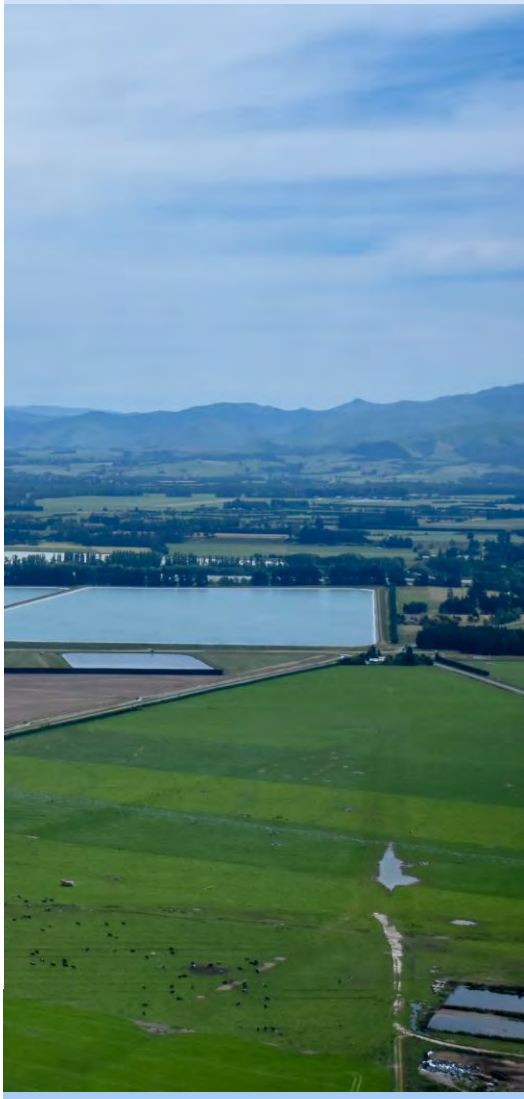
Environmental Monitoring Plan for CRC185857



12 October 2021

Date	12 October 2021
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Document Control

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Executive Summary

Condition	Requirements	Dependencies	Response	
c22	Develop and submit an Environmental Monitoring Plan	c23 c24	This document	
	Develop and submit an Environmental Monitoring Plan by suitably qualified and experienced person(s)		Justin Legg Senior Hydrogeologist Mel Brooks MHV CEO	
c23(a)	Obtain water quality information that may assist in better understanding the effects of nutrient discharges from properties within Schedule CRC185857A		Groundwater NO_3-N Refer to section 4	Surface water Quality Refer to section 5
c23(b)	Reporting of any water quality information gathered to the Canterbury Regional Council		Refer to section 6	
c23(c)	Investigate and respond to changes in water quality attribute state(s) for certain contaminants as to be identified based on five years of data		Refer to section 6.2	
c23(d)	Prepare a Remediation and Response Plan in consultation with Te Rūnanga o Arowhenua following any identified Deterioration		Refer to section 6.2	
c24(a)	Undertake water quality sampling on a minimum of 10 bores, with all bores being sampled quarterly for NO_3-N	c27	Refer to section 3.2.3 section 4	section 3.2.4 section 3.3
c24(b)	undertake (either directly or through a catchment group) surface water quality monitoring		Refer to section 3.2.3 section 5	section 3.2.4 section 3.3
	surface water monitoring shall include monitoring of thecontaminants listed in Table CRC185857-2		Refer to sections: 3 to 3.2.4 & 3.3	
c25	provide a summary within the annual report by 1 December 2022 and then annually thereafter		Refer to section 6	
c26 (a) – (e)	In the event that there is a Deterioration that is identified as a part of the surface water monitoring the Consent Holder shall engage a suitably qualified and experienced person to prepare a Remediation and Response Plan		Refer to section 6.2.2	
c27	undertake a review of the groundwater and surface water monitoring required under c24		Refer to section 3.4	

Nitrogen naming & unit convention

When a laboratory reports directly the concentration of nitrate, it is referring specifically to the nitrate compound, which is designated chemically as NO_3. The drinking-water Standards for New Zealand 2005 (Revised 2018) currently define the Maximum Acceptable Level (MAV)[1] for NO_3 in potable water as 50 mg/L (Ministry of Health, 2018).

However, nitrate (NO_3) is one-part Nitrogen (N) plus three parts oxygen (O), so, nitrogen only makes up about 22.6% of the nitrate compound by weight (nitrogen weighs 14u, oxygen weighs 16u). Hence it can also be reported as the concentration of nitrogen (N) in the form of NO_3 (denoted as NO_3-N), as opposed to the amount of nitrogen in the form of NO_2, NH_4, NH_3, N_2 etc. which may also be present in a water sample.

Hence the following conversion is often applied:

Nitrate-Nitrogen (NO_3-N) = Nitrate (NO_3) x 0.226

Or conversely

Nitrate (NO_3) = Nitrate-Nitrogen (NO_3-N) x 4.43

So **50 mg/L NO_3** **=** **11.3 mg/L NO_3-N**

As the National Policy Statement for Freshwater Management (NPS-FM), the Ashburton Zone Committee and others refer to nitrate concentrations in terms of NO_3-N, all references to nitrates in this report will be with respect to NO_3-N.

Additionally, concentrations of NO_3-N can be reported as:

- milligrams per litre (mg/L),
- parts per million (ppm) and/ or
- grams per metre cubed (g/m^3).

All of which are different volumetric expressions of 1 g solute per 1,000,000 g solution (i.e. they are the same).

To avoid all ambiguity, NO_3-N will be reported in this document in terms of ppm (e.g. NO_3-N MAV = 11.3 ppm).

[1] *"The MAV of a chemical determinand is the highest concentration of a determinand in drinking water that, on the basis of present knowledge, is considered not to cause any significant risk to the health of the consumer over 70 years of consumption of 2 litres per day of that water. Wherever possible, MAVs have been based on the latest World Health Organization (WHO) guideline values, adjusted to a body weight of 70 kg"* (Ministry of Health, 2018)

Abbreviations

°C	Degrees Celsius
CHI	Cultural Health Indicators
CRM	Certified Reference Material
Cumec	Cubic Meter per Second (m^3/s) = 1,000 litres per second
CWMS	Canterbury Water Management Strategy
DIN	Dissolved inorganic nitrogen. The sum of (NO_2-N) + (NO_3-N) + (NH_3)
DO	Dissolved Oxygen
DON	Dissolved Organic Nitrogen
DRP	Dissolved Reactive Phosphorus
DTM	Digital Terrain Model
ECan	Canterbury Regional Council. It uses the promotional name Environment Canterbury, frequently abbreviated to ECan
E. coli	*Escherichia coli*
GL	Giga Litre (1,000,000,000 Litres)
ha	10,000 square meters (2.471 acres)
HMWC	Highly modified water course
IWM	Integrated Water Management
JSEA	Job Safety and Environment Analysis
K	Hydraulic conductivity
kL	Kilo Litre (1,000 Litres or $1m^3$)
l	Litre: a metric unit of capacity equal to 1,000cm^3 (0.264 gallons)
m	Metre
MAR	Managed Aquifer Recharge
MAV	Maximum Acceptable Level
MHV	MHV Water Ltd
MHV-EMP	MHV Environmental Monitoring Programme (MHV-EMP)
m bgl	Metres below ground level
mg/ L/ p.a.	milligrams per litre per annum
ML	Mega Litre (1,000,000 Litres)
ML/ d	Mega Litre per day
mm	Millimetres
NEMS	National Environmental Monitoring Standards
NH_3	Ammonia
NH_4^+	Ammonium
NH_3-N	Ammonia-Nitrogen. The concentration of nitrogen (N) present in the form of ammonia (NH_3)
NO_2-N	Nitrite-Nitrogen. The concentration of nitrogen (N) present in the form of nitrite (NO_2)
NO_3-N	Nitrate–Nitrogen. The concentration of nitrogen (N) present in the form of nitrate (NO_3)
NPSFM 2020	National Policy Statement for Freshwater Management 2020

OFG	Open Framework Gravels
p.a.	per annum (for each year)
pH	a numeric scale used to specify the acidity or alkalinity of an aqueous solution
QAQC	Quality Assurance & Quality Control
RDR	Rangitata Diversion Race
SOP	Standard Operating Procedures
SPC	Specific conductance
SWL	Standing water level
T	Transmissivity
t/ ha/ yr	Tonnes per hectare per year
TARP	Trigger Action Response Plan
TDN	Total dissolved nitrogen. DIN + DON
TN	Total Nitrogen. The sum of NO_3-N + NO_2-N + NH_3-N and organically bonded nitrogen
TKN	Total Kjeldahl Nitrogen. The sum of NH_3-N + organically bound nitrogen - but does not include NO_2-N or NO_3-N.

Contents

1. Introduction

1.1. Discharge Permit CRC185857

Discharge Permit CRC185857 (CRC18585) was granted to MHV Water Ltd (MHV) on April 21, 2021.

The consent authorises the discharge onto or into land where contaminants may enter water arising from farming activities on Properties:

a) listed in Schedule CRC185857A, or any subsequent revisions thereof as provided for under Condition 8; and

b) located within the area shown on Plan CRC185857A (the Command Area),

and including the expansion of dairy support land and irrigated dairy farmland, the conversion of land to dairy farmland and the undertaking intensive winter grazing.

A copy of Discharge Permit CRC185857 is available in Appendix .

1.2. Document Purpose

Pursuant c22 of CRC185857, MHV is required to develop an Environmental Monitoring Plan that satisfies Conditions c23 and c24. In broad terms this means MHV:

a) obtain water quality information that may assist in better understanding the effects of nutrient discharges from properties within Schedule CRC185857A:

   i. on groundwater nitrate-nitrogen concentrations over-time; and

   ii. surface water quality over time; and

b) report of any water quality information gathered to the Canterbury Regional Council (ECan) to inform future water resource management in the Hinds/Hekeao Plains Area;

c) MHV to investigate and respond to changes in surface water quality attribute state(s) or band(s) for certain contaminants as to be identified. Deterioration are determined following the collection of five years of baseline data;

d) prepare a Remediation and Response Plan in consultation with Te Rūnanga o Arowhenua following any identified Deterioration that includes:

   i. MHV to manage nutrient losses that are determined to be contributing to any identified Deterioration in a manner that is consistent with improving water quality over time; and

   ii. reviewing individual Property Farm Environment Plans or Certified Freshwater Farm Plans (as might apply) through the EMS programme where it is determined those farming activities are contributing to any identified Deterioration.

2. Background

2.1.MHV Water Ltd

MHV is a farmer owned water co-operative that has been delivering water for irrigation to the Hekeao Hinds plains since 1947. On 1 June 2017 Mayfield Hinds Irrigation Limited merged with Valetta Irrigation Limited to form MHV Water Limited. MHV now stores and delivers water for the purpose of irrigation to over 200 shareholders via ~320km of open race and ~100km of piped infrastructure and manages the environmental compliance for those farmers over an area of ~58,000 ha.

2.2.Climate and Rainfall

The Hekeao/Hinds plains are prone to drought, with a cool temperate climate, (Köppen climate classification Cfb).

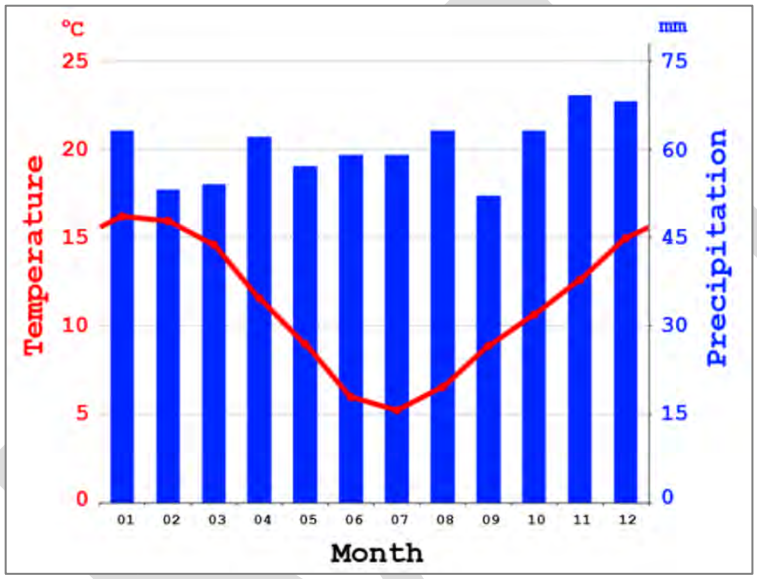

Figure 1 Ashburton Climate[2]

The mean annual rainfall of 680 mm p.a. varies from 614 mm at the coast to approximately 950 mm at the foothills near the top of the plains (2). Regular snow does not make up a large proportion of the total precipitation in the catchment since only a small area of the catchment lies above 500 m (Durney et al., 2014).

[2] https://en.climate-data.org/oceania/new-zealand/canterbury/ashburton-26549/

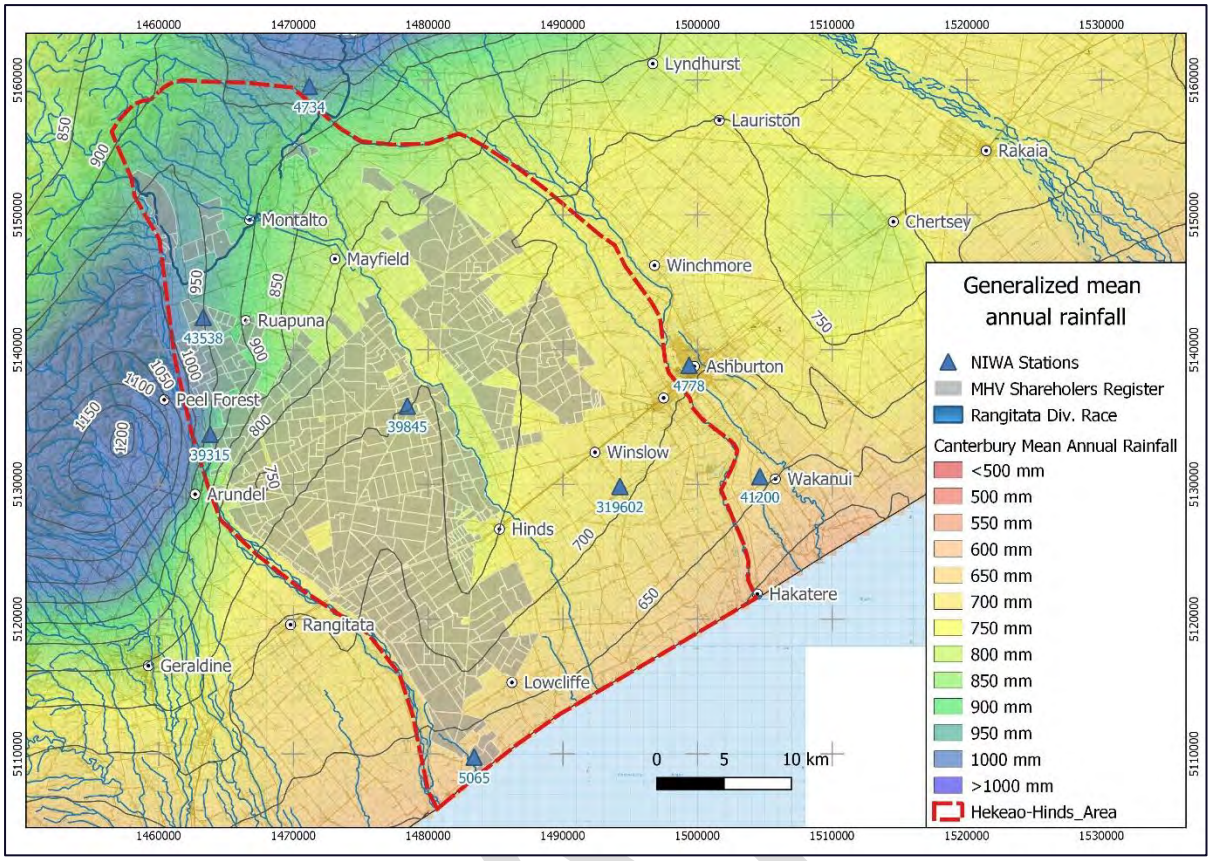

Figure 2 Generalized mean annual rainfall distribution across the Hekeao Hinds Plains

2.2.1. River Flows

River flows across the Hekeao / Hinds almost mirror the seasonal rainfall average as shown in 2, with river flows in all three rivers having reduced flows from 2019 (Table 1).

Table 1 Average daily flow rates (m³/ second) for the rivers in the survey area between 2015 - 2020

	Ashburton River at SH1	Hinds River at Poplar Rd	Rangitata River at Klondyke
2015	13.3	0.36	86.9
2016	14.5	0.39	90.6
2017	29.4	2.99	86.1
2018	40.8	3.24	91.2
2019	25.0	1.54	105.7
2020	11.6	0.33	82.6

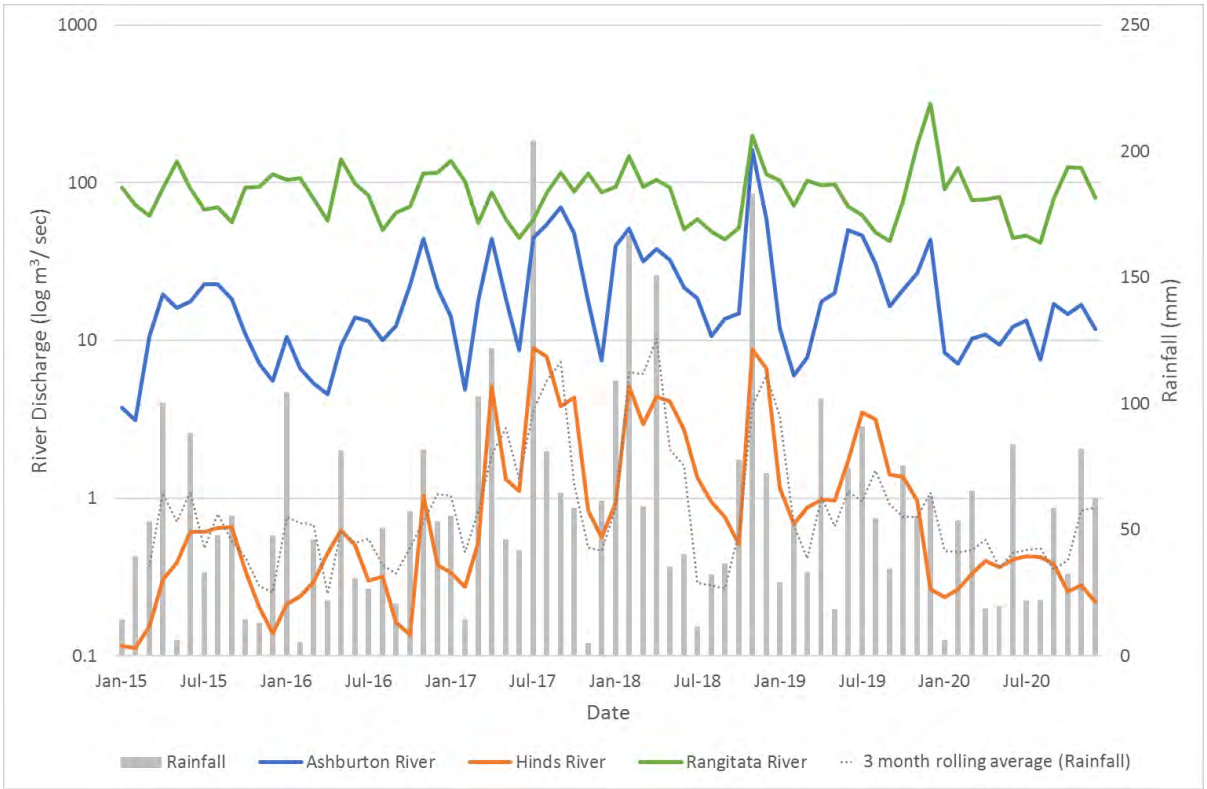

Figure 3 Rainfall and river flow data for the period 2015 to 2020

2.3.Catchment Characteristics

2.3.1. Soils

The Hekeao Hinds Plains has over twenty main soil types, the most common being thin (<0.5 m) sequence of stony, free-draining loess and Lismore-type soils, with a low water holding capacity of less than 75 mm (4) (Hanson and Abraham, 2013).

Closer to river margins, soils tend to be deeper and more varied in type, depth and quality. Notably, the area between from Lagmhor to Waterton, as well as the coastal margin of the plain, the area is dominated by Waterton gley soils and Wakanui deep silt loam soils with higher water holding capacities up to more than 150 mm associated with swamp deposits (Aitchison-Earl, 2019; Hanson and Abraham, 2013, 2010).

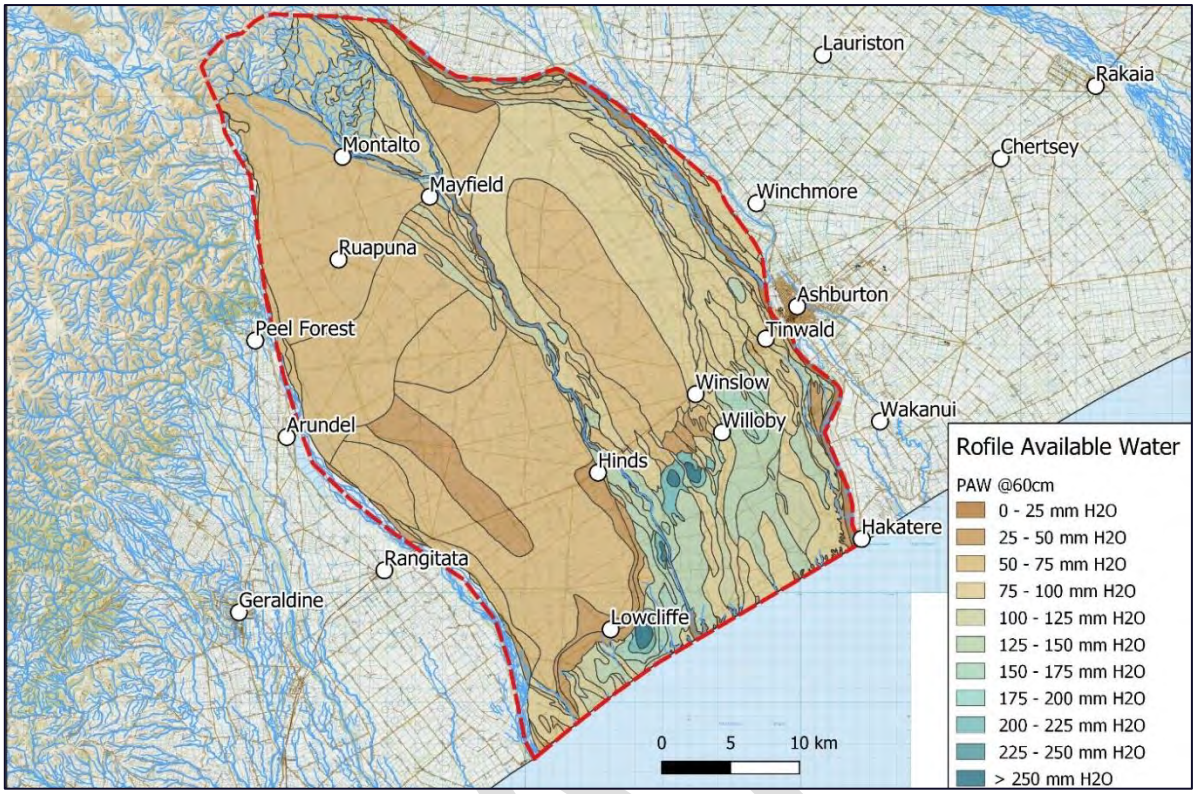

Figure 4 Soils of the Hekeao/Hinds Plains

2.3.2. Geology

Deep (>600 m) Quaternary[3] aged anisotropic and heterogeneous glacial outwash alluvial gravel fans underlie these soils; these were deposited as part of the uplift and erosion of the Southern Alps (Dommisse, 2006; Hanson and Abraham, 2013). These gravels are predominantly composed of greywacke gravel clasts, in a matrix of sandy fine gravel and minor silt with minimal clay (colloquially known as clay-bound gravels), resulting in sediments that are variable and heterogeneous in structure.

Due to their fluvio-tectonic origins, the alluvial gravel fans are up to 600 m thick, within highly permeable lenses of course, matrix-free gravel, surrounded by less permeable gravel with sandy or silty matrix - often referred to as Open Framework Gravels - OFG's (refer to section 2.4.2).

These Quaternary sediments are underlain by Tertiary sediments and Cretaceous greywacke basement of the Torlesse Group (Hanson and Abraham, 2010).

2.4.Hydrology

2.4.1. Catchment Scale

The Hekeao/Hinds plains are serviced by three rivers: the Ashburton/ Hakatere, Rangitata and Hinds/ Hekeao, with a combined catchment of some 148,000 ha. As the Ashburton/ Hakatere and Hinds/ Hekeao rivers are considered foothill rivers and the Rangitata an Alpine river these rivers have variable flow rates and are confined to terraced alluvial fans.

Both mātauranga māori and local farm knowledge attest that the local hydraulic gradient runs obliquely across the Hekeao Hinds from Tarahaoa/ Mt Peel towards the mouth of the Hakatere/ Ashburton River.

[3] Late Quaternary (0.4 Ma) to Holocene (0.014 Ma).

A high-level interpretation of the 1 m LiDAR[4] digital terrain model (DTM) supports this assertion, whereby observable lineation's (i.e., trends that were immediately observable in the data[5]) were digitised (Figure 5). These lineation's are interpreted to be 'paleo drainage channels', associated with the migration of Hekeao/ Hinds Plains rivers over time; and may represent near-surface preferential flow paths and/ or indicators of open framework gravels (see section 2.4.2).

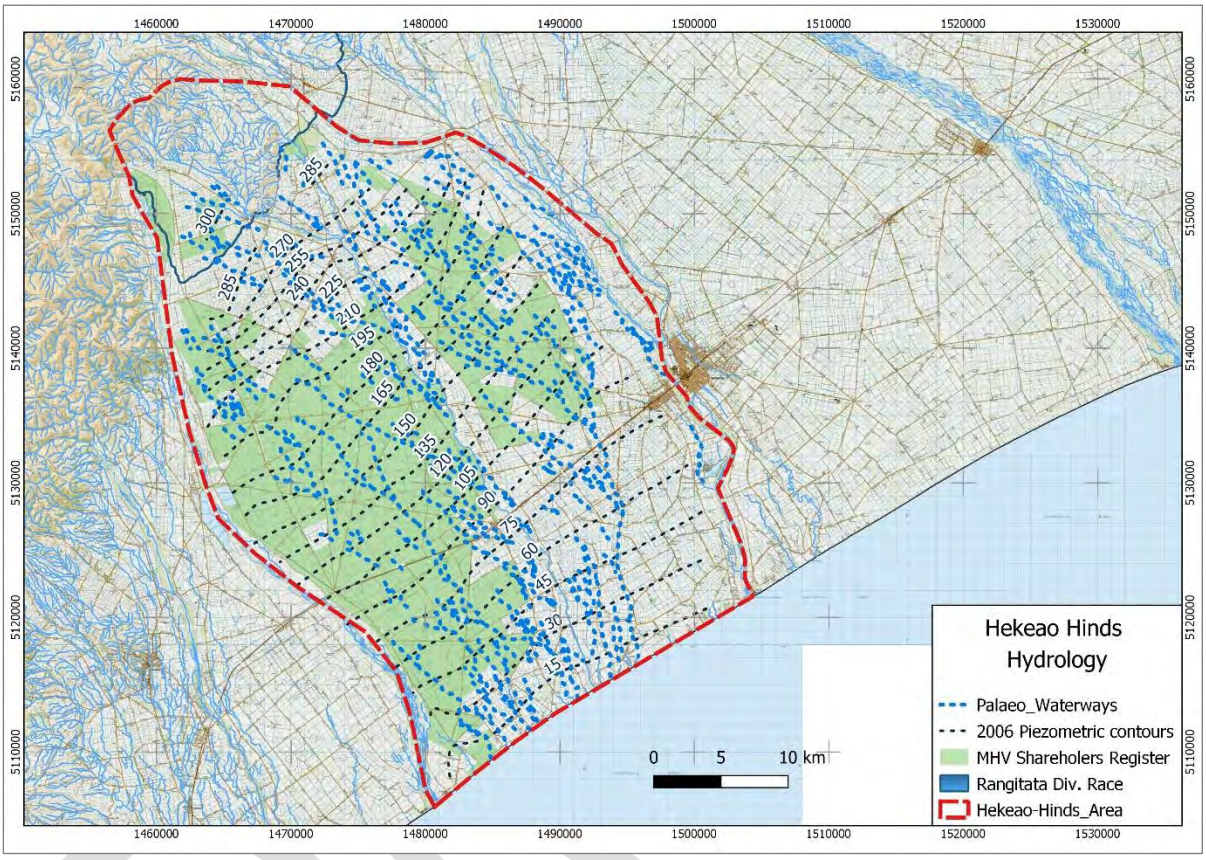

Figure 5 High-level interpretation of the 1m LIDAR digital terrain model (DTM) mapping paleo channels

2.4.2. Aquifers

Historically, the groundwater has been conceptualised as three poorly connected, and laterally discontinuous, aquifers at near surface, ~50 m and ~100 m depths respectively (Dommisse, 2006). The current interpretation (at a regional scale) considers the aquifers of the Hekeao / Hinds plains to be a gravitationally driven flow system with the Quaternary gravels behaving as a *single hydrological system with close connectivity to surface waters* (i.e. rivers and drains). At a local scale, semi-confined (leaky) conditions are likely to be encountered, with confinement generally increasing with depth (Burbery et al., 2018; Durney et al., 2014; Hanson and Abraham, 2013).

Due to the inherent variability of the sedimentary facies, there is a corresponding variability in hydrological transmissivity[6] with calculated flows ranging from 150 to 7,000 m^2/ day (Hanson and Abraham, 2010).

Aquifer recharge is derived from rainfall, irrigation losses, and seepage from the Hekeao/ Hinds, Hakatere/ Ashburton, and Rangitata Rivers.

[4]Light detection and ranging
[5] The LIDAR data was not manipulated via differential methods such as a 1st vertical derivative (1VD) as part of this process
[6] Transmissivity is a measure of the rate at which groundwater flows through a unit width of an aquifer under a unit hydraulic gradient

The majority of flow and transport is to be through open framework gravels (OFG's). Notably, based on work in the Burnham area, it has been suggested that >95% of groundwater flow occurs through OFG's gravels; however, their lengths and interconnectedness is not well understood.

These gravel lenses can (Burbery et al., 2018; Hanson and Abraham, 2010; Rutter et al., 2016):

- be planar-stratified or cross-stratified,
- vary in thickness from centimetres to decimetres,
- be variable in their spacing between lenses,
- can extend from metres to tens of metres,
- account for approximately 1% of braided river sedimentary systems in the Canterbury Plains.

The gravels within the lenses are characterised as (Jussel, 1989; Lunt and Bridge, 2007):

- well sorted (possessing a unimodal grain size distribution) with a mean grain size $\geq$ 2 mm,
- negligible sand and/ or clay matrix,
- having hydraulic conductivities (K) of up to 5 x 10^{-1} m/ sec (i.e. up to two orders of magnitude greater than for sandy gravel, and up to four orders of magnitude greater than for sand)
- having Mn or Fe staining of the clasts.

Figure 6 Example of an open framework gravel lens

OFGs are important as they contribute significantly to flow within, and transport of solutes through, the Canterbury gravel aquifer system. Their exact role, in terms of nitrate transport, is not yet fully understood.

2.5.Localized surface hydrology

The Hekeao/Hinds plains possess several different types of watercourse (Figure 7). These include:

- **Highly modified water courses (HMWC)** - often lowland streams / creeks that have been straighten or incorporated into larger extensive drainage and flood protection works (ECan, 2013; Meredith and Lessard, 2014). There are 6 HMWC's within the MHV command area that have a combined total length of 35.3 km.
- **Drains** - extensive drainage and flood protection works including channelization and man-made drains (ECan, 2013).
- **Races** – Primary water delivery canals.
- **Springs**- a natural discharge point of subterranean water at the surface of the ground or directly into the bed of a stream.
- **Rivers** – i.e., the Hakatere/ Ashburton, Hekeao/ Hinds and Rangitata Rivers.

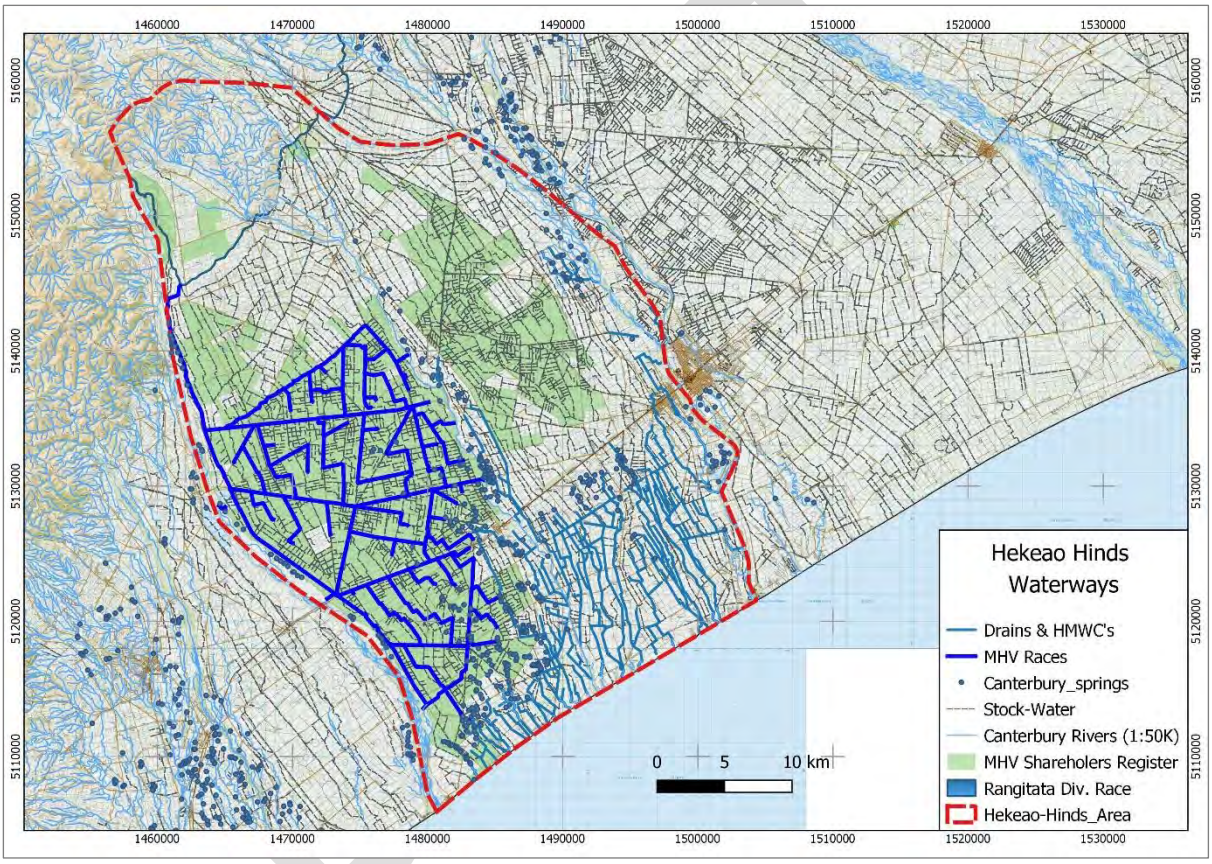

Figure 7 Surface waterways on the Hekeao Hinds Plains

2.6. Nitrate

2.6.1. Sources

Nitrate is a stable, plant available form of oxygenated nitrogen formed through various chemical and biological processes. In the Hekaeo/Hinds catchment, nitrate is mostly derived from several sources including (Aitchison-Earl, 2019; Hanson and Abraham, 2010):

Point sources such as

- septic tanks (human effluent)[7],
- dairy and other animal effluent,
- stormwater and contaminated water,
- Industrial water such as factory washdown water and gravel processing.
- refuse dumps,
- animal feedlots.

Diffuse sources such as

- Urbanisation and construction,
- Stormwater runoff and urban drainage,
- Decaying plant debris,
- Agricultural fertilisers.

Nitrate is one component of a broader natural cycle known as the **Nitrogen Cycle** (Figure 8). In simple terms:

- Nitrogen enters the soil via fertilisers, animal effluent (dung and urine), fixated from the atmosphere or soil organic matter.
- It is then first converted into ammonium (NH_4^+) via a process known as *mineralisation*.
- The ammonium then undergoes *nitrification* that oxidises it to form nitrite (NO_2^-) and the more stable nitrate (NO_3)
- The nitrate is then consumed by plants and bacteria in the soil profile, returned to the atmosphere via *de-nitrification* or is transported as a soluble leachate into the hydrosphere.

[7] In Canterbury, septic tanks are estimated to contribute a load of 9 kg of nitrogen (a concentration of 55 mg/L) per dwelling per year for those installed pre-2006, and 3 kg (a concentration of 20 mg/L) post-2006 (Aitchison-Earl, 2019).

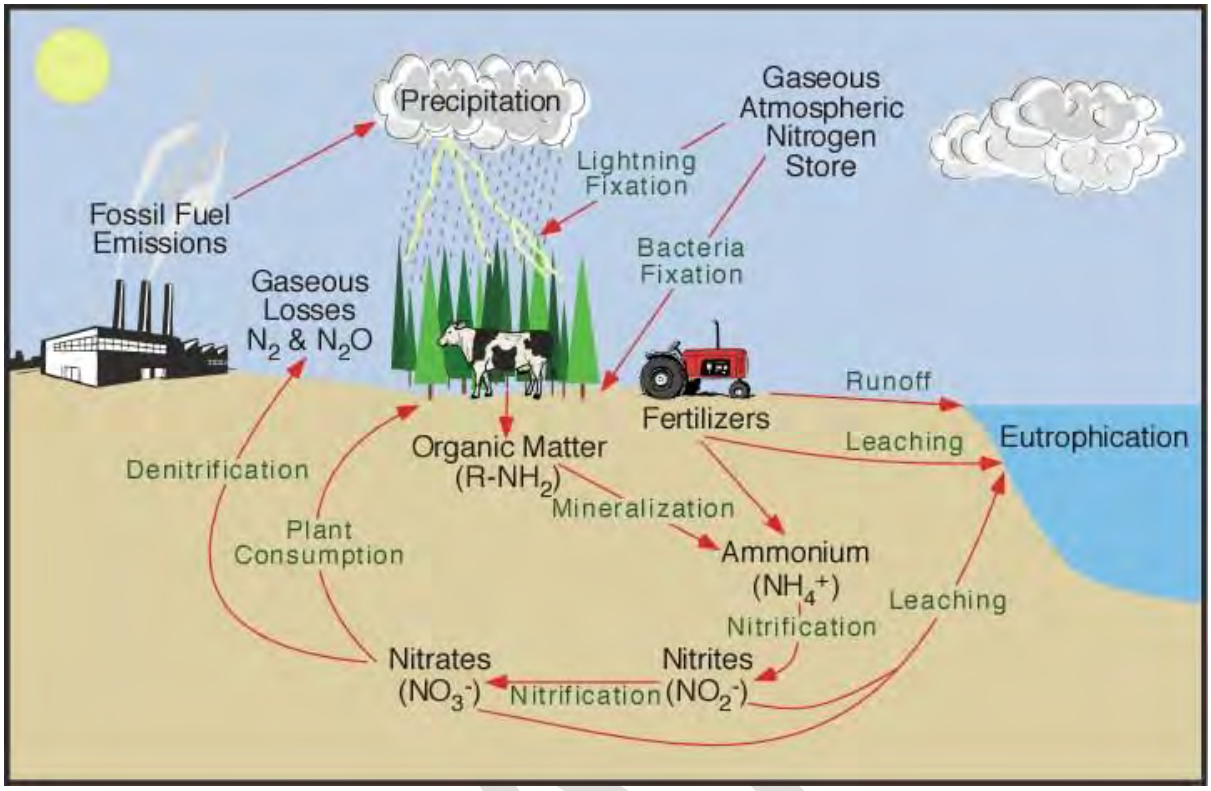

Figure 8 The nitrogen cycle[8]

It is important to note that depending on hydrological conditions, it may take years (and potentially decades) for nitrate to move from the original source and through the groundwater system, so current and historical sources for nitrate must be considered.

2.6.2. Nitrate Distribution

Work undertaken by ECan has revealed variable nitrate distribution across the Hekeao Hinds plains (Figure 9) in response to different soil types (refer to section 2.3.1). In summary (Aitchison-Earl, 2019; Hanson and Abraham, 2010)

- Higher nitrate concentrations were found in the middle and upper parts of the plain with free-draining loess and Lismore-type soils and well oxygenated groundwater,
- lower nitrate concentrations were found in groundwater near the coast. This area was formerly covered by swamp and is characterised by heavy Waterton gley soils and low-permeability Wakanui loam silts,
- The highest nitrate nitrogen concentrations, including those in the Tinwald area, were found near the transition zone between high-permeability sediments beneath the upper plain and the lower-permeability sediments near the coast.

Due to the confluence of the soil type(s), the interconnectivity of surface and groundwater as well as numerous nitrate sources, it is important to recognise that NO_3-N levels in shallow bores in the Hekeao Hinds Plains can fluctuate significantly over short periods of time (Rutter and Rutter, 2019)

[8] http://www.physicalgeography.net/fundamentals/9s.html

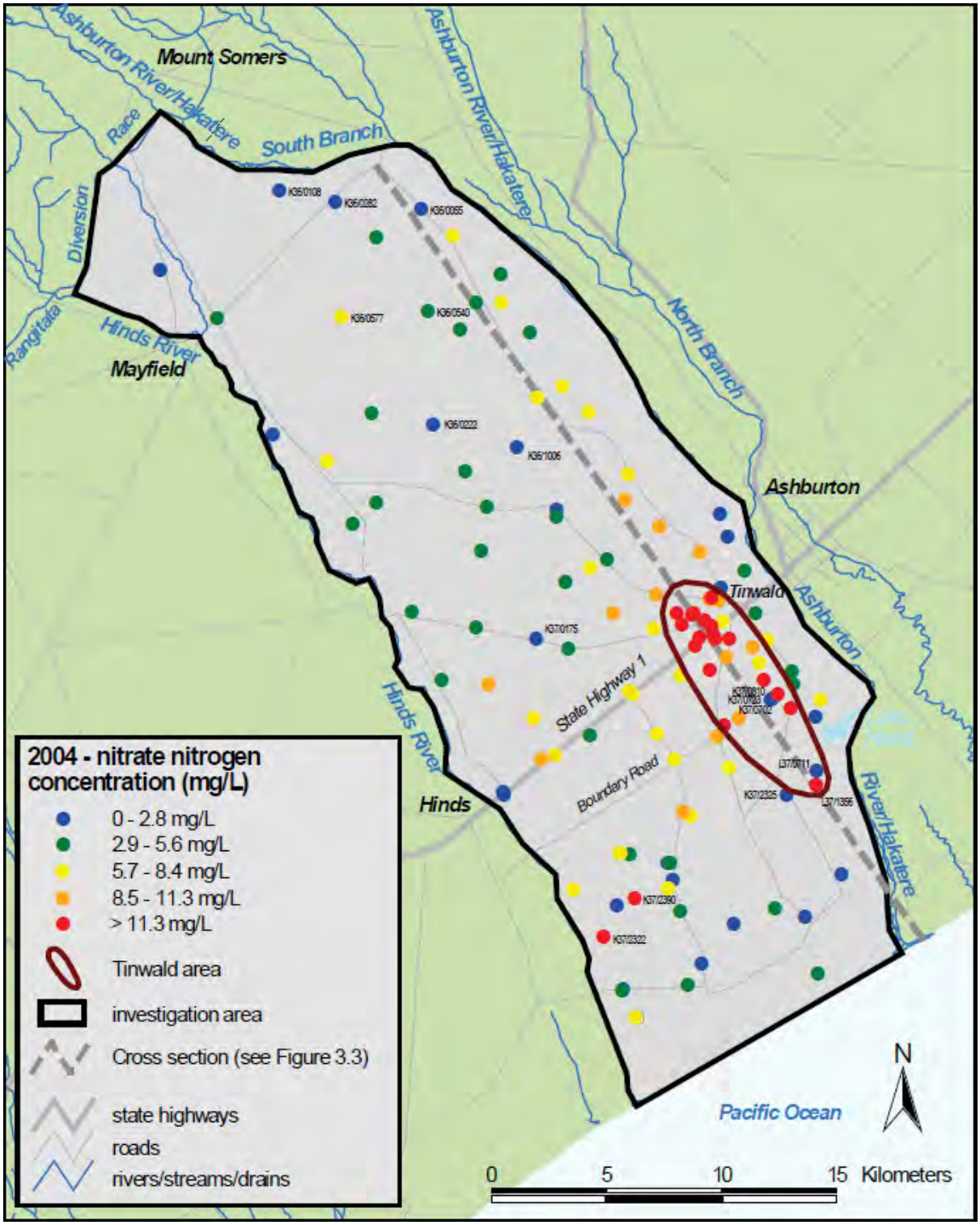

Figure 9 Nitrate nitrogen concentrations in groundwater, (Hanson and Abraham, 2010)

3. Environmental Monitoring Plan

3.1. Monitoring Requirements

To meet the requirements of CRC185857, the MHV Environmental Monitoring Programme (MHV-EMP) will undertake a monitoring program outlined in Table 2 for:

- 10 specified groundwater monitoring sites; and
- 3 surface water sites namely
  i. The Oakdale Drain (also referred to as Coldstream Creek)
  ii. The Harris Drain; and
  iii. The Hinds River.

Table 2 Surface Water sampling requirements for CRC185857, and definitions of Deterioration

Contaminant	Program	Frequency of sampling	Base Attribute State	Deterioration
Nitrate toxicity mg NO_3-N mg/L	Ground and Surface water	Monthly	Median and 95th percentile of previous 5 years' data.	Where the annual (1 July to 30 June) median and/or 95th percentile NO_3- N mg/L are greater than the calculated base attribute state.
Dissolved reactive phosphorous DRP mg/L	Surface water	Monthly	Median and 95th percentile of previous 5 years' data.	Where the annual (1 July to 30 June) median and/or 95th percentile DRP mg/L are greater than the calculated base attribute state.
Escherichia coli E. coli/100ml	Surface water	Monthly	The attribute band as calculated in accordance with the NPSFM 2020 and using 5 years of data	Where the attribute band (NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macroinvertebrates (percentage cover)	Surface water	Annually between December and March (inclusive)	The median attribute band as calculated in accordance with the NPSFM 2020 and using 5 years of data.	Where the attribute band (NPSFM 2020) is worse than the calculated base attribute state (using annual data)
Deposited fine sediment (percentage cover)	Surface water	Monthly	The attribute band as calculated in accordance with the NPSFM 2020 and using 5 years of data.	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Periphyton (percentage cover and chlorophyll-a)	Surface water	Monthly	Not applicable for percentage cover. For Chlorophyll-a: the attribute band as calculated using 5 years of data in accordance with the NPSFM 2020	Not applicable for percentage cover For Chlorophyll-a: where the attribute band (NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macrophytes (percentage cover)	Surface water	Monthly	Not applicable	Not applicable

3.2. Methodology

3.2.1. Program design considerations

As noted in section 3.1, the monitoring program has both a surface water and groundwater component. Subsequently the sampling monitoring program will be broken in a surface water and groundwater program for the following reasons:

i. The Oakdale and Harris drains are the only permanently flowing water systems within the MHV Shareholder area. These waterways are designated as 'Highly Modified Water Courses' (HMWC) - lowland streams or creeks that have been straighten or incorporated into larger extensive drainage and flood protection works (ECan, 2013; Meredith and Lessard, 2014).

ii. To provide enough spatial coverage across the MHV shareholder area (also referred to as the Command Area in CRC185857); as well as avoid connectivity issues, monitoring bores are placed across the Command area on a >2km radius (refer section 3.3).

3.2.2. NEMS

The sampling procedures and for both ground and surface water have been developed in accordance with the National Environmental Monitoring Standards (NEMS) for Discrete River Water Quality Data[9] (Milne, 2019).

To meet the NEMS requirements, MHV has developed a comprehensive management system that informs Standard Operating Procedures (SOP's), which in turn provides guidance to ensure that data is collected in a systematic and consistent manner. Table 3 presents a summary of how the NEMS for Water Quality Data has been applied to this MHV-EMP (refer to Appendix 1 for a detailed explanation).

[9] NEMS for Discrete River Water Quality Data. Part 2 of 4: Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data

Table 3 Summary of application of NEMs to this EMP.

NEMS for Water Quality Data		MHV	
Sect^{n}	Title	MHV Management	
1	Preparatory Work in the Office	MHV utilises the SOP's, JSEA's, a cloud based digital data logging system (Assura®) and a site register (referred to in house as the bore hole Information Register)	
2	Monitoring Site Location	MHV uses a risk-based job safety assessment (JSA) management system to minimise the risks associated with undertaking field work both on public and private land. Site locations and conditions are recorded in Borehole Information Registry.	
3	Field Measurements	The following observations are captured in the field and entered into Assura®	
		Date & Time of Sample Collection	
		Bore Location	Address and NZTM mE and mN
		Well head security	• Collar present • Concrete Pad • A secure well head cap • Proximity to pollution • Security from livestock or vehicle interactions
		Weather Conditions	Basic descriptors
		Recent (last 24 hrs) rainfall	Basic descriptors
		Water temperature	°C
		Specific conductance	µS/cm
		Conductance	µS/cm
		Dissolved Oxygen	%L
		Dissolved Oxygen	mg/l
		Turbidity	NTU
		REDOX Potential	mV
		pH	
4	Water Sample Collection	MHV has SOP's for sampling both ground and surface water MHV Groundwater Sampling SOP based on the NEMS protocols. Purge time is calculated in Assura based on depth sounding to SWL and bore hole details. If a depth to SWL cannot be determined, then a SWL of '0' is assumed for the purge time calculations.	
5	Laboratory Measurements on Water Samples	All samples to be reported for consenting purposes will be sent to Hill Laboratories or an equivalently accredited laboratory.	

		Hill Laboratories is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
6	Data Processing and Quality Assurance	**Quality Assurance** Calibration records of field monitoring data will be collected and stored in Assura Sampling data will be collected and stored in Assura All data is stored in Assura® with a numerical quality designator assigned a value based on the inputs entered at the time of sampling.

The MHV-EMP is supported by four components as shown in Figure 10:

i. Specific monitoring site location information is recorded in a Borehole Information Sheet register.

ii. Field data (water quality data as well as meta-data) is recorded onsite (in real time) into Assura – a cloud-based data recording platform. If connectivity is unavailable at the time.

iii. SOP's that specify the protocol and practices for undertaking sampling water peripheral supporting activities such as instrument calibration etc and thus inform Water Sampling Practices.

iv. A Job Safety and Environment Analysis (JSEA) to ensure that MHV staff, the landowner and the environment are not compromised during the sampling process

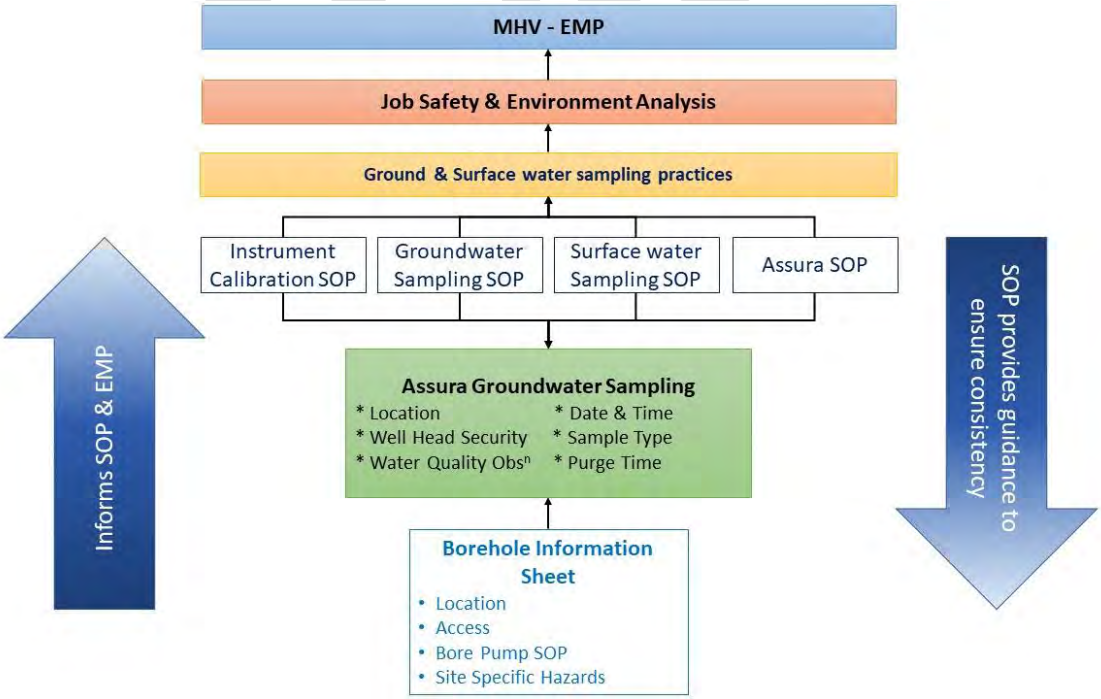

Figure 10 Conceptual structure of the MVH-EMP

3.2.3. Quality Assurance / Quality Control

In addition to ancillary data outlined in section 3.2, Quality Assurance / Quality Control (QAQC) protocols will be incorporated to support the veracity and validity of the data.

In this instance QA/QC is defined as:

Quality Assurance the process or set of processes used to measure and assure the quality of a product. It is process oriented and focuses on defect prevention. It focuses on product defect identification.

Quality Control the process of ensuring products and services meet consumer expectations. It focuses on product defect identification.

Table 4 presents a summary of the QAQC protocols that will be included as part of the MHV-EP.

Table 4 Summary of QAQC Protocols

Variable	Details recorded in Assura
Quality Assurance	Samples will be collected via a standard methodology Instrumentation will be calibrated weekly during sampling Calibration records will be collected and stored in Assura Sampling data will be collected and stored in Assura
Quality Control	Sample chain of custody protocols Duplicate field samples will be tested in-house 10% of samples (1/10) will be submitted as blind duplicates to the laboratory 10% of samples (1/10) will be field blanks are samples obtained in the field using distilled water. 1 Certified Reference Material (CRM) will be inserted into the sample stream on a 1:10 ratio

3.2.4. Sampling methodology

Sampling will be undertaken by MHV staff (refer to section 3.3.1) in accordance with MHV Standard Operating Procedures.

The sampling method is summarised as (see Figure 1111)

i. Field observations are recorded in Assura
ii. Samples are taken in accordance with the NEMS protocols
iii. A NO_3-N sample is tested in house
iv. QAQC sample(s) (CRM, duplicate and/ or Blank) is submitted into the sample stream to the laboratory
v. The results from the lab are compared to the in-house test and the QAQC Samples
vi. The results are imported into Assura

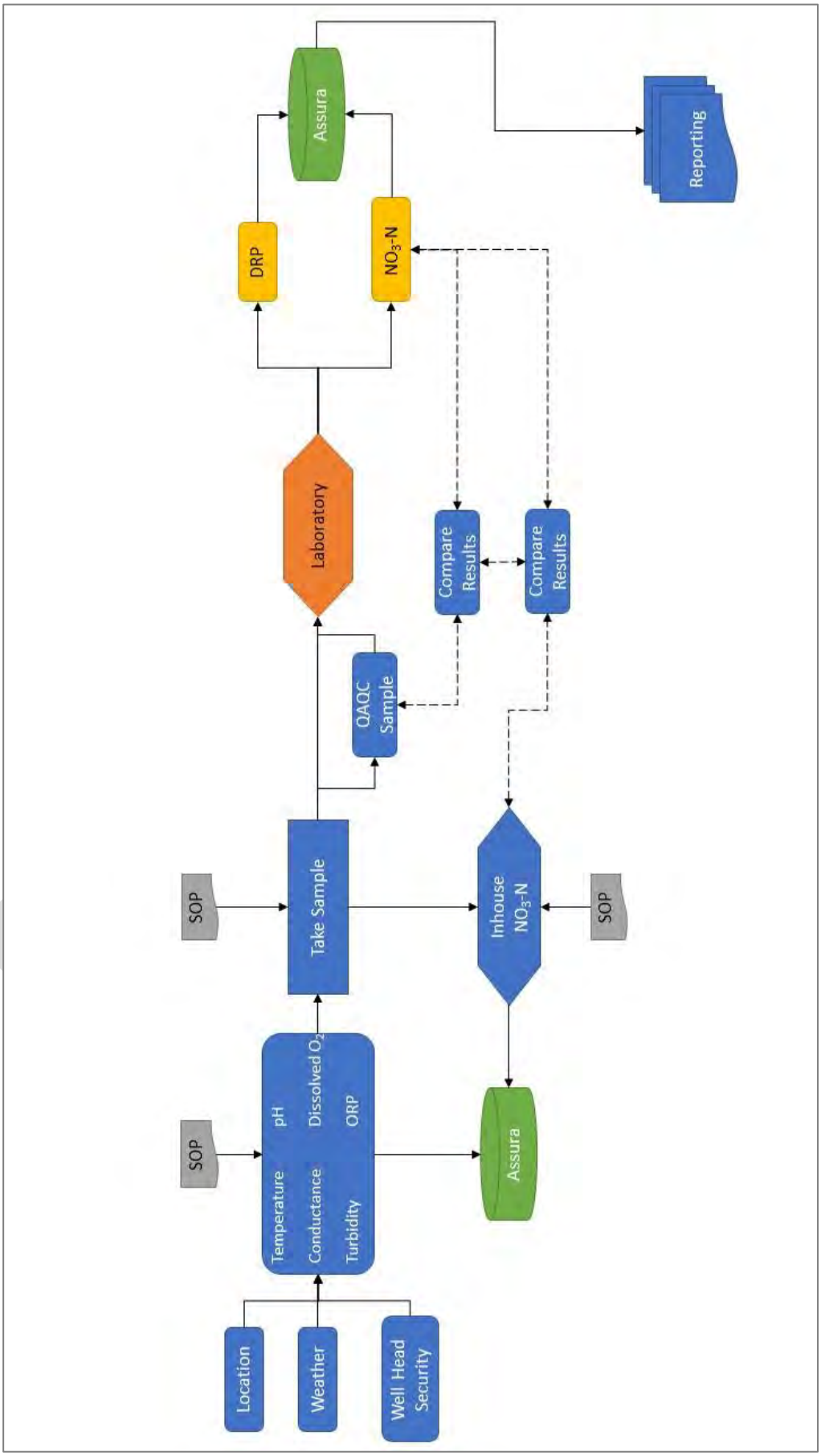

Figure 11 Sampling Procedure Flow Chart

3.2.5. Well Head Security

Section 5.103 of the LWRP requires that all wellheads are secure, such that the construction prevents contaminants or surface water from entering the top of the bore or gallery or underlying groundwater. Whilst not necessarily relevant to nutrient sampling, non-secure well heads could present an opportunity for localised, point source contamination to occur. Therefore, as part of the monitoring program, visual inspections of well head security were completed based on the following criteria (Environment Canterbury, 2019) and summarised in Figure 12:

Collared Does the bore have a portion of the gallery pipe extending above the surface that is >200m in height that is in reasonable condition?

Capped Does the bore have a robust, permanent and weatherproof cap on the collar?

Pad Is the collar of the bore encased in a single concrete pad of at least 0.3 m radius and 0.1 m thickness which is contoured to slope away from the bore or pipe?

Proximity Is the bore <20 m from a potential pollution source? e.g. a dairy track to the milking shed.

Secure Is the bore in a secure location – is the bore confined to a shed or a small fenced area?

NB: It should be noted that this inspection does not consider section 8 "Meaning of drinking water supplier" of the Water Services Bill that is before parliament at the time of writing.

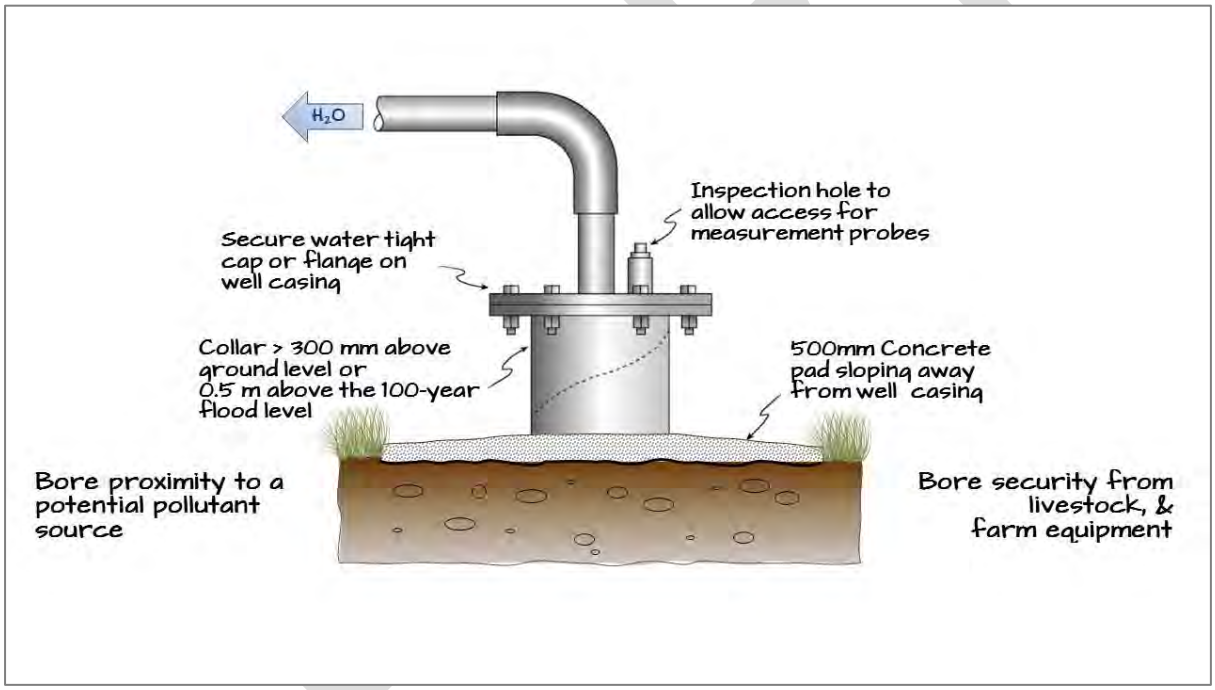

Figure 12 Well head security considerations

3.3. Monitoring Schedule

As noted in section 3.1 sampling is required on both a monthly and annual basis. Additionally, the irrigation season is from the 10th of September until the 9th of May each year.

Timing between monitoring will not be less than 1 week (i.e. week 4 of month A and week 1 of month B) nor greater than 6 weeks (i.e. week 1 of month A and week 4 of month B).

An indicative schedule of field sampling is presented in Figure 13. This schedule is indicative only and may change.

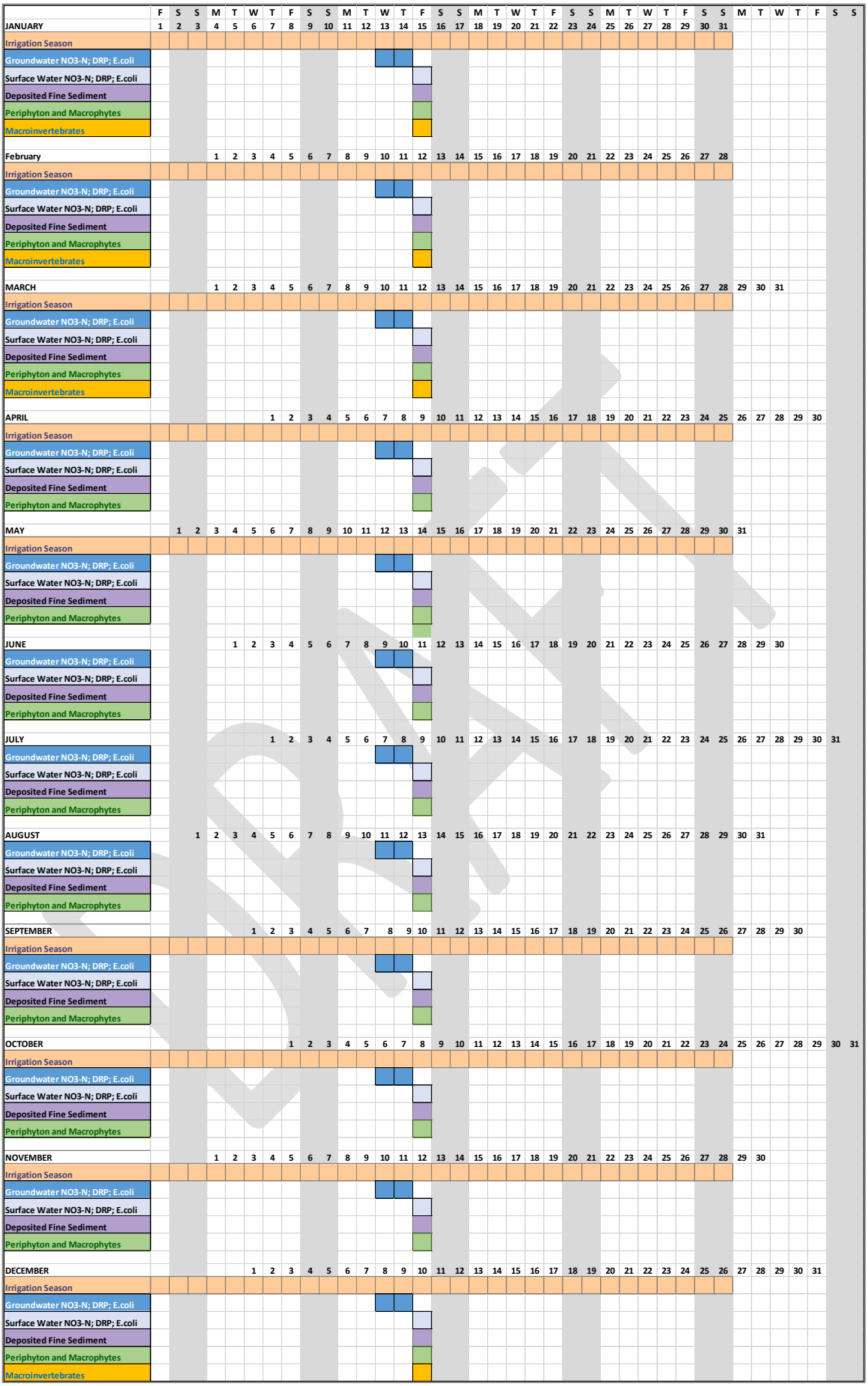

Figure 13 Indicative schedule of ground and water monitoring

3.3.1. RACI Responsibility Matrix

A R.A.C.I. responsibility matrix methodology has been employed to clearly identify, clarify and define roles and responsibilities within the MHV-EMP.

In this instance R.A.C.I. stands for

- **R** = ***Responsible***. Those who do the work to complete the task
- **A** = ***Accountable***. The one ultimately answerable for the correct and thorough completion of the deliverable or task
- **C** = ***Consulted***. Those whose opinions are sought, typically subject-matter experts; and with whom there is two-way communication.[6]
- **I** = ***Informed***. Those who are kept up to date on progress, often only on completion of the task or deliverable

Table 5 R.A.C.I. responsibility matrix for the MHV-EMP

MHV-EMP	MHV Scheme Operator	Senior Hydro-Geologist	MHV Enviro Team	MHV CEO	Te Rūnaga o Arowhenua	External Technical Review	ECan
Design	I	R / A	C	C	C	I	I
Implementation	R	A	I	I	C	I	I
Execution	R	A	I	I	I	I	I
Review	C	A	C	C	R	R / A	I
Reporting	I	R	I	A	C	C	I

3.4. Program Review

c.27 determines when MHV shall undertake a review of the EMP;

a. within the six month period that begins on the date that is five years after the Commencement Date, being the date which the Base Attribute State has been determined for all listed contaminants, or
b. at any other time that may be determined by the Consent Holder; or
c. on making any change to Schedule CRC185857A that results in increasing the area managed by the scheme on a Property or adjoining Properties by more than 200 hectares over that occurring at the Commencement Date, provided that in the case of a review under this Condition 27(c), the review shall be limited to the effects of the change and the need to consider further groundwater and/or surface water monitoring sites.

Any review will be undertaken by a suitably qualified and experienced person and will include engagement with Te Rūnanga o Arowhenua and the Regional Leader – Monitoring and Compliance, Canterbury Regional Council.

4. Groundwater Monitoring Program

A 12-point selection criterion was used to identify the 10 bores required accommodate the requirements of c24(a) of CRC185857 (refer to Appendix).

The selected bores range in depth from 10m to 97m as shown in Table 6 and Figure 14. The locations of these bores are presented in Figure 15.

Table 6 Details of monitoring bores for CRC185857

WELL NO	NZTM mE	NZTM mN	Drilled	Depth	Screen Top	Screen Bottom	Use
BZ20/0079	1481717	5117008	2020	30.0	28.5	30.0	Domestic and Stockwater
K36/1072	1478173	5152240	2011	97.0	95.5	97.0	Domestic and Stockwater,
K37/0442	1476960	5131945	1991	24.0	23.0	24.0	Domestic Supply
K37/0948	1480897	5139885	1999	10.0	5.0	10.0	Water Level Observation
K37/1290	1466787	5134604	2001	53.0	49.0	53.0	Domestic and Stockwater
K37/2162	1473649	5137895	2004	48.16	46.7	48.2	Domestic and Stockwater
K37/2766	1483493	5119767	2006	53.5	47.5	53.5	Irrigation
K37/3000	1481771	5144529	2007	77.25	73.2	77.3	Domestic and Stockwater
K37/3155	1488759	5144768	2008	38.0	36.5	38.0	Domestic and Stockwater
K37/3500	1480912	5128041	2010	42.0	35.1	41.1	Irrigation

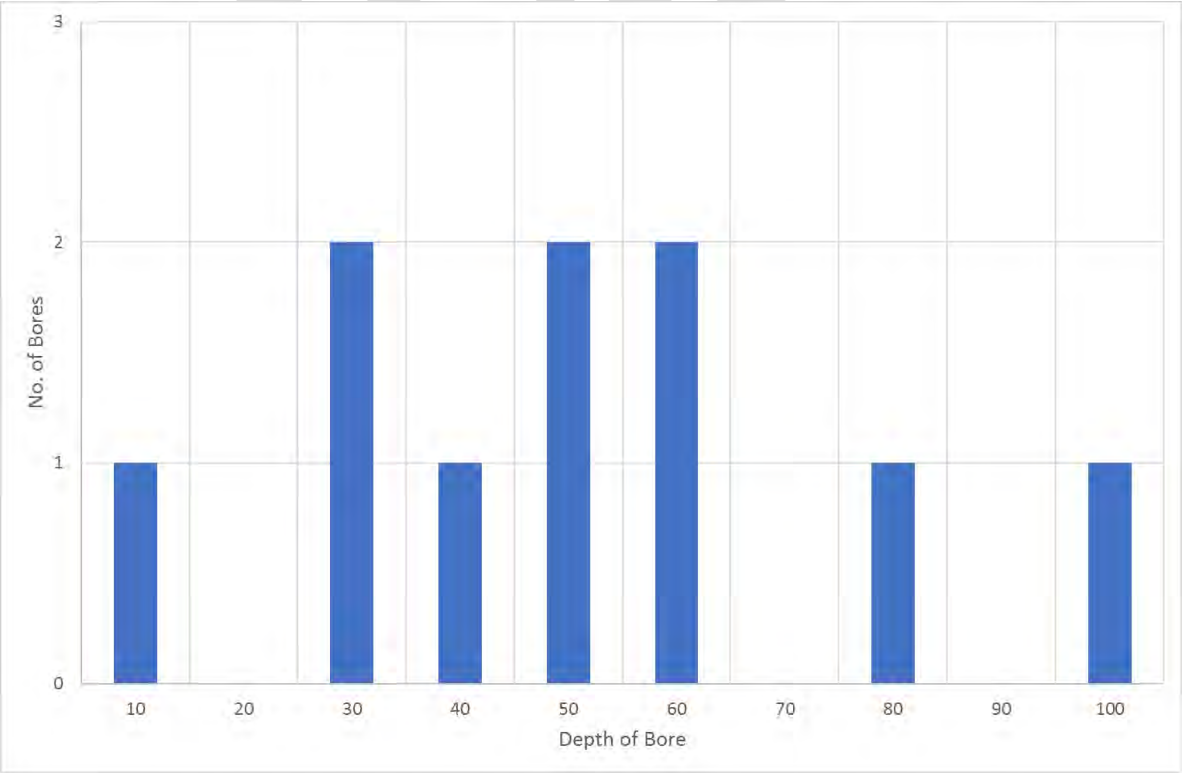

Figure 14 Frequency histogram of depths of monitoring bores for CRC185857

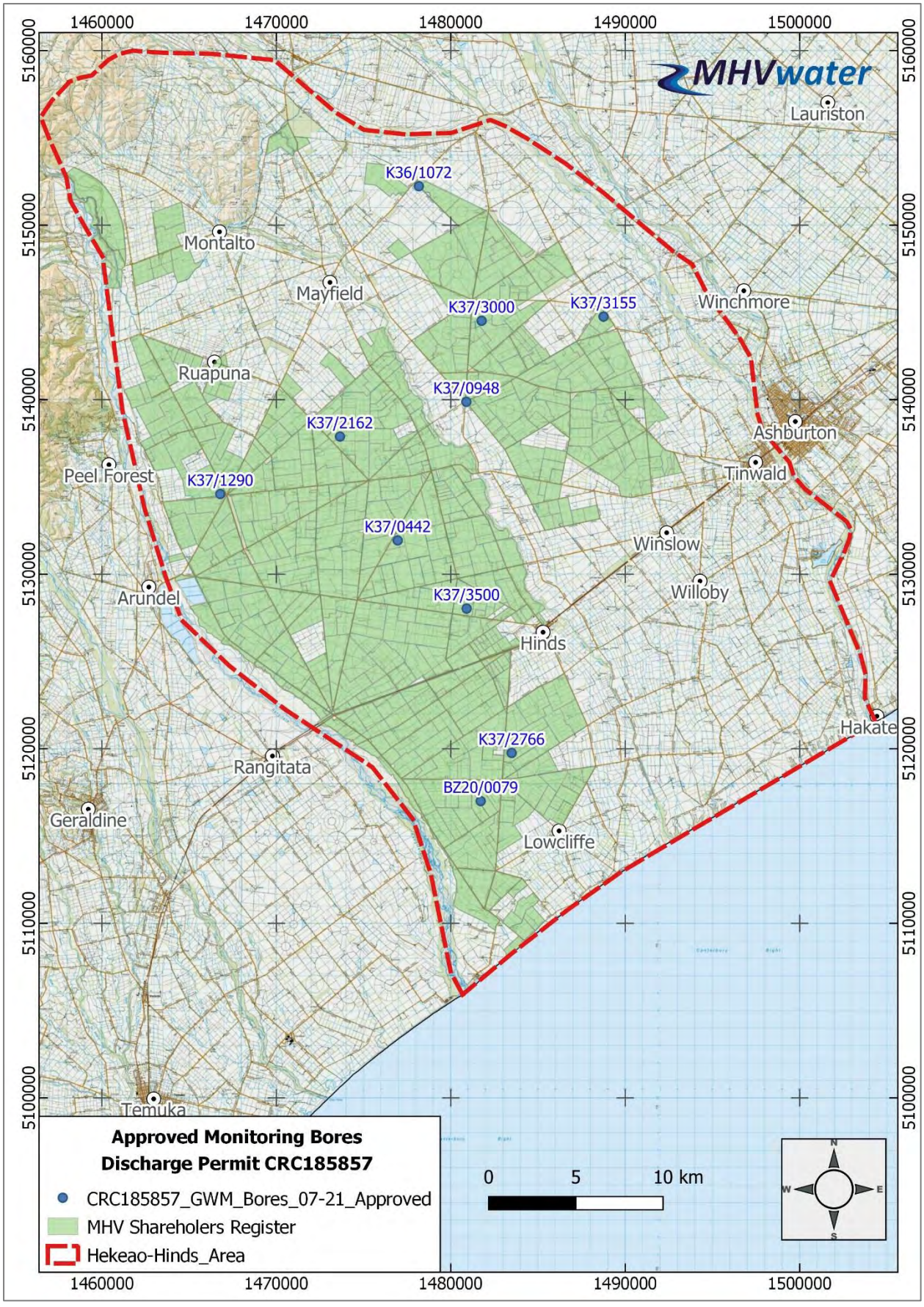

Figure 15 Locations of the monitoring bores for CRC185857

5. Surface water monitoring

As specified in c24(b) of CRC185857, surface water quality monitoring is required in the Oakdale and Harris Drains as well as the Hinds River.

NB** The Oakdale drain is also referred to on LINZ Topographic Maps as **Coldstream Creek.

The locations of the surface water sites are presented in Table 7 and Figure 16 and Figure 17.

Table 7 Locations of surface water monitoring sites

Site ID	NZTM mE	NZTM mN	Type	Name
SQ20507	1485065	5109795	HMWC	Harris B
SQ26072	1484397	5109164	HMWC	Harris C
SQ34916	1482102	5110698	Spring	Oakdale Drain
SW08	1483455	5111952	HMWC	Harris Drain
SW41	1483470	5108870	HMWC	Oakdale Drain
SQ20150	1490780	5119480.	River	Hekeao / Hinds

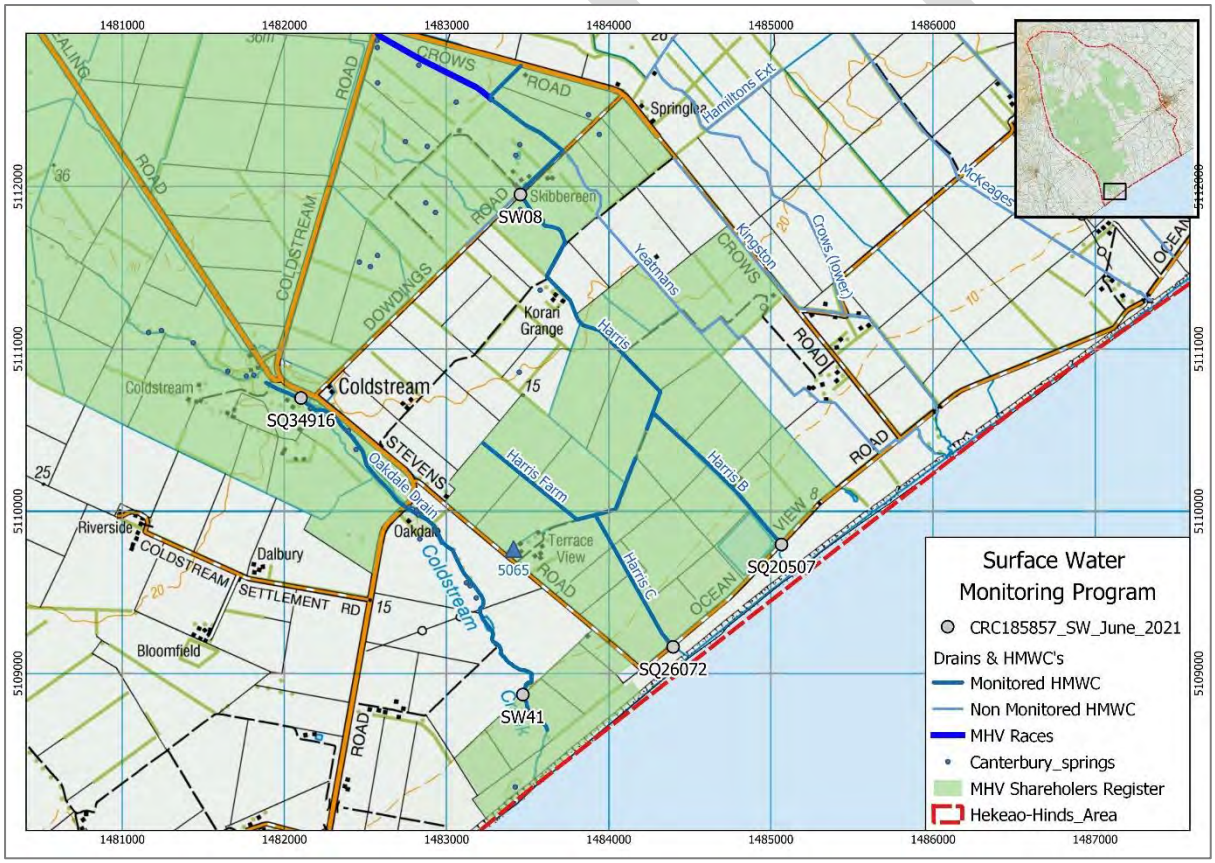

Figure 16 Surface Water Monitoring Locations – Harris and Oakdale Drains

