estimates. The cost estimates only consider the cost differences to the present proposed ATWIS design for additional infrastructure required to implement each option. These estimates accounted for the following:

- Option 1 - The costs associated with upgraded pipe sizes from the Hammond Point take off to the Hammond Point irrigation network has been estimated to account for conveyance of larger volumes to driplines. The dripline infrastructure is expected to stay the same as presently proposed. Increased pump capacity is not included as pump sizes from the WWTP are not expected to increase and volumes are the same as if the treated wastewater were being pumped to the ATWIS.
- Option 2 - The costs associated with upgraded purple pipe size from the wetland to the Akaroa TPS as well as outfall valves and connections have been estimated to account for conveyance to an outfall during high tides.
- Option 3 - The costs associated with additional infrastructure for the constructed land passage, including additional pipeline, bulk earthworks, rock materials, lining, and the outlet have been estimated. Gravity flow is considered sufficient to convey the treated wastewater and therefore no additional pumping is expected.
- Option 4 - The costs associated with upgraded main size from the Robinsons Bay storage offtake to the Duvauchelle TPS as well as outfall valves, purge tank, and connections have been estimated. For costing purposes, the upper flow rate of 20 L/s has been used to provide capacity for these flows.

Costs are shown for each option in Appendix B and summarised in Table 26.

Table 25: Summary of rough order of cost (ROC) estimate for each option

Options	Cost (excluding GST)
Option 1 – Increased irrigation at Hammond Point	$72,500
Option 2- OCR Wetland to Childrens Bay	$266,250
Option 3- OCR Wetland via a new land passage system to Childrens Bay	$1,510,600
Option 4- OCR Wetland to Existing Duvauchelle Outfall	$587,500

[72] Beca Limited . (2020). Akaroa Wastewater Treatment Upgrade - Concept Estimate Whole Scheme High Level Summary . Christchurch: Beca.

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Option 1 for Hammond Point is the most cost-effective option as it utilises a lot of infrastructure already proposed as part of the ATWIS with some short sections of pipe upsizing. Option 2 is also relatively cost effective to implement however slightly more expensive than Option 1 due to longer lengths of pipe requiring upsizing.

Option 3 will have significant additional associated costs to implement and may vary significantly depending on the final technical design of the land passage system.

Option 4 is relatively expensive to implement given it is unlikely to provide capacity for higher exceedance event volumes.

Combining TLA outcomes and costs was considered during the workshop, but it was agreed that the cost assessment should take a more informative approach for the purposes of the overall assessment, and that the outcomes of the TLA would be sufficient to select a BPO.

6.0 Short-List Options Workshop

A short-list options workshop was held with CCC and Ōnuku rūnanga on 15 October 2024 to discuss the outcomes of the short list assessment and select an option for progression to consent application.

At the start of the TLA discussion, Ōnuku rūnanga indicated that they felt a hybrid approach of more than one of the options would be the best complete solution for management of the storage exceedance discharges. As discussion progressed, various possible variations of the defined options were also raised.

These included:

- Inclusion of multiple discharge locations to allow inclusion of discharge locations which do not have sufficient capacity (such as the Duvauchelle outfall and increased irrigation rate options). It was acknowledged that this option would significantly increase consenting complexity and that applying to consent a single discharge point would be a simpler and hopefully more straightforward process.
- Replacement of the Duvauchelle outfall pipe for Option 4. Standard installation would require sea floor disturbance which would likely impact the nearby sea grass, but it was agreed that short-term disturbance may be viewed as preferable to potential longer-term effects of discharge closer to the sea grass. The potential for pipe bursting (provided the existing pipe is PE which would need to be verified) was also raised but this was viewed as a very high-risk option which would also incur significantly high costs. The challenge of maintaining a long ocean outfall for only intermittent use was also discussed as there would be an increased risk of blockages which may be challenging to avoid even

with regular maintenance. Due to the cultural preference of keeping the discharge location away from Ōnawe, and the significant technical and operational challenges associated with installing a new outfall pipe and then maintaining it for only very occasional use, the Childrens Bay outfall location was seen as preferable during the workshop.

Ōnuku rūnanga indicated that their understanding of Option 1 (increased irrigation at Hammond Point) had always been that it would just be a slight increase in irrigation rates and not a discharge of entire exceedances onto already saturated ground. It was confirmed that, due to the conditions associated with storage exceedance discharges, soils would likely already be saturated when discharges occurred so the majority of discharges would be likely to create runoff rather than infiltrate the ground. The risks associated with causing runoff that would eventually end up on the beaches (which are public space) was also acknowledged.

There was agreement at the workshop that it would be preferable not to divert storage exceedance discharges from the wetland outlet back through the WWTP for filtration and disinfection prior to discharge. It was also acknowledged that this may result in certain water quality parameters being increased as a result of the natural processes in the wetland and that this could be addressed by agreement of appropriate compliance testing location(s) and regimes during the consenting process. Of particular note was the fact that the wetland outflow was still likely to display better water quality characteristics than that of surrounding streams. The possibility of using water quality of nearby streams as a benchmark was suggested and viewed favourably by Ōnuku rūnanga.

Due to the inclusion of an open channel in the Option 3 design, it was acknowledged that there would likely be small discharges of stormwater from the outfall pipe following rainfall. It is possible that, if the system is not fully understood, this could be perceived negatively by members of the public due to the association of the outfall with treated wastewater and the higher frequency of rainfall events that would probably cause a small stormwater discharge.

