Discharge to Land of Takapau Wastewater Assessment of Environmental Effects: Land (LEI, 2021:T:D.10)

Prepared for

Central Hawkes Bay District Council

Prepared by

Lowe Environmental Impact

April 2021

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Ref: TD.10-RE-10690-CHBDC-LandAEE-SM

Job No.: 10690

Date: April 2021

Revision Status			
Version	Date	Author	What Changed and Why
2	26/04/21	SM	Final
1	19/04/21	SM	Client draft

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1 EXECUTIVE SUMMARY

Central Hawkes Bay District Council (CHBDC) is responsible for the management of wastewater from the township of Takapau. Currently, wastewater is reticulated around 1.5 km from the township to a single pond oxidation system on Burnside Road. CHBDC holds resource consent DP180115W for the discharge of the treated wastewater from the Takapau WWTP (TWWTP) to a wetland and subsequently to the Makaretu River. Resource Consent DP180115W will expire on the 31st of October 2021.

Through the previous consenting process and consultation that has occurred, the preferred option identified by the community, iwi and CHBDC for future wastewater discharge from the TWWP is a land based discharge system. CHBDC, with assistance from Lowe Environmental Impact (LEI), has identified suitable land for a low rate wastewater application system, undertaken investigations and determined a suitable discharge and storage regime.

This report describes previous reporting, including description of the proposed discharge system and provides an assessment of the effects of the proposed activity from three activities being:

- Discharge to land of treated wastewater for land treatment;
- Land use intensification due to irrigation of farmland; and
- Discharge to air from the WWTP and land discharge of treated wastewater.

Effects to groundwater, surface water, cultural, habitat, recreation and amenity values are described elsewhere. The proposed discharge area is located across two properties north of Takapau and adjacent to the TWWP.

The development of the discharge system for Takapau's wastewater is proposed to be staged. This allows for a rapid reduction in the amount of treated wastewater discharged via the current discharge system to the Makaretu River, while managing the costs to the Council and the time for procurement and construction to occur. Key parameters for each of these stages for which effects are assessed are summarised in Table 1.1 below.

Table 1.1: Discharge and Management Summary

Parameter	Current (Stage 0)	Stage 1	Stage 2
Storage volume (m^3)	None	2,000	18,000
Average annual outflow from TWWTP (m^3)	~60,000	~60,000	~93,000
High Rate Land Passage			
HRLP Maximum application rate per event (m^3)	750	200	200
HRLP Volume per year (m^3)	~60,000	~20,900	~8,600
HRLP N mass loading from wastewater (kg/y)	857	316	130
HRLP P mass loading from wastewater (kg/y)	221	81	33
Irrigation			
Irrigation regime	Nil	Deferred, non-deficit	Deferred, non-deficit
Landform	Nil	Lower terrace	Upper and lower terraces

Parameter	Current (Stage 0)	Stage 1	Stage 2
Total area – including non irrigated (ha)	42.4	42.4	42.4
Wastewater irrigated area (ha)	0	5	20
Irrigation event application (mm/event)	0	up to 20	up to 20
Average annual irrigation volume (m^3/y)	0	36,300	83,500
Average annual application depth (mm)	0	480	360
Wastewater Nitrogen load (kg N/ha/y)	0	140	84
Wastewater Phosphorus load (kg P/ha/y)[3]	0	60	34
Upper Terrace			
Farm Management current/proposed	Rotational cropping, cut and carry	Rotational cropping, cut and carry	Rotational cropping, cut and carry
Vegetation current/proposed	Cropping (e.g. barley, peas oats, turnips, ryegrass)	Cropping (e.g. barley, oats, ryegrass)	Cropping (e.g. barley, oats, ryegrass)
Lower Terrace			
Farm Management current/proposed	Low intensity grazing	Low intensity grazing	Low intensity grazing
Vegetation current/proposed	Ryegrass pasture	Ryegrass pasture	Ryegrass pasture

Wastewater irrigation is expected to increase the drainage from the Site by 190 % and 250 % at Stages 1 and 2 respectively. Table 1.2 gives a nutrient loss summary for Stages 0 to 2 for the combined wastewater irrigation and farming activity i.e. with fertiliser application and cultivation effects.

Table 1.2: Nutrient Loss Summary

	HRLP / Wetland		Farm		Totals	
	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)
Current (Stage 0)	857	221	2,097	10	2,954	231
Stage 1	316	81	2,530	20	2,846	101
Stage 2	130	33	2,530	20	2,660	53

The effects of the proposed land application regime have been assessed based on the potential loading of nutrients, contaminants and water received for an average year. In addition to the irrigated land, there is expected to be a continued discharge to the Makaretu River from the WWTP when land cannot receive wastewater and storage is at capacity. It is concluded that:

The activities that may produce actual or potential effects on the environment that need to be considered relate to:

- Discharge to land of treated wastewater for land treatment;
- Land use intensification due to irrigation of farmland; and
- Discharge to air from the WWTP and land discharge of treated wastewater.

The treated wastewater to be irrigated onto the land application site will have the following properties of potential environmental concern:

- Organic material, expressed as carbonaceous biochemical oxygen demand ($CBOD_5$);
- Cations (Sodium, potassium, calcium and magnesium);
- Nitrogen (N as ammoniacal nitrogen (NH_4-N) and nitrite/nitrate nitrogen (NO_x-N));
- Total phosphorus (TP); and
- Water.

This report assesses the effects of the wastewater discharge to the soil and plant system, and to air. Effects from the discharge to land of wastewater on other environments are assessed in other technical reports which form part of the consent application bundle of documents.

The use of discharge to land is a key mitigation measure for the avoidance of direct discharge of wastewater into surface water bodies. In addition, the application of wastewater to land at a rate which allows for filtration, absorption and beneficial use of wastewater components (nutrients, contaminants and water) provides mitigation and avoidance of adverse effects to groundwater. The adoption of an irrigation method with a low application rate as proposed by the assessed discharge regime achieves the beneficial use (for plants and soil biota) and retention (by soil storage) of wastewater components, thereby minimising their release into the groundwater or surface water environment.

The methods that have been adopted to avoid adverse effects to soils of the Site are:

- The selection of a site whose soils are dominated by gravelly subsoils (lower terrace) and free draining Allophanic soils (upper terrace);
- Application rates per event which are more than 3 times less than the soil unsaturated hydraulic conductivity when applications are at the maximum proposed 20 mm per event;
- Managing stock and cropping activities to enable with holding periods before and after irrigation to avoid soil damage and maintain adequate vegetative cover; and
- Withholding of irrigation when rainfall or prolonged wetness occurs.

The mitigation methods to avoid adverse effects to air quality due to discharges from the irrigation of wastewater are:

- Maintain aerobic conditions in the treatment and storage ponds
- UV treatment of wastewater to reduce pathogen levels;
- Adoption of separation distances, being:
  - 20 m from property boundaries;
  - 150 m from the nearest residential buildings, public place and amenity area where people congregate, or education facility;
  - 50 m separation distance from the sites of cultural significance known to exist at the time of developing the concept design;
  - 50 m from rare habitats, threatened habitats or at-risk habitats; and
  - 20m from surface water including the Makaretu River.
- The irrigation Site is located in a down-wind position from the township based on the predominant wind directions;
- The selection of an irrigation system (system pressure and nozzle size) to produce droplets greater than 200 μm in size to limit spray drift; and
- Automatic shut-down of irrigation when wind speed reaches an average of 4 m/s in the direction of dwellings within 300 m of the irrigation wetted radius (noting that the

wetted radius can be shortened), and shut-down of irrigation when wind speed reaches an average of 12 m/s in any direction

In summary, there will be no effects to the soil and landform that are not capable of satisfactory avoidance, remediation, or mitigation. The individual effects concluded from the assessments completed are all less than minor for land and air.

2 INTRODUCTION

2.1 Purpose

The purpose of this report is to provide an assessment of the effects to the environment from four activities being:

- Discharge to land of treated wastewater for land treatment;
- Land use intensification due to irrigation of farmland; and
- Discharge to air from the WWTP and irrigation of treated wastewater.

2.2 Background

Central Hawke's Bay District Council (CHBDC) is responsible for the management of Takapau's wastewater. The treated wastewater is currently discharged via a drain wetland into the Makaretu River, north of the Takapau township. This consent was granted on the 10th of December 2018 and is scheduled to expire on the 31st of October 2021.

Complete removal of the direct discharge of wastewater to the Makaretu River is the expressed preference of parties consulted prior to the new discharge concept being prepared (as explained in LEI, 2021:T:C.15). An extensive process has been undertaken to develop a conceptual design for consenting, which amongst other things, takes into account a number of technical investigations. CHBDC have engaged LEI to provide this assessment of the effects to land of the discharge of wastewater onto land.

2.3 Scope

This report provides an assessment of the environmental effects of the discharge of treated wastewater from the Takapau WWTP.

The report covers:

- Section 3 outlines the receiving environment for the discharge;
- Section 4 describes the proposed activity;
- Section 5 outlines an assessment of the environmental effects; and
- Section 6 gives key conclusions of the report.

The assessment of effects is based on the conceptual design of the land treatment system. Detailed design will follow resource consenting, as changes may result during the consenting process. A separate report has been prepared to assess the effects to the river of the proposed activity (Beca, 2021:T:D.25). Consideration of effects to ecological, landscape, community, cultural and heritage values are assessed elsewhere.

3 RECEIVING ENVIRONMENT

3.1 General

Section 3 summarises the receiving environment for the proposed application area to receive wastewater from the Takapau WWTP.

3.2 Site Location and Description

The proposed application site, referred to as "the 'Site", is 1 km north of Takapau on the corner of SH2 and Burnside Road (Figure 3.1). Located west of the existing TWWTP, the Site includes two properties, totalling 42.4 ha, bounded to the south by SH2 and the north by the Makaretu River, a tributary of the Tukituki River. Figure 3.2 shows the cadastral boundaries of the proposed application Site. Table 3.1 provides details for the two land application properties, as well as the TWWTP parcel owned by CHBDC.

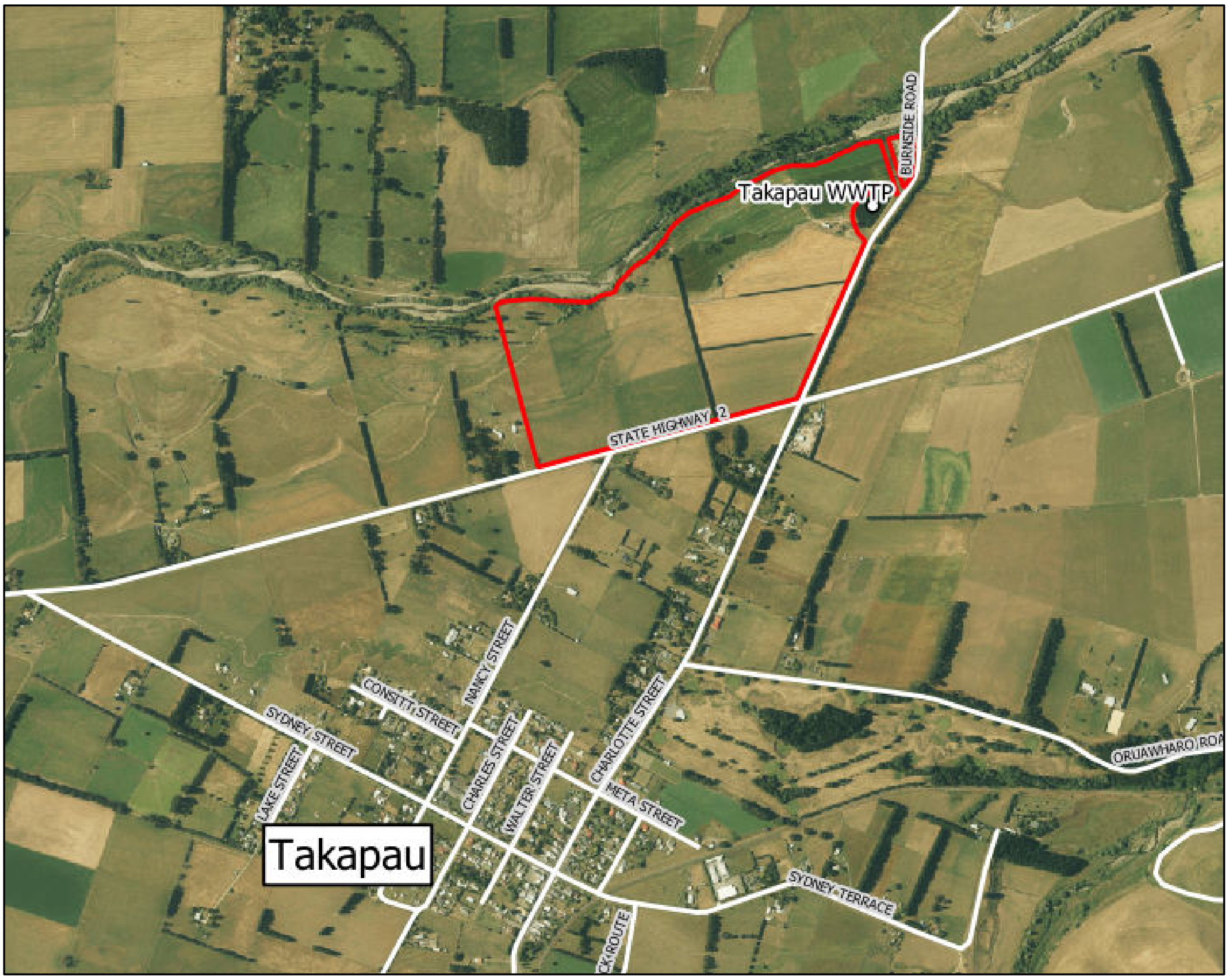

Figure 3.1: Proposed Land Application Site Location

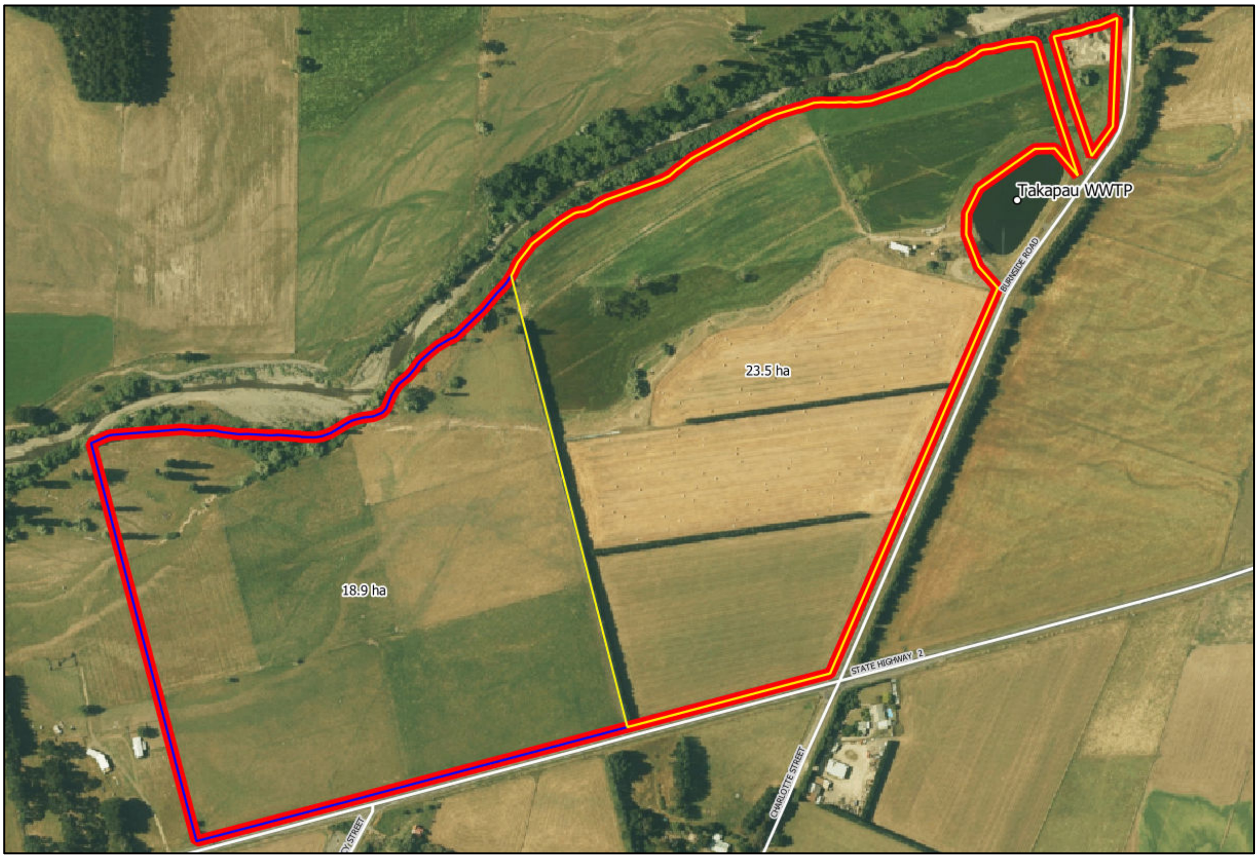

Figure 3.2: Land Application Site – Blue = 4292 SH2 block (Leased), Yellow = 45 Burnside block (Owned), Red = Proposed Application Site

Table 3.1: Site Location Details

Landowner	Malcolm and Doug Drummond	Mike Dalby	CHBDC (WWTP Site)
Managed	Drummond	Drummond Lease	CHBDC
Site Address	45 Burnside Road, Takapau	4292 State Highway 2, Takapau	53 Burnside Road, Takapau
Legal Description	PT LOT 1 DP 15623 BLKS II III TAKAPAU SD	LOT 1 DP 16445 LOT 1 DP 20596 LOTS 1 2 DP 313211	Lot 1 DP 17032
Certificate of Title	J3/1143 J3/1142	51946 51947	J3/1142
Map Reference	1886360 N, 5565330 E	1885963 N, 5565134 E	1886630 N, 5565537 E
Area (ha)	23.5	18.9	0.9

The total area available across the Site is 42.4 ha.

3.3 Land Use of Site and Adjacent Areas

3.3.1 Site Land Use

The existing land use over the Site is low intensity sheep and beef finishing, with rotational cropping of ryegrass, barley, oats and peas, primarily for export. From field investigations, there did not appear to be significant variation in pasture growth within and between paddocks, nor was there signs of limited plant growth or crop failure under the current management.

Across the Site, rotational cropping (including some pasture rotations) is commonly practiced on the elevated terrace paddocks. Pastoral grazing is dominant on stonier soils on the lower terrace adjacent to the river. Following recent site visits and correspondence with landowners, the maximum number of livestock over the past year across the Site was 30-40 1-2 year old steers.

3.3.2 Surrounding Land Use

The application site is surrounded in all directions by farmland of largely lower to moderate intensity sheep and beef finishing and rotational cropping. Within close proximity to the application area, the Drummonds own land on the northern side of the Makaretu River, north-east of the Site, and lease further land west of the proposed application area. Land operated by the Drummonds is shown in LEI (2021:T:B.13).

Land on the northern side of the Makaretu River, directly north of the leased land parcel is owned by Kintail Honey Limited. South of the application area, between the Site and the Takapau township are a series of lifestyle blocks. An extensive network of irrigators, in particular, centre pivot irrigators are located on landforms similar to those of the Site. These irrigators are visible all along SH2 across the Takapau Plains.

3.4 Topography, Landform and Geology

The application site expands across a series of four terraces formed by the Makaretu River. Of these terraces, two are distinctive; a lower terrace adjacent to the river extending across the owned parcel's northern extent, as well as a higher terrace dipping northwards, to which the remaining property overlies. Across this higher terrace, there appears to be three respective terraces with minor variations in elevation that can only be distinctively noticed through elevation imagery.

The variation in elevation between the lower terrace adjacent to the Makaretu, and the higher terrace, is in the order of 4-6 metres. Elevations across the site vary between 230-246 m.a.s.l.

The application site itself is the product of river deposits over the Holocene and Late Pleistocene periods. The lower terrace is described as containing Holocene aged, poorly consolidated alluvial gravels, sands and muds, with the remaining site classified as being poorly to moderately sorted gravels with minor sand and silt underlying the terraces, including minor fan deposits and loess (GNS, 2021).

Information relating to the topography, landform and geology of the site is provided within LEI (2020:T:B.15).

3.5 Description of Soils

From desktop investigations, the Site contains a combination of Land Use Capability (LUC) class 2 and 3 land, with the majority being class 3. 5.6 ha of class 2 land is restricted to a wedge extending across the northern extent of the leased parcel, parallel to the Makaretu River. The remaining 36.8 ha is class 3 land.

Following a combination of field and desktop investigations (LEI, 2020:T:B.15), a total of six soil types were identified across the Site. A description for each of these soil types is provided in Table 3.2 below. Figure 3.3 shows the distribution of soil types determined from field investigations.

Table 3.2: Drummond Farm Site Soil Types

Soil Type	Description
Poporangi – (Ruataniwha_7a.1)	These soils are classified as being poorly drained due an underlying pan at approximately 85-95 cm depth. Evidence for this pan is represented within soil hydraulic conductivity results. This moderately deep soil contains a brown silty topsoil texture with a moderate over slow permeability status. The observed soil resembles the Smap description aside from stone content. Smap notes the Ruataniwha Silt Loam as a stoneless soil, however on site, this soil contains a moderate presence of smaller rounded river gravels. Despite variation in stoniness, this soil is still considered to be the Ruataniwha Silt Loam.
Takapau (Tarar_6a.1)	These soils are moderately deep, well drained, silty textured soils. They contain a rapid permeability profile, however, lack the presence of stones. These brown type of soils are extensive across the Takapau Plains region and contain high P retention statuses.
Tikokino (Orono_83a.1)	This is a moderately deep, moderately well drained, silty loam textured soil residing on steeper slopes between higher and lower terraces. This soil lacks the gravels noticed within soils on the lower lying terrace.
Tikokino shallow (Mandamus_22a.1)	This soil and its sibling (Mandamus 25a.1) extends throughout much of the property, particularly towards the south/south-east. This soil contains a silty topsoil texture with a moderately well drained drainage status. As with previous soils, this too lacks a gravel component, with no clear presence of underlying pans. At the time of site investigations, this soil appeared to be drier than what would be expected and drier than surrounding soil types on the property.
Tikokino shallow & stony (Mandamus 25a.1)	This soil is very similar to its sibling described above. The only clear difference with this soil is the strong presence of river gravels ranging in size between 1-10 cm within the topsoil. This soil appears to extend throughout much of the centre of the leased parcel and within the western extent of the owned parcel on the higher terrace.
Tukituki shallow (Ashburton_38a.1)	These soils are located overlying the lower river terrace adjacent to the Makaretu River within the northern extent of the property. This soil contains a brown silty to sandy loam topsoil texture with a strong presence of rounded river gravels ranging between 1-10 cm. This soil appeared dry at the time of investigations with no clear presence of any underlying pans.

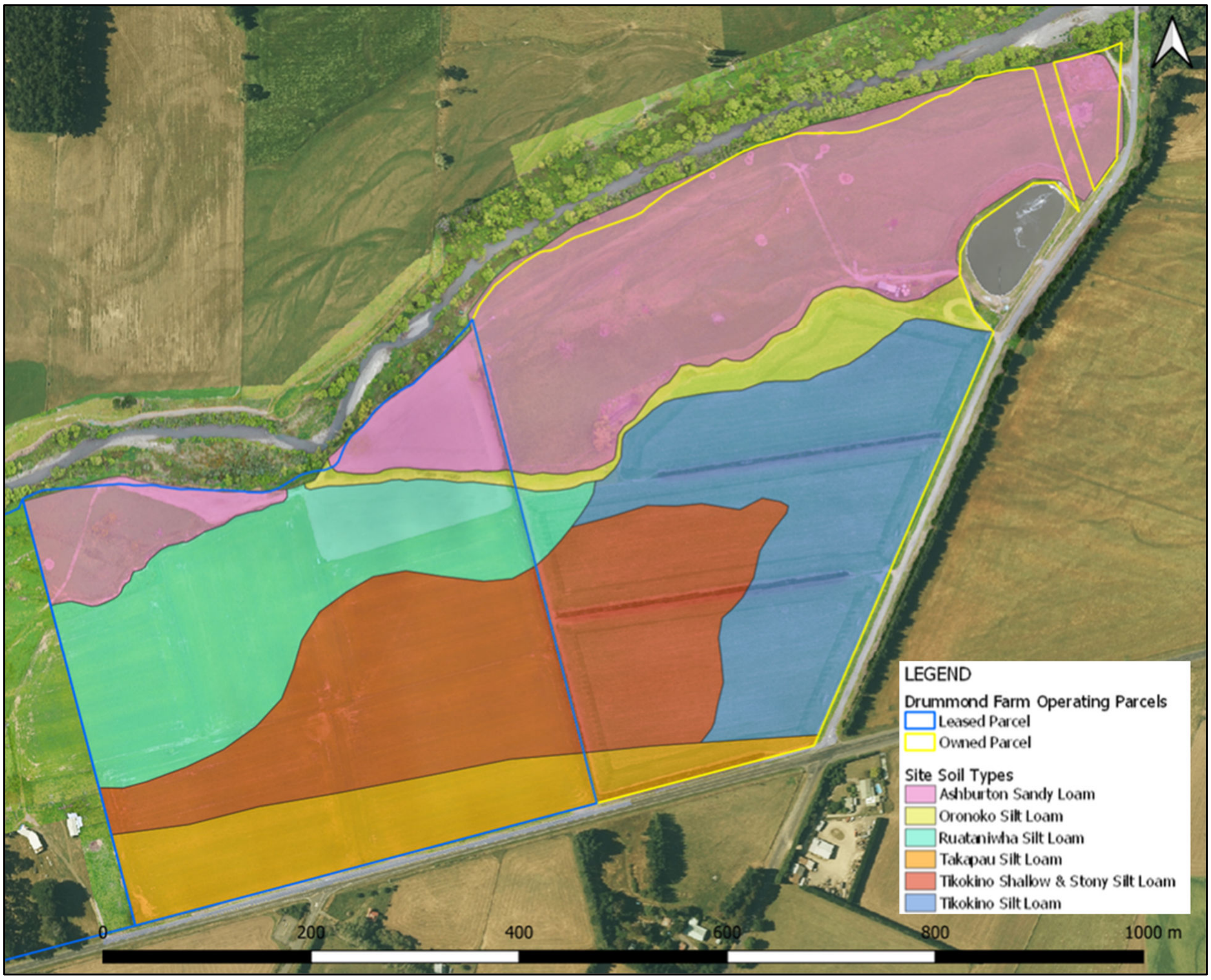

Figure 3.3: Drummond Farm Site Soil Map

3.6 Hydrology

The application site is located within the Makaretu River catchment, a sub-catchment of the Tukituki River.

3.6.1 Makaretu River

A detailed discussion of the hydrological setting of the adjacent Makaretu River is provided in Beca (2020:T:B.24).

Regular flow monitoring does not occur on the Makaretu River, however flow statistics given by Wilding & Waldron (2012) from the SH50 bridge site are shown in Table 3.3 .

Table 3.3: Makaretu River Flow Statistics (1987-2011, Wilding & Waldron, 2012)

Parameter	Flow (l/s)
Mean Annual Low Flow	340
Median	1,308
Mean Annual Flow	2,191

Table 3.4 summarises approximately 70 monthly water quality samples (2014-2020) retrieved from CHBDC from 50 m upstream of the TWWTP discharge point (Table taken from Beca, 2020:T:B.24). The Makaretu River is considered to be in a good state relative to the wider Tukituki River catchment zone and national bottom lines (Beca, 2020:T:B.24). Water quality

monitoring done by CHBDC upstream of the existing TWWTP discharge location demonstrated that the river has a phosphorus load (total and dissolved), typically above Plan Change 6 (PC6) and Australian and New Zealand Environmental Conservation Council (ANZECC) physical and chemical guidelines (Beca, 2020:T:B.24).

Table 3.4: Makaretu River Water Quality 50 m US of TWWTP Discharge (Beca, 2020:T:B.24)

Parameter	5%	Median	95%	Criteria	Trigger[2]
$cBOD_5$*	1	1	3		
Chemical Oxygen Demand *	7.5	7.5	17.0		
Total Ammoniacal N (mg/L)	0.01	0.01	0.02	0.03[5] / 0.05[5]/ 0.24[3]	
Nitrate (mg/L)	0.01	0.21	1.16	3.8(a) / 5.6(b)	
DIN (mg/L)*	0.01	0.07	0.32	0.8	
Total N (mg/L)*	0.04	0.16	0.39	0.281[2]	
Total P (mg/L)*	0.016	0.034	0.044	0.023[2]	
DRP (mg/L)	0.007	**0.017**	**0.031**	0.010	
TSS (mg/L)	2	3	182		
Faecal Coliforms (CFU/100 ml)	34	110	**600**	200[4]	
E.coli (CFU/100ml)*	22	140	**300**	261-550	>550[1]
Horizontal Visibility (Water clarity)	1.2	3.68	7.424	>3.0	
pH	7.3	7.7	8.0	7.27-7.8[2]	
Temperature	6.9	12.0	19.4	Sustain aquatic habitat	
Dissolved Oxygen (ppm)#	9.18	10.61	12.09	>80%	82-100
Conductivity (µS/cm)	6.4	9.3	11.5	86[2]	

Note: Orange highlight indicates the ANZECC chemical and physical stressor[2] trigger are exceeded, red highlight indicates the NPS:FM national bottom lines[5], or relevant toxicity triggers are exceeded, and **bold text** indicates the HBRC RRMP[1] target or regional river guidelines are exceeded[6].

* Sampling of these analytes began in August 2019 (11 monthly samples).

\# Dissolved Oxygen criteria and trigger values are presented as percentage saturation (%) and should not be compared directly with the datasets (ppm).

1 All parameters are Hawkes Bay Regional Resource Management Plan Change 6 (2014) Surface water quality limits, targets and indicators for the Tukituki catchment (Tables 5.9.1B and C) – Zone 3, Mainstem, except where otherwise stated.

2 All parameters are ANZECC (REC) default guideline values (DGVs) for physical and chemical (PC) stressor values for Warm Dry Low-elevation classification, except where otherwise stated

3 National Policy Statement for Freshwater Management (NPS-FM) – Attribute States B, 95% species protection level (annual median/maximum).

4 Hawke's Bay Regional Resource Management Plan (RRMP) (republished as at 1 October 2015). Note that the faecal coliform surface water guideline value represents the concentration of contaminant in the water body that should not be exceeded after reasonable mixing.

5 NPS-FM – Attribute State A, 99% species protection level (annual median/maximum).

3.7 Hydrogeology

An evaluation of the hydrogeological setting and groundwater properties in the vicinity of the site are given in the Groundwater Assessment report (Beca, 2021: T:B.14). The proposed land application area resides on the Takapau Plains, underlain by the Ruataniwha aquifer system, the largest aquifer within the Hawke's Bay region. There are 38 known groundwater bores within two kilometres to the discharge site, including monitoring bores installed for this project (six). A further two bores (No. 5335 & 16478), located on the corner of Burnside and Nelson

Roads north of the application site, are regularly monitored by HBRC. Outside of these monitoring bores, the large majority are for domestic and stock water supply, with a few being for potable water. Figure 3.4 shows the location of all bores within 2 km of the application site.

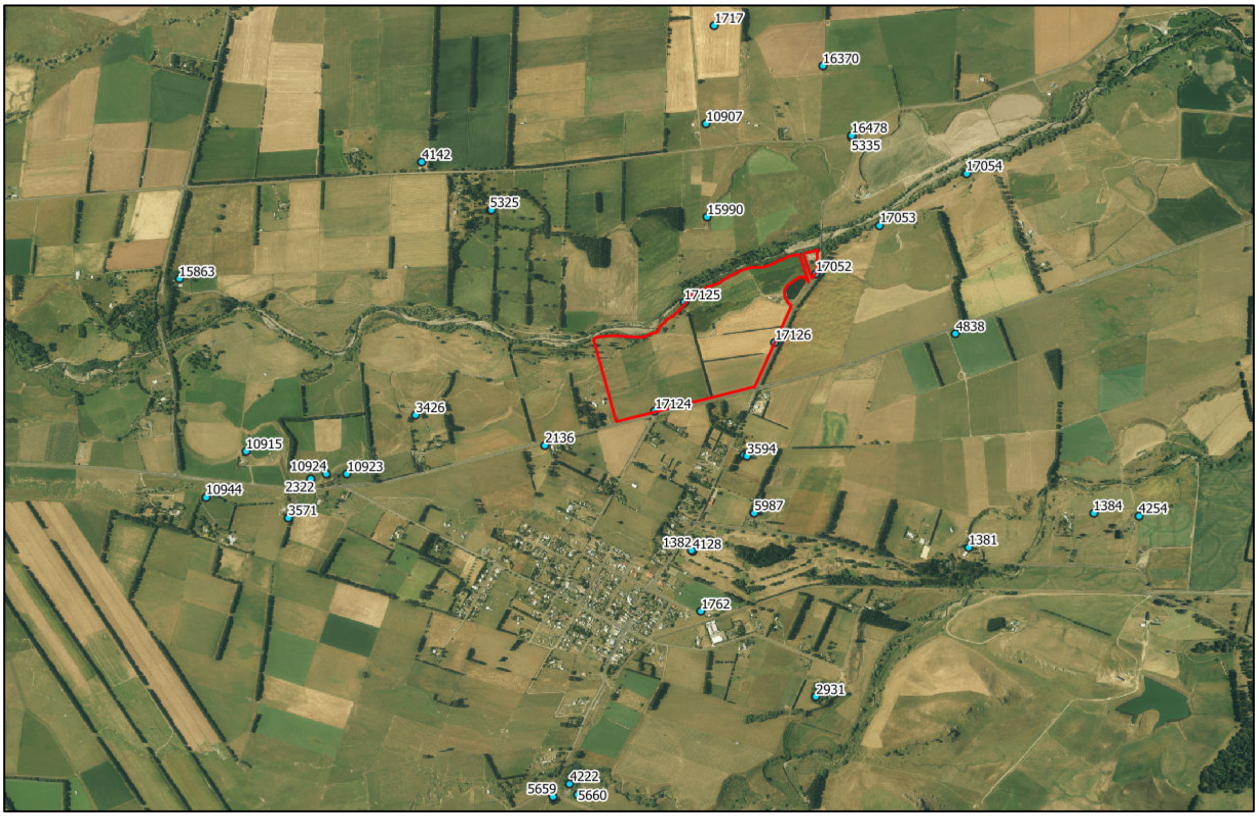

Figure 3.4: Groundwater Bores within 2 km of the Application Site

Six bores were installed around the Site in October 2020 for purposes of monitoring groundwater associated with the existing TWWTP, and the future land application of wastewater. Three of these (17052, 17053, 17054) are to assess potential leakage from the pond and the existing wetland discharge, with the remaining three (17124, 17125, 17126) being for groundwater monitoring of the future land application. Details for each of these bores, as well as water levels for the latest round of sampling are provided within Table 3.7. Table 3.8 and 3.9 represents field measurements and laboratory results for each of these bores following the latest round of sampling.

Table 3.7: Takapau Bore Characteristics

Bore Number	Landowner/ Location	Bore Depth	Static WL (18th Feb 21)		Coordinates: WGS84	
		mbgl*	mbgl*	RL**	Latitude	Longitude
17052	Burnside Road Road Reserve	4.15	2.89	227.86	-40.01115	176.35912
17053	Ian Ellis	4.5	1.78	224.97	-40.00883	176.36259
17054	Ian Ellis	4.26	0.90	222.10	-40.00643	176.36716
17124	Drummonds	4.23	3.38	240.62	-40.01737	176.35089
17125	Drummonds	5.82	2.00	232.25	-40.01255	176.35194
17126	Burnside Road Road Reserve	4.16	2.92	234.58	-40.01431	176.35701

Table 3.8: Water Quality - Field Measurements (18/02/21)

Bore	Temp	DO	DO	EC	EC	TDS	pH	Redox
	°C	%	mg/L	SPC µS/cm	C µS/cm	mg/L	pH units	ORP mV
17052	16.6	59.7	5.88	403.0	338.7	261.95	6.51	222.5
17053	15.9	38.8	3.78	122.0	101.5	79.30	6.37	211.8
17054	17.0	54.3	5.24	130.7	111.2	85.15	6.37	214.5
17124	18.7	79.3	7.31	256.6	226.2	167.05	6.68	212.5
17125	17.3	45.1	4.25	123.4	105.6	79.95	6.62	203.1
17126	16.5	60.0	5.81	296.5	250.4	192.40	6.56	210.3

Table 3.9: Water Quality: Laboratory Results

Bore	As Total	Cd Total	Cr Total	Cu Total	Ni Total	Pb Total	Zn Total
	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3
17052	<0.001	<0.00006	<0.001	0.002	<0.008	<0.001	<0.002
17053	<0.001	<0.00006	<0.001	<0.001	<0.008	<0.001	<0.002
17054	<0.001	<0.00006	<0.001	<0.001	<0.008	<0.001	<0.002
17124	<0.001	<0.00006	0.001	0.002	<0.008	<0.001	0.002
17125	<0.001	<0.00006	<0.001	<0.001	<0.008	<0.001	<0.002
17126	<0.001	<0.00006	<0.001	<0.001	<0.008	<0.001	<0.002

Table 3.9: Water Quality: Laboratory Results (cont.)

Bore	N Total	SIN	NH_3-N	NO_2-N	NO_3-N	TP	DRP	*E. coli*	Faecal coliforms
	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	MPN/ 100mL	MPN/ 100mL
17052	5.50	5.54	0.016	<0.005	5.52	0.20	0.075	* <20	<20
17053	0.60	0.66	0.011	<0.005	0.64	0.13	0.098	1	<20
17054	1.30	1.41	0.012	<0.005	1.40	0.08	0.048	<1	<20
17124	18.00	18.20	0.011	<0.005	18.20	0.24	0.018	* <20	<20
17125	0.52	0.58	0.010	<0.005	0.57	0.06	0.023	1	<20
17126	13.00	13.10	0.012	<0.005	13.10	0.26	0.015	34	<20

*non-accredited test method for *E.coli* (APHA 23rd Ed. 9221E) was used instead due to high solids in sample.

Results in Table 3.9 indicate that elevated levels of nitrogen and phosphorus are present in the vicinity of the site. It is likely that land use at and beyond the Site, and the groundwater recharge and movement strongly influence groundwater quality at this location.

3.8 Climate

3.8.1 Rainfall and Evapotranspiration

Average monthly rainfall data and average potential evapotranspiration (PET) data is shown in Table 11. The nearest climate station to the land application site with a complete record covering at least the previous 20 years is the Waipukurau Climate Station. This station is located at Waipukurau, approximately 16 km east of the application site and is operated by HBRC.

Table 3.11: Rainfall and Evapotranspiration (mm) for Waipukurau (1997-2019)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Rainfall	56	40	55	61	55	69	89	59	62	60	46	52	705
PET	181	126	112	82	65	53	59	71	96	129	151	160	1286
Surplus/Deficit	-125	-86	-57	-21	-10	16	30	-12	-34	-68	-105	-108	

From Table 3.11, the wettest month is July at 89 mm, with the month having greatest evapotranspiration being January (181 mm). Overall, the annual rainfall is low and there is a substantial water deficit near the site.

3.8.2 Wind

Figure 3.5 shows the wind rose for the 1981-2010 period for the Takapau Plains (NIWA Station No. 93441) (Chappell, 2013). From this, the dominant wind direction (5%-8%) for all wind strengths is from the south-west, with winds from the north-east and west also being frequent.

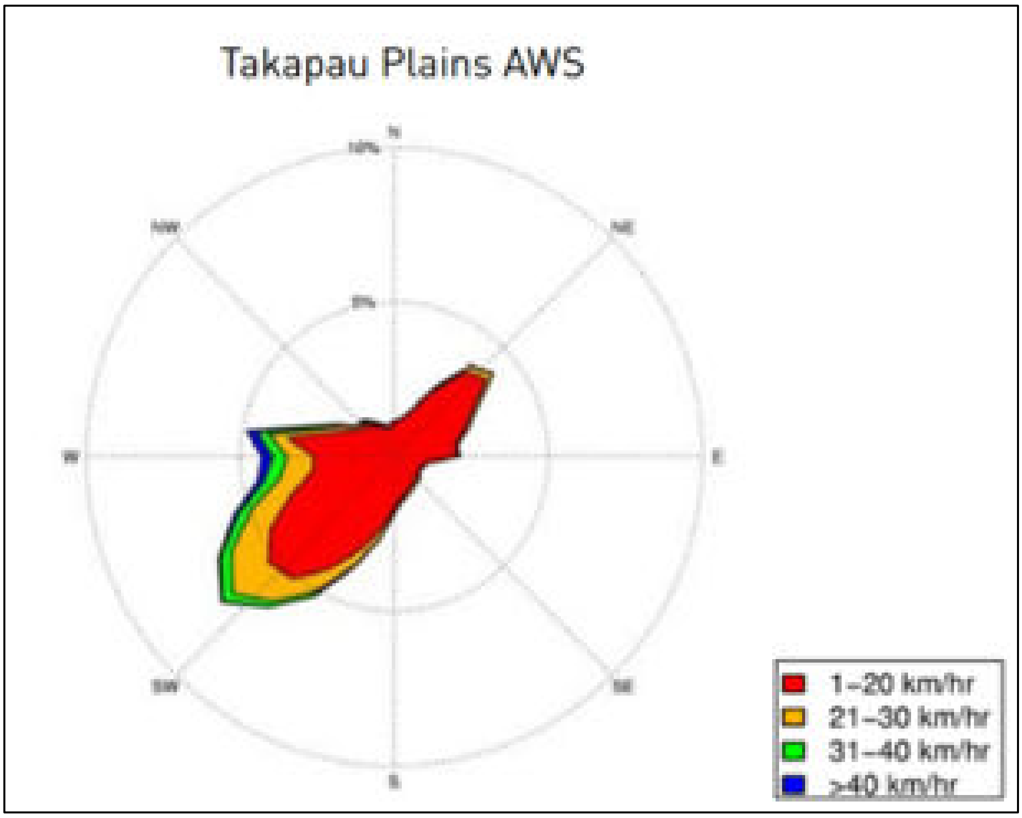

Figure 3.5: Takapau Plains Wind Rose (1981-2010) (Chappell, 2013).

Figure 3.5 indicates that the predominant wind at the Site is away from the Takapau township and nearby dwellings.

3.9 Natural Hazards

3.9.1 Fault Lines

Due to being situated within a tectonically active region of New Zealand, it is unsurprising that the application site is surrounded by a series of faults. The nearest active fault is the Takapau faultline running in an approximately north-south direction terminating at the Takapau township one kilometre south of the application site (GNS, 2021).

Additionally, the application area is located between the Ruataniwha and Oruawharo faults, both of which are approximately north-south running, active reverse faults at a distance of 3 km to the west and 4 km to the east respectively (GNS, 2021).

Finally, the Waikopiro faultline, also running in a north-south direction, is located 500 m east of the property, however this faultline is classified as being inactive (GNS, 2021).

3.9.2 Flooding

The lower terrace of the application Site is located adjacent to the Makaretu River. Flood modelling done by HBRC for a 100 year return period flood, indicates that approximately 12 ha of land (the entire lower terrace) is inundated in a 1 in 100 year event. Figure 3.6 shows the flood hazard map for the Makaretu River surrounding the application site.

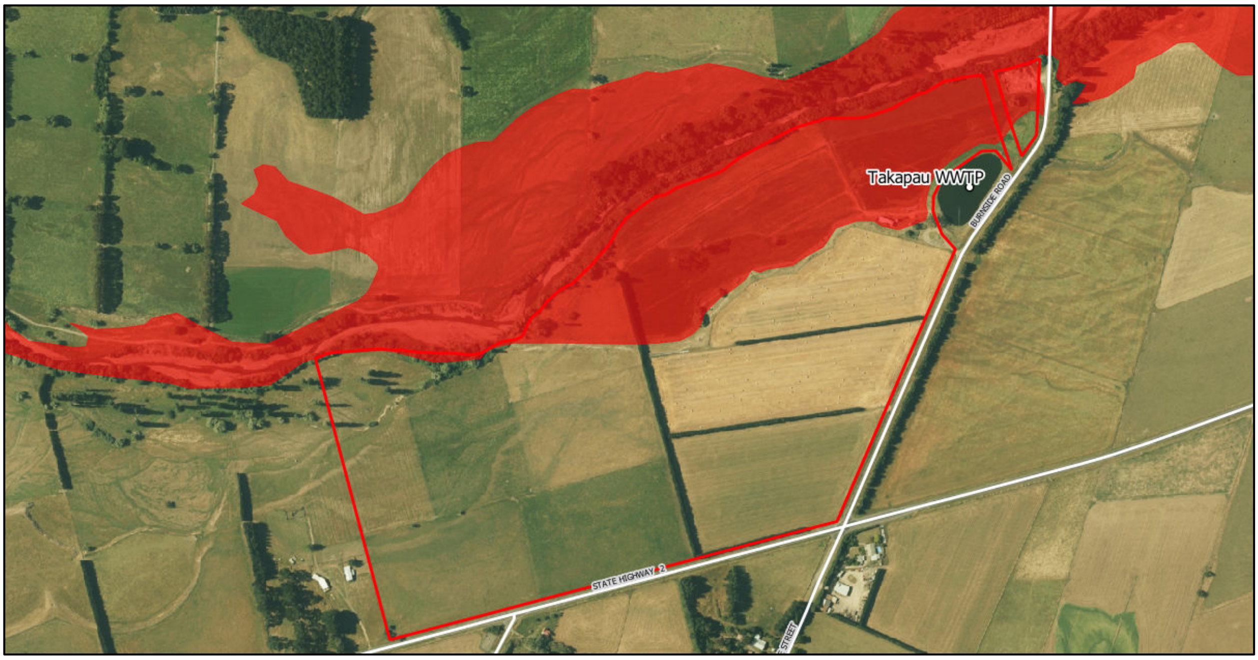

Figure 3.6: Flood Risk Region of Proposed Discharge Site

Discussions with the farmer identified that the lower terrace has not been fully or partially inundated in the 37 years of their ownership.

3.10 Projected Climate Changes

3.10.1 Temperature

Compared to 1995, daily temperatures within the Hawke's Bay region are expected to increase between 0.7°C and 1.1°C by 2040 and between 0.7°C and 3.1°C by 2090. Alongside this, the Hawke's Bay region is projected to gain between 8 to 51 extra days per year where the maximum daily temperature exceeds 25˚C. Finally, the number of frosts experienced within the Hawke's Bay region could decrease up to 15 days per year by 2090 (MfE, 2018).

3.10.2 Rainfall

Currently, the rainfall distribution varies both spatially and temporally throughout the region, which is projected to continue for the future. Seasonal changes of precipitation are expected to change of greatest proportions within future years. Winter rainfall is projected to decrease between 2% and 17% by 2090 with spring rainfall also projected to decrease between 2% to 13% by 2090. Precipitation is however expected to increase for both the summer and autumn seasons. Finally, with ongoing climate change, the Hawke's Bay region is not expected to experience significant changes to the frequency of extreme rainy days (MfE, 2018).

3.10.3 Wind

Future climate change is not projected to have a significant impact on the Hawke's Bay region by 2090. There is potential for increases in westerly wind flow during winter and north-easterly wind flow during summer (MfE, 2018). Based on the wind rose in Figure 3.5 above, this essentially represents that winds from a westerly or north-easterly direction are expected to increase in frequency at the expense of wind from the remaining directions.

3.11 District Planning

District Planning provisions are addressed in the project Statutory Planning Review (Beca, 2021: A:B.43).

3.12 Buffers

Buffer distances from sensitive receptors are proposed. There is potential to reduce the required buffers by utilising additional treatment of the wastewater (e.g. use of UV). However, for the purposes of conservative design the buffer distances applied are as follows:

- 20 m from property boundaries;
- 20 m from surface water bodies;
- 50 m from bores for water supply; and
- 150 m from dwellings.

A 20 m property boundary buffer will be employed along the northern, eastern and southern boundaries along Burnside Road and SH2. A corridor owned by Hawke's Bay Regional Council exists along the Makaretu River channel. This corridor already provides a buffer from the active channel, to which a further 20 m property buffer will be applied from the property boundary.

No buffer will be required around the existing TWWTP due to existing agreement between both the Drummonds and CHBDC.

CHBDC have installed monitoring bores around the Site. No buffer distance is provided for these since their purpose is for water quality sampling only. There are no known groundwater bores or wells within 50 m of the application site that haven't been installed by CHBDC.

There are three dwellings within 150 m of the proposed wastewater application area, with the closest being 120 m.

4 DESCRIPTION OF THE ACTIVITY

4.1 General

There have been a number of iterations to determine the discharge activity for which consent is sought. There are three activities that need to be considered as part of the management of the land based application of wastewater from the TWWTP. These are:

- Discharge to land of treated wastewater for land treatment;
- Land use intensification due to irrigation of farmland; and
- Discharge to air from the WWTP and irrigation of treated wastewater.

This section provides a summary of these activities, with further detail given in:

- Evaluation of Soils Receiving Takapau Wastewater (LEI, 2020:T:B.15).
- Conceptual Design report (LEI, 2021:T:C.15).
- Existing Farming System (LEI, 2021:T:B.13).
- Existing/Future Farming System and OverseerFM Analysis (LEI, 2021:T:C.14a).
- Drummond Overseer & Planning Assessment (2021:T:C.14b).

The indirect discharge through a High Rate Land Passage (HRLP) is addressed elsewhere (LEI, 2021:T:C.15 & Beca, 2021:T:D.25).

The sections below provide a summary of the key parameters relied upon to determine the effects of the land discharge, as described in the above reports. It is advised that these reports are reviewed to obtain a more complete understanding of the proposed system.

4.2 Takapau Township

In 2019, Takapau had a population of 620 people, with this expected to grow to 790 people by 2028, and 1,093 by 2,048 (Beca, 2021:T:B.31c). This high growth population projection scenario was produced in July 2020 by Squillions Ltd and has since been adopted for the Long Term Plan by CHBDC. Table 4.1 represents this projected high growth scenario for Takapau. The adoption of a high growth scenario enables a level of conservatism to be applied to the discharge design.

Table 4.1: Takapau Population Projection (2019-2048) (Beca, 2021:T:B:31c)

	Actual	Projected					
	2019	2028	Change 2019-2028	% Change	2048	Change 2019-2048	% Change
Population	620	790	170	27.4	1,093	473	76.3

4.3 Discharge Characteristics – Wastewater Flow

The TWWTP has had issues over the past five years relating to flows exceeding the current consented flow of 216 m^3/day.

Figure 4.1 represents the monthly average daily flow (ADF) for the TWWTP in 2019, as well as the projected ADF in 2048. Actual flow per capita is estimated from the pond effluent volume for the current Takapau population of 620 people. The projected 2048 ADF is estimated using a population of 1,093 people (Table 4.1). Table 4.2 provides a summary of the flows for the 2019 year, as well as the projected 2028 and 2048 years.

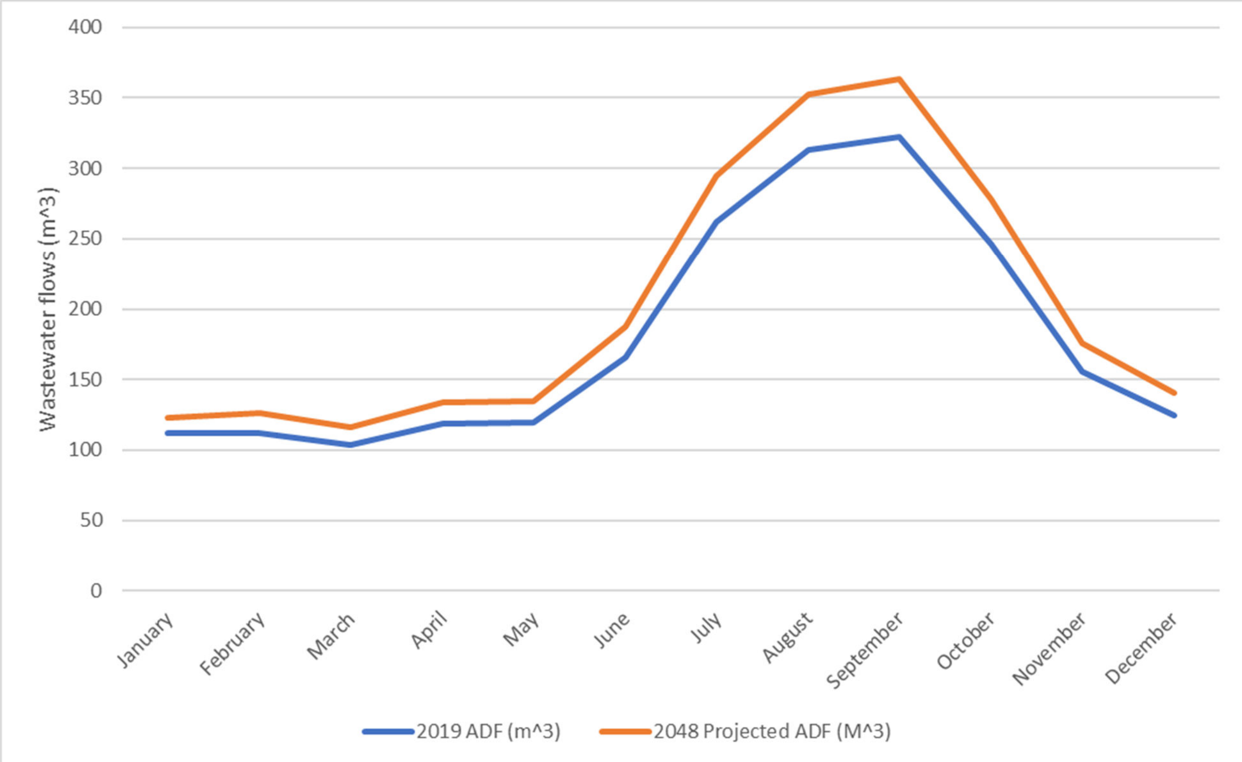

Figure 4.1: Average daily wastewater flows per month (LEI, 2021:T:C.15).

Table 4.2: Daily Flow Record adjusted for 2048 predicted flows (after Beca, 2021:T:B.31c)

Year	2019	2028	2048
Population	620	790	1,093
Projection Type	Actual	Actual	Actual
Dry Weather Inflow (ADWF) (m^3/d)	67	85	118
Average Daily Flow (m^3/d)	180	229	317
99%ile Flow (m^3/d)	595	653	756
Maximum Flow (m^3/d)	750	807	910

Wastewater outflow rates have been used for the determination of the discharge to the irrigated land and high rate land passage (HRLP) design since these represent the flows that require discharge on any day.

4.4 Discharge Characteristics – Wastewater Quality

Constituents of the treated wastewater to be irrigated that are considered in the Discharge Conceptual Design (LEI, 2021:T:C.15) are predominantly due the potential environmental or public health risk. The key parameters are summarised in Table 4.5.

Table 4.5: Key Wastewater Parameters, Takapau WWTP (Jan 1999 to Aug 2020) (LEI, 2021:T:C.15)

Parameter	Units	n	Mean	Median	95th Percentile	Range
$ScBOD_5$	g O_2/m^3	354	32	28	72	1 to 98
TSS	g/m^3	238	72	70	140	2.5 to 433
TN*	g/m^3	20	15.6	15.4	24.3	5.8 to 26.8
Ammoniacal N*	g/m^3	20	4.6	0.09	19.9	0.005 to 20.9
DIN*	g/m^3	21	7.6	7.4	19.95	0 to 21
TP*	g/m^3	20	3.9	3.9	5.3	1.9 to 5.9
DRP	g/m^3	20	2.7	2.5	3.797	1.3 to 3.93
Faecal Coliforms	cfu/100 mL	356	14,695 (geomean)	15,900	140,000	74 to 410,000
*E. coli**	cfu/100 mL	20	13,178 (geomean)	18,000	72,950	100 to 110,000

* Sampling of these analytes began in February 2019.

4.5 Proposed Discharge to Land

The proposed discharge to land is detailed in the report:

- Takapau Community Wastewater Discharge Conceptual Design (LEI, 2021:T:C.15).

Key information to enable the effects of the activity to be assessed are summarised as follows:

The discharge system is proposed to consist of the following components:

- 2,000 m^3 of storage at the WWTP for Stage 1;
- 18,000 m^3 of storage in a new pond for Stage 2;
- Irrigation pump station located at the WWTP built during Stage 1;
- 660 m rising main to irrigation system;
- Approximately 460 m centre pivot boom; and
- Wet well and pumping to:
    - High rate land passage system (all stages);
    - 5 ha at Stage 1; and
    - 25 ha additional area at Stage 2.

Management of irrigated land is to remain as low intensity cattle finishing with rotational cropping, albeit with proposed land management changes. Pasture/crop types are not expected to change from the status quo, aside from the removal of crops for human consumption (peas). Areas receiving wastewater are expected to increase in productivity from existing yields. As part of the establishment for irrigation across a maximum of 30 ha via a centre pivot system, re-contouring may need to occur, to reduce the slope between the upper and lower terraces. Further earthworks will be required associated with the construction of storage ponds outlined within Section 4.4. of LEI (2021:T:C.15), as well as trenching from the TWWTP/ponds to the centre pivot system. Construction and earthworks consents not included in this bundle of consents since design work to determine layout and requirements is dependent on the consented system to be permitted.

The work required to construct this land application of wastewater system and have this being fully operational is extensive, thus a staging system is required. The staging is outlined within LEI (2021:T:C.15). A summary of these stages is as follows:

- **Stage 0** allows for the current discharge to occur for up to three years while the subsequent stages are enacted;

- **Stage 1** involves the provision of 2,000 m^3 of storage within the treatment system and development of a minimum 5 ha of irrigation, allowing for irrigation of approximately 60% of the **current** average annual wastewater discharge volume to irrigation and 40 % to the high rate discharge system when river flows exceed half median flow.

  The discharge regime assumes that currently occurring wastewater flows occurs, up to 2,000 m$_3$ of storage is available in the treatment pond and discharge to the HRLP system can occur only when river flows are above half median;

- **Stage 2** involves development of an additional 15 ha and up to 25 ha of irrigation. A new storage pond is to be built adjacent to the existing treatment system with a capacity of 18,000 m$_3$. The changes allow for irrigation of approximately 90% of the **future (2048)** average annual wastewater discharge volume to irrigation and 10 % to the high rate discharge system when river flows exceed median flow.

The wastewater discharge regime has been determined from actual daily flow data over 9 years of record, climate data for the same period, future flow predictions (Beca, 2021: T:B.31c) and river flow data. Table 4.7 shows the annual discharge details for Stage 1 for an average, wet and dry year (LEI, 2021:T:C.15).

Table 4.7: Stage 1 – Discharge Management Outcomes (2019 Flows)

Regime	Average Year	Wet year	Dry Year
IRRIGATION			
Annual application depth (mm)	730	830	560
Maximum application rate per event	20 mm/d	20 mm/d	20 mm/d
Volume per year	36,300 m^3	41,500 m^3	27,800 m^3
N mass loading (from wastewater)	140 kg N/ha/y	166 kg N/ha/y	111 kg N/ha/y
P mass loading (from wastewater)	60 kg P/ha/y	66 kg P/ha/y	45 kg P/ha/y
HIGH RATE SYSTEM			
Maximum application rate per event	200 m^3	200 m^3	200 m^3
Volume per year	20,935 m^3	28,900 m^3	9,800 m^3
N mass loading (from wastewater)	316 kg N/y	436 kg N/y	148 kg N/y
P mass loading (from wastewater)	81 kg P/y	112 kg P/y	38 kg P/y

Table 4.8 shows the annual discharge details for Stage 2 for an average, wet and dry year (LEI, 2021:T:C.15).

Table 4.8: Stage 2 – Discharge Management Outcomes (2048 Flows)

Regime	Average Year	Wet year	Dry Year
IRRIGATION			
Annual application depth (mm)	421	507	281
Maximum application rate per event	20 mm/d	20 mm/d	20 mm/d
Volume per year	83,500 m^3	101,500 m^3	56,300 m^3
N mass loading (from wastewater)	84 kg N/ha/y	101 kg N/ha/y	56 kg N/ha/y
P mass loading (from wastewater)	34 kg P/ha/y	41 kg P/ha/y	23 kg P/ha/y
HIGH RATE SYSTEM			
Maximum application rate per event	200 m^3	200 m^3	200 m^3
Volume per year	8,600 m^3	10,034 m^3	160 m^3
N mass loading (from wastewater)	130 kg N/y	152 kg N/y	2 kg N/y
P mass loading (from wastewater)	33 kg P/y	39 kg P/y	1 kg P/y

4.6 Land Use Intensification

A detailed evaluation of proposed land management regimes for the application site and associated nutrient losses are given within the reports:

- Current Farming System (LEI, 2021:T:B.13);
- Existing/Future Farming System and OverseerFM Analysis (LEI, 2021:T:C.14a);
- Drummond Overseer & Planning Assessment (LEI, 2021:T:C.14b); and
- Takapau Community Wastewater Discharge Conceptual Design (LEI, 2021:T:C.15).

A proposed 'business as usual' approach will be adopted for the Site management albeit with multiple changes to align with best management practices following the irrigation of wastewater.

A target nitrogen loss for the single 45 Burnside Road block will be 95 kg N/ha, with the inclusion of the adjacent 4292 SH2 block reducing this to a combined 60 kg N/ha (LEI, 2021:T:C.14a).

The land use intensification will occur with a concurrent reduction in the volume of treated wastewater discharged to the Makaretu River via HRLP. Table 4.9 summarises the nutrient loss as determined from directly discharge mass (HRLP) and predicted by Overseer™ for each of the stages of the land application regime outlined within LEI (2021:T:C.15).

Table 4.9: Nutrient Loss Summary

	HRLP / Wetland		Farm		Totals	
	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)	N (kg/y)	P (kg/y)
Current (Stage 0)	857	221	2,097	10	2,954	231
Stage 1	316	81	2,530	20	2,846	101
Stage 2	130	33	2,530	20	2,660	53

An evaluation of the effects associated with these nutrient losses is given in the Surface Water Assessment of Effects (Beca, 2021: T:D.25).

4.7 Activity Summary

Key design parameters for each stage are provided in Table 4.10.

Table 4.10: Discharge and Management Summary

Parameter	Current (Stage 0)	Stage 1	Stage 2
Storage volume (m^3)	None	2,000	18,000
Average annual outflow from TWWTP (m^3)	~60,000	~60,000	~93,000
High Rate Land Passage			
HRLP Maximum application rate per event (m^3)	750	200	200
HRLP Volume per year (m^3)	~60,000	~20,900	~8,600
HRLP N mass loading from wastewater (kg/y)	857	316	130
HRLP P mass loading from wastewater (kg/y)	221	81	33
Irrigation			
Irrigation regime	Nil	Deferred, non-deficit	Deferred, non-deficit
Landform	Nil	Lower terrace	Upper and lower terraces
Total area – including non irrigated (ha)	42.4	42.4	42.4
Wastewater irrigated area (ha)	0	5	20
Irrigation event application (mm/event)	0	up to 20	up to 20
Average annual irrigation volume (m^3/y)	0	36,300	83,500
Average annual application depth (mm)	0	480	360
Wastewater Nitrogen load (kg N/ha/y)	0	140	84
Wastewater Phosphorus load (kg P/ha/y)[3]	0	60	34
Upper Terrace			
Farm Management current/proposed	Rotational cropping, cut and carry	Rotational cropping, cut and carry	Rotational cropping, cut and carry
Vegetation current/proposed	Cropping (e.g. barley, peas oats, turnips, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)	Cropping (e.g. barley, oats, maize, ryegrass)
Lower Terrace			
Farm Management current/proposed	Low intensity grazing	Low intensity grazing	Low intensity grazing
Vegetation current/proposed	Ryegrass pasture	Ryegrass pasture	Ryegrass pasture

5 ASSESSMENT OF EFFECTS

5.1 General

This section provides an assessment of the effects of the discharge of treated wastewater as outlined in Section 4, on the receiving environment as described in Section 3.

5.2 Summary of Effects

Environmental risks arising from discharges depend on three major factors, as follows:

- Source and type of contaminant;
- Migration pathways; and
- Receptors.

If one of these factors is absent, then the potential risk is greatly reduced.

The activities that may produce actual or potential effects on the environment that need to be considered relate to:

- Discharge to land of treated wastewater for land treatment;
- Land use intensification due to irrigation of farmland; and
- Discharge to air from the WWTP and land discharge of treated wastewater.

The treated wastewater to be irrigated onto the land application site will have the following properties of potential environmental concern:

- Organic material, expressed as carbonaceous biochemical oxygen demand (BOD);
- Nitrogen (N) as ammoniacal nitrogen (NH_4-N) and nitrite/nitrate nitrogen (NO_x-N));
- Total phosphorus (P);
- Pathogens; and
- Water.

Actual or potential effects upon the environment are considered as:

- Effects of the discharge on the soil;
- Effects of the discharge on groundwater quality;
- Effects of the discharge on surface water quality;
- Effects on habitats;
- Effects on Amenity, Community, Cultural and Heritage values; and
- Effects of the discharge on air quality.

This report assesses the effects of the wastewater discharge to the soil and plant system, and to air. Effects from the discharge to land of wastewater on other environments are assessed in other technical reports which form part of the consent application bundle of documents (CHBDC, 2021:T.D.1).

In summary, there will be no effects that are not capable of satisfactory avoidance, remediation or mitigation. The individual effects concluded from the assessments completed are all less than minor. This conclusion is detailed in the following sections. A risk summary of the potential and actual effects from the Takapau WWTP wastewater is given in Table 5.1.

Table 5.1: Summary of Potential and Actual Effects

		Source / Contaminant		
	Sensitivity	Organic matter, cations, Nitrogen, Phosphorus	Pathogens	Water
Soil	Potential risk	Low	Moderate	High
	Actual effect	Less than minor	Less than minor	Less than minor
Air	Potential risk	Moderate	High	Moderate
	Actual effect	Less than minor	Less than minor	Less than minor
Land Use	Potential risk	No more than minor	No more than minor	No more than minor
	Actual effect	Less than minor	Less than minor	Less than minor

5.3 Receiving Environment

The initial environment to receive the discharge of treated wastewater is the soil and plant system of the Site and area around the WWTP. If the treated wastewater is not retained or renovated in the soil it may travel to shallow groundwater, or by overland flow to local surface water (Makaretu River), at rates that could potentially generate adverse effects.

5.4 Sensitivity of the Receiving Environment

The land application areas themselves are not sensitive to wastewater irrigation, and the application of treated wastewater can be managed to ensure it will not adversely affect farming operations.

The main receiving environment of potential concern is the Makaretu River. Measures to avoid overland flow to the river have been proposed. Any discharge from the Site to the river would be via drainage to groundwater which would then end up in the river. If treated wastewater reaches the river, it will do so having passed through the plants and soil and mixed with contaminants from surrounding land, including leaching from existing farming operations.

While leaching will be minimised by diligent design and management, the effect of the existing direct discharge on the Makaretu River is minimal, the River is already subject to other nutrient inputs not related to the Project or the Site. Therefore, the proposed discharge to land regime and its potential leaching through the soils is a big improvement on water quality compared to the effect of current 100% direct discharge to river.

5.5 Effects of the Discharges on Soil and Plants

The treated wastewater will be applied at a rate equivalent to a maximum application depth per application event of 20 mm for Stage 1 and Stage 2. The impact of the discharge on the soil and plant system relates the potential for a reduction in soil quality which would reduce the future land use options for the Site, and potential for loss of productivity leading to poor performance of plant growth on the Site. These are discussed below with regard to the contaminants of concern identified in Section 5.4 above.

Effects due to land intensification on soil and plants are not due specifically to the components of the wastewater and are assessed here with regard to the potential soil physical changes.

5.5.1 Effect of Water on Soil Structure

Soil structure refers to the size and distribution of soil particles and void spaces (pores) in the soil. It is important since it controls the rate at which water can be infiltrated into and drained from the soil, and the amount of water that can be retained in the soil. In addition, the distribution of pores influences the aeration of the soil. If the soil structure is degraded, drainage and root passage becomes impeded which leads to a loss of productivity and reduction in soil quality.

Irrigation has the potential to initiate soil structural degradation if not sustainably managed. If soil is allowed to remain at a high soil moisture content or saturation for a prolonged period damage to soil structure may occur by:

- Pugging due to animal traffic on wet soils;
- Mechanical damage by cultivation or vehicle traffic on wet soils; and
- Chemical and biological damage to structure by treated wastewater constituents or microbial action in anoxic conditions due to saturated conditions.

The silt dominated soils across the Site have potential of water logging issues due the ability to retain water under negative potential (suction/matrix potential). These characteristics were measured over the Site (LEI, 2020:T:B.15) enabling appropriate management and system design to be proposed which avoids soil damage due to the additional water from irrigation.

The methods to avoid adverse effects due to water on the soil over the Site are:

- The selection of a site whose soils have the potential to effectively receive and assimilate wastewater;
- Application rates per event which reflect the soil unsaturated hydraulic conductivity; and
- Withholding of irrigation when rainfall, flooding or other prolonged wetness occurs.

The depth of treated wastewater to be applied in any event has been designed to meet industry best practice for wastewater irrigation and is based on the actual measured hydraulic properties of the soil on the Site. Application to land is to be halted during periods of wet weather to ensure that the additive effect of treated wastewater plus rainfall does not cause prolonged soil wetness.

It is considered that the effect of the hydraulic component of treated wastewater application on the soil will be less than minor.

5.5.2 Effect of Cations on Soil Structure

Sodium has not been tested for in the Takapau WWTP discharge, however a typical value would be in the order of 100 g/m^3 for municipal wastewater. This is low compared to industrial wastes. The effects of sodium on soil structure are considered to be negligible for the site because:

- The clay minerals, dominated by allophane, soils are not sensitive to sodium damage; and
- Natural rainfall with the addition of irrigation at the site is sufficiently high to flush accumulated sodium from the soil profile.

The effect of wastewater derived cations on the soil of the site is considered to be less than minor.

5.5.3 Effect of Organic Material on Soil and Plants

Potential adverse effects of organic material, measured as BOD, on soil and plants of the site include the generation of anaerobic conditions in the soil as oxygen is consumed. Not properly managed this could cause production of surface bioslimes with the associated problems of:

- Soil pore blockage, leading to reduced soil infiltration capacity;
- Plant die off;
- Degraded visual appearance;
- Production of odour; and
- Degradation of soil structure.

Over time the addition of organic carbon and nutrients associated with the wastewater application will increase the organic carbon in the topsoil. This results in an increase in the soil quality and production from these areas.

A healthy soil environment can assimilate up to 600 kg BOD/ha/day (NZLTC, 2000). The BOD of the wastewater has a mean of 32 g/m^3. The maximum loading of BOD to be applied by the system is:

- Stage 1 – 6.4 kg BOD/ha/application event and 154 kg BOD/ha/year for an average year.
- Stage 2 – 6.4 kg BOD/ha/application event and 115 kg BOD/ha/year for an average year.

These rates are well within the capacity of a healthy soil, so the effects of BOD on soil and plants within the proposed application are expected to be less than minor.

5.5.4 Effect of Nitrogen on Soil and Plants

Potential adverse effects of high nitrogen loading on soil and plants may include:

- Oversupply of nitrogen in excess of plant requirements, leading to leaching to groundwater and drainage to surface water; and
- Plant damage due to high ammonia.

Much of the nitrogen will be removed by soil microbe use, plant uptake, short-term soil storage and gaseous losses (volatilisation and denitrification). The proposed nitrogen loading to the Site from treated wastewater in Stage 1 will be 140 kg N/ha/y. Stage 2 will receive on average 84 kg N/ha/y.

A nitrogen application load of 3.2 kg N/ha at Stage 1 and Stage 2 will occur for each application event. By comparison, a typical Urea application is likely to be no less than 25 kg N/ha. As a result of smaller, more frequent nitrogen applications there will be better plant use efficiency than would occur under conventional fertiliser applications.

Despite the low nitrogen loading rate, limited leaching may still occur due to the function of natural systems (inhomogeneity, rainfall extremes, etc.). However, the proposed conservative rates will enable a level of confidence that leaching will not be more due to wastewater irrigation, and typically will be less, than occurs under the surrounding land use that receives fertiliser application. As a result, the effects are expected to be less than minor on the soil.

There may be a need for targeted fertilisation (in addition to wastewater) to manage pasture or crop production, and it is proposed that up to 250 kg N/ha/y from all sources may be applied. This results in up to 166 kg N/ha/y applied from additional sources in an average year. It should be noted that the application of this mass of nitrogen is not a requirement, instead it is assessed to determine the effects of this rate (250 kg N/ha/y), to allow the land managers flexibility to manage the site as a productive unit.

From Table 4.9, with the inclusion of nitrogen from other sources, the estimated nitrogen leaching from the Site increases by 20 % from the current land use. This is the equivalent of 10 kg N/ha/y.

A nitrogen application rate of 250 kg N/ha/y is not unusual for an intensively grazed, or non-intensively cropped land unit. The current land use is mixed grazing and cropping and so the proposed nitrogen loading is in keeping with the existing land use, especially if there is to be a regular cropping programme. The supplementary nutrients will be applied in accordance with best practice (Fertiliser Association, 2013) to minimise losses. The effects of this additional nitrogen will be positive for the soil and plant system by optimising productive growth. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated wastewater. The impact of this greater loading, whether it be more wastewater or synthetic fertiliser will result in adverse effects that are less than minor for soil and plants.

The implication for water ways is discussed in the Surface Water AEE (Beca, 2021: T:D.25).

5.5.5 Effect of Phosphorus on Soil and Plants

The treated wastewater contains phosphorus, which is an essential nutrient for plant growth and microbial activity. The risk from phosphorus is predominantly due to the effects if it reaches surface water, causing nuisance growths in streams and rivers.

The proposed phosphorus loading to the Site from treated wastewater is on average 60 kg P/ha/y (Stage 1) and 34 kg P/ha/y (Stage 2). These rates are low to moderate (50 kg) for a productive system. At the proposed rate of application it is expected that soil fertility and plant production will benefit from the irrigation of the treated wastewater. Soil transformation and plant uptake of the applied P is expected to match the rate of application for Stages 1 and 2. The impact on ground and surface water will be discussed within the Surface Water AEE (Beca, 2021: T:D.25) however, it is noted that the discharge design avoids leaching, ponding and run-off. The inclusion of a buffer from water ways and irrigation to predominantly flat to gently sloping land will assist to avoid phosphorus containing discharge from the land application to surface water.

Adverse effects on soil and plants due to phosphorus from treated wastewater application are considered to be less than minor.

5.5.6 Effect of Pathogens on Soil and Plants

Land Discharge: The treated wastewater has the potential to contain pathogens, as indicated by *E. coli* levels. The risk from pathogens in the soil occurs when they enter the food chain by consumption of raw crops. Effects due to pathogens reaching groundwater or surface are assessed in the Surface Water AEE (Beca, 2021: T:D.25).

On the Site, the main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. It is understood that 92 - 99.9 % of applied microbes are removed in the top 10 mm of the soil (Crane and Moore, 1984; Gunn, 1997).

The greatest risk is potentially not with the soil but with stock ingesting the pathogens that have been applied. This is a farm management and animal health issue which is to be managed using stand-down periods. UV disinfection will be included for flows from the treatment pond, resulting in a significant reduction in risk due to pathogens. It is expected that the effect of pathogens from irrigation of treated wastewater on soil and plants will be less than minor.

<u>Land Intensification:</u> In addition to *E. coli* in wastewater, land intensification could result in increased stocking rates and potentially higher *E. coli* levels deposited on the soil. The mechanisms to reduce the *E. coli* levels are the same soil processes as described above and adverse effects on soil and plants from *E. coli* due to land intensification are expected to be less than minor.

5.5.7 Effect of Land Intensification on Soil and Plants

The process of land intensification generally results in increased productive capacity of the soil and plant system. If intensification is mismanaged, or if the soils are not suitable for intensification, there is a risk of long term damage to the site from erosion, compaction, and damage to adjacent environments.

Key intensification risks to be managed at the Site are:

- Erosion;
- Over wetting and compaction (by pugging) of alluvial plains; and
- Management of nutrient loadings to avoid excessive nutrient loss.

The soils on site are silty and are resilient to compaction albeit with appropriate management. The avoidance of erosion will be achieved through appropriate management practices including:

- Withholding irrigation for periods before and after cultivation and harvest activities;
- Stock stand down periods;
- Preventing overgrazing;
- Ensuring application rates correspond to soil assimilation capabilities; and
- Maintaining an appropriate level of groundcover under irrigation.

Over-wetting could potentially occur on the lower terrace if it is over-irrigated, or if wastewater applied to the higher terrace travels via overland flow to the Site's lower terrace. Care has been taken to adopt a rate of application to the Site which does not cause the soil to become saturated. This avoids gravitational flow of water through the soil and reduces the risk of high soil moisture levels around the Site.

Avoidance of over-wetting is the main means to avoid compaction and also to avoid excessive nutrient loss. Nutrient loss becomes a concern for groundwater and surface water and its effects are discussed within the Surface Water AEE (Beca, 2021: T:D.25).

5.6 Effects of the Discharge on Air Quality

The use of spray irrigation from a centre pivot has the potential to influence air quality. WWTP ponds may also have associated odour. The nearest receptors are a series of dwellings on the southern side of SH2, approximately 120-150 m from the exterior of the proposed irrigation reach. The Takapau township is located 1.5 km to the south of the Takapau WWTP, and residential dwellings are considered to be sensitive receptor for air quality effects.

There are no dwellings to the west or east of the application site within 1 km. There is one dwelling located 650 m north of the application site along Nelsons Road.

5.6.1 Aerosols and Spray Drift

Aerosols and spray drift are not generated by the WWTP pond.

The land treatment system has the potential to impact on air quality through production of aerosols generated during irrigation. The risk related to spray drift of wastewater relates primarily to pathogen transport and this is greatly reduced by the use of UV disinfection of the treated wastewater. In order to minimize the production of aerosols and minimise spray drift, the system pressure and nozzle size will be selected to produce droplets greater than 200 µm in size, which do not travel far and typically do not form aerosols.

Some proportion of smaller droplets, which have the potential to become aerosolised, will still be produced and so the following methods for reducing spray drift effects are to be used:

- Minimise travel distance: Use of irrigators with large droplet sizes; and
- Buffers: maintain separation distances between irrigation and any receptors. This is achieved through the outer spans of the centre pivot boom applying freshwater, rather than wastewater to enable this sufficient distance from buffers. Also, the use of the end gun will be limited to freshwater. Across the property, there will be a minimum separation distance of 5 m from the wastewater irrigated area to any property boundary, 20 m to any sensitive environment or water way, and 150 m separation to any dwelling for all wastewater application. It should be noted that freshwater could be applied within this buffer.

As described in Section 3.8.2, the predominant wind direction is from the SW. The nearest dwelling in a NE direction (opposite of dominant wind direction) that is not owned by the Drummonds is located 1.3 km way. If spray drift was to occur, diffusion and dispersion between the irrigation area and the dwelling would cause the discharge to be undetectable.

It is concluded that with the appropriate mitigation as identified above, the effects of aerosols and spray drift will be less than minor.

5.6.2 Odour

WWTP: The TWWTP has the potential to produce odorous compounds. While the treated wastewater is in an aerobic state, as it is when it exits the pond, the potential for nuisance odour is low. The TWWTP has operated in its current form and at its current location since 1982 (Beca, 2020:P:C.10a). During that time there have been no recorded instances of complaints regarding odour from the plant. No increased risk of odour from the WWTP will occur due to the proposed activity. The odour produced is in keeping with the TWWTP's rural surrounds and can be managed by the methods outlined for aerosols above. In addition, sludge management is required to ensure that anaerobic conditions do not develop in the pond. The sludge management activity may cause a temporary release of odour, however this will be addressed if necessary, by temporary consents at the time of desludging activities.

Storage pond: A change to the TWWTP that is proposed is the addition of a storage pond. Stored wastewater may behave differently to wastewater in the treatment ponds since there is no active treatment process, resulting in changes in the chemical and biological status of the wastewater are occurring. As a result, and coupled with a likely deeper pond, conditions in the storage pond have the potential to become anaerobic, leading to the production of odorous compounds.

The main method for managing odour effects from the storage pond is the avoidance of conditions which favour the production of odorous compounds. Based on the proposed discharge regime there is a rapid turnover of stored wastewater, with insufficient time to become static and produce odorous compounds. Over the 8-10 year period that the water balance covers, the longest period where no discharge from the pond occurs is 5 days (over the period modelled). In all cases, where cumulative storage with no discharge occurred for 4 or more days, it occurred in June. Climate conditions that would favour the production of odour are low at that time of the year. In addition, fresh flushes of oxygen containing treated wastewater and wind effects occur continuously, further reducing the potential for odour production.

In the unlikely event that odour is produced, the pond will be located sufficiently far from receptors to enable diffusion and dispersion to occur so that odour from the storage ponds is not detectable at nearby residences.

<u>Irrigation:</u> Odours associated with treated wastewater irrigation are in keeping with the rural surrounds and are expected to less than would occur from a dairy effluent discharge. As the wastewater is irrigated it is in an aerobic state and typically has minor odour at the location of the discharge, and is expected to be undetectable at the property boundary.

Should there be an issue with odour, it is likely to be a result of treated wastewater having gone anaerobic in the irrigation lines where there is a long period between irrigation events. Should this be the case, a flushing volume of clean water will be pumped through the irrigation lines.

It is concluded that with the appropriate mitigation as identified above, the effects of odours will be less than minor.

5.7 Summary of Effects of the Discharge

The proposed loading rate of the wastewater discharge to land will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of any suspended solids;
- Assimilation of organic material;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Cation adsorption; and
- Filtration and attrition of pathogens.

The amounts of wastewater applied nutrients that are likely to enter surface or groundwater are low, and their effects are expected to be less than minor.

The effects due to pond leakage will not change from the current situation. Overall, there is a significant net reduction in wastewater derived contaminants discharged to the Makaretu River due to the proposed activity.

6 CONCLUSIONS

The discharge of treated wastewater from the TWWTP directly to the Makaretu River is currently having a less than minor effect to this surface body. CHBDC has engaged with the Drummonds for the potential of establishing a land application regime to irrigate up to a maximum of 30 ha of the 42.4 ha total land area. The establishment of land application will result in a reduction in wastewater discharged to the Makaretu River over Stages 1 and 2 of the upgrade. Upon commencement of Stage 2, land irrigation of approximately 90% of the future (2048) average annual wastewater discharge volumes will be achieved.

The assessment of effects has determined that the proposed loading rate of the wastewater discharge to land will enable soil remediation and plant uptake of applied contaminants including:

- Filtration and incorporation of any suspended solids;
- Assimilation of organic material;
- Plant uptake, microbe use, and soil occlusion of nitrogen and phosphorus, and gaseous loss of nitrogen;
- Cation adsorption; and
- Filtration and attrition of pathogens.

The assessment leads to the conclusion that the amounts of wastewater applied nutrients that are likely to enter surface or groundwater are low, and their effects are expected to be less than minor. Overall, there will be a significant net reduction in wastewater derived contaminants discharged to the Makaretu River due to the proposed activity compared with the current 100% discharge via the wetland. Significant positive effects will be achieved as a result of this change to a land discharge system.

There will be no effects that are not capable of satisfactory avoidance, remediation or mitigation. The individual effects concluded from the assessments completed are all less than minor.

7 REFERENCES

Beca. (2020:T:B.24). *Water Quality Assessment – Makaretu River.*

Beca. (2020:T:C.10a). *Takapau Options Report*.

Beca. (2021:A:B.43). *Statutory Planning Review*.

Beca. (2021:T:B.14). *Groundwater Assessment.*

Beca. (2021:T:B.31c). *Growth Impact Assessment – Small WWTPs.*

Beca. (2021:T:D.25). *Surface Water & Ecology AEE.*

Chappell, P. R. (2013). *The climate and weather of Hawke's Bay* (3rd Edition). NIWA Science.

CHBDC. (2021:T:D.1). *Takapau Wastewater Treatment Plant Discharge: Resource Consent Application and AEE.*

Crane, S.R. and Moore, J.A. (1984): Bacterial Population of Groundwater: A Review. Water Air & Soil Pollution, Vol 22 No1, Springer, Netherlands.

Fertiliser Association 2013 Code of Practice for Nutrient Management (with emphasis of fertiliser use)

GNS. (2021). *New Zealand Geology Web Map*. https://data.gns.cri.nz/geology/

Gunn, I. (1997): On-site wastewater and bacterial reduction in subsoil disposal areas – a review. On-site NewZ Special Report – 97/2 a CaRE for the environment project.

Landcare Research. (2020). *Poporangi (Ruataniwha_7a.1)*. Manaaki Whenua Landcare Research

Landcare Research. (2020). *Takapau (Tararu_6a.1).* Manaaki Whenua Landcare Research

Landcare Research. (2020). *Tikokino shallow (Mandamus_22a.1)*. Manaaki Whenua Landcare Research

Landcare Research. (2020). *Tukituki shallow (Ashburton_38a.1)*. Manaaki Whenua Landcare Research

Landcare Research. (2020). *Twyford (Waimakariri_41a.2)*. Manaaki Whenua Landcare Research

LEI. (2021:T:B.13). *Existing Farming System.*

LEI. (2020:T:B.15). *Evaluation of Soils Receiving Takapau Wastewater*.

LEI. (2021:T:C.14a. *Existing/Future Farming System and OverseerFM Analysis.*

LEI. (2021:T:C.14b). *Drummond Overseer & Planning Assessment.*

LEI. (2021:T:C.15). *Takapau Community Wastewater Discharge Conceptual Design.*

Ministry for the Environment. (2018). *Climate change projections for the Gisborne and Hawke's Bay region.* Ministry for the Environment.

NZLTC (2000): New Zealand Guidelines for Utilisation of Sewage Effluent on Land. New Zealand Land Treatment Collective and Forest Research. Rotorua, New Zealand. 180 pp.

Wilding, T., & Waldron, R. (2012). *Hydrology of the Tukituki Catchment: Flow metrics for 17 sub-catchments* (HBRC Plan No. 4405). Retrieved from https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/4405-EMT-1218-Hydrology-of-the-Tukituki-Catchment.pdf