The risk of rock fall at the Duvauchelle TPS site was identified during the desktop assessment for Option 4 due to the requirement for a purge tank to be installed at the site. CCC advised that there should be sufficient space on the site to avoid this risk and allow for construction of both the new Duvauchelle TPS and the Option 4 purge tank.

The feedback on options from Ōnuku rūnanga was that none of the options provide an ideal solution as they all result in an eventual discharge to the harbour. Ōnuku rūnanga also emphasised the importance for all options to have a clear understanding of the efficiency and likely treatment performance of the wetland; both from a chemical and land contact perspective. Of particular interest was the likely treatment available for emerging contaminants. Due to the current stage of design for the wetland, it would be challenging to try and define the performance further than has been done in this report. However, it is understood that current detailed design and optimisation of the OCR wetland is under way in consultation with Ōnuku, so a clearer picture of what can be achieved should be available following this process. It was also noted that wetlands could be optimised for treatment of current flows with future provision for additional wetland cells or similar treatment or storage stages.

Various discussions were had about the anticipated I&I reductions in the wastewater network and the factors that had been applied to the flow series resulting in the inputs to the latest version of the model. It was agreed that a good approach would be to re-run the technical assessment calculations using a flow series more indicative of current population and climate to allow a comparison with the adjusted flow series which has been used for design and adopts a more conservative approach.

Workshop discussions concluded with an agreement that Option 1 and Option 4 should not be progressed further, and that a version of Option 2 or Option 3, potentially with increased wetland area or storage, should be developed as the BPO. It was agreed that the extent of the land passage / additional treatment required downstream of the OCR wetland would be dependent upon confirmation of the treatment efficiency predicted for the optimised OCR wetland design following the detailed design process.

7.0 Traffic Light Assessment

A TLA for each option was undertaken to supply a relative comparison of the assessed options. It was agreed at the long-list options workshop that weightings for importance of each criterion would not be used for the TLA. Contributing factors for all options and criteria are detailed in Section 4.0. Scoring for each option was completed collaboratively during the short-list options workshop.

Table 27 summarises the comparative scores for each option based on the TLA.

Table 26: Summary of the Traffic Light Assessment (non-cost)

	Option			
Criteria	1	2	3	4
Environmental	R	O	O	G
Technical	R	G	O	R
Social	R	O	O	O

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Table 26: Summary of the Traffic Light Assessment (non-cost)

Criteria	Option 1	Option 2	Option 3	Option 4
Climate Change Adaptation	O	O	O	G
Climate Change Mitigation[a]				
Cultural	R	O	O	R[b]
Legal/consenting	R	O	O	O
Resilience	R	G	O	O
Intergenerational Equity	R	G	O	O
Timeliness	G	G	G	G
Outcome				
Sum Green	1	4	1	3
Sum Orange	1	5	8	4
Sum Red	7	0	0	2
Progression?	*No*	*Potential optimised option, further development required*		*No*

Notes:

a) *Climate change mitigation was discussed at the workshop, and it was agreed that there was too much uncertainty around the implementation approach and holistic effects of each option to confidently assign scores at this stage of development.*

b) *It was indicated by Ōnuku rūnanga at the workshop that this score could be adjusted to Orange provided that proof could be given that pre-treatment was sufficient to restore mauri of the treated wastewater prior to discharge.*

As described in Section 6.0, it was agreed at the conclusion of the short-list options workshop that an optimised version of Option 2 or Option 3 should be developed as the BPO.

8.0 Conclusion

The short list options assessment and TLA concluded with an agreement that Option 1 and Option 4 should not be developed further, and that the best option to carry forward would be an optimised version of Option 2 or Option 3. This option will include treatment of storage exceedance discharges at the OCR wetland, possibly followed by some additional land passage treatment if required

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to provide assurance of sufficient transformation of the treated wastewater, with ultimate discharge to the harbour via an outfall located at the boat park seawall at Childrens Bay.

The extent of any additional constructed land passage and / or land contact processes required for inclusion will be determined after optimisation of the OCR wetland has been completed and the extent of treatment achievable within that wetland is fully defined. The workshop group agreed that it would be preferable to focus resources on optimising the proposed wetland when viable as opposed to creating additional standalone infrastructure for occasional storage exceedance discharges which would have associated maintenance requirements and costs above those of the wetland.

9.0 Recommendations

9.1 Further Work

The following work is recommended to provide supplementary information for consenting and future design decisions for the hybrid option selected as the BPO:

- Replication of the modelled storage exceedance discharges using base flows (a flow series more indicative of current operations rather than future projections) to provide comparison with the model outputs for the more conservative design flow series;
- A wetland performance assessment (with base flows) following on from the modelling work above; and
- Possible development of a staged wetland development process that aligns with needs and optimises costs if the wetland performance following optimisation and detailed design is not considered sufficiently fit for purpose.

9.2 Technical Assessment Required

For support of a consent application, PDP recommends the following further assessments are undertaken:

- Coastal assessment of effects to Childrens Bay.
- For options including constructed land passage:
  - Detailed geotechnical assessments and design input;
  - Cultural Impact Assessment of the proposed land passage construction area; and
  - Archaeological assessment of the proposed land passage construction area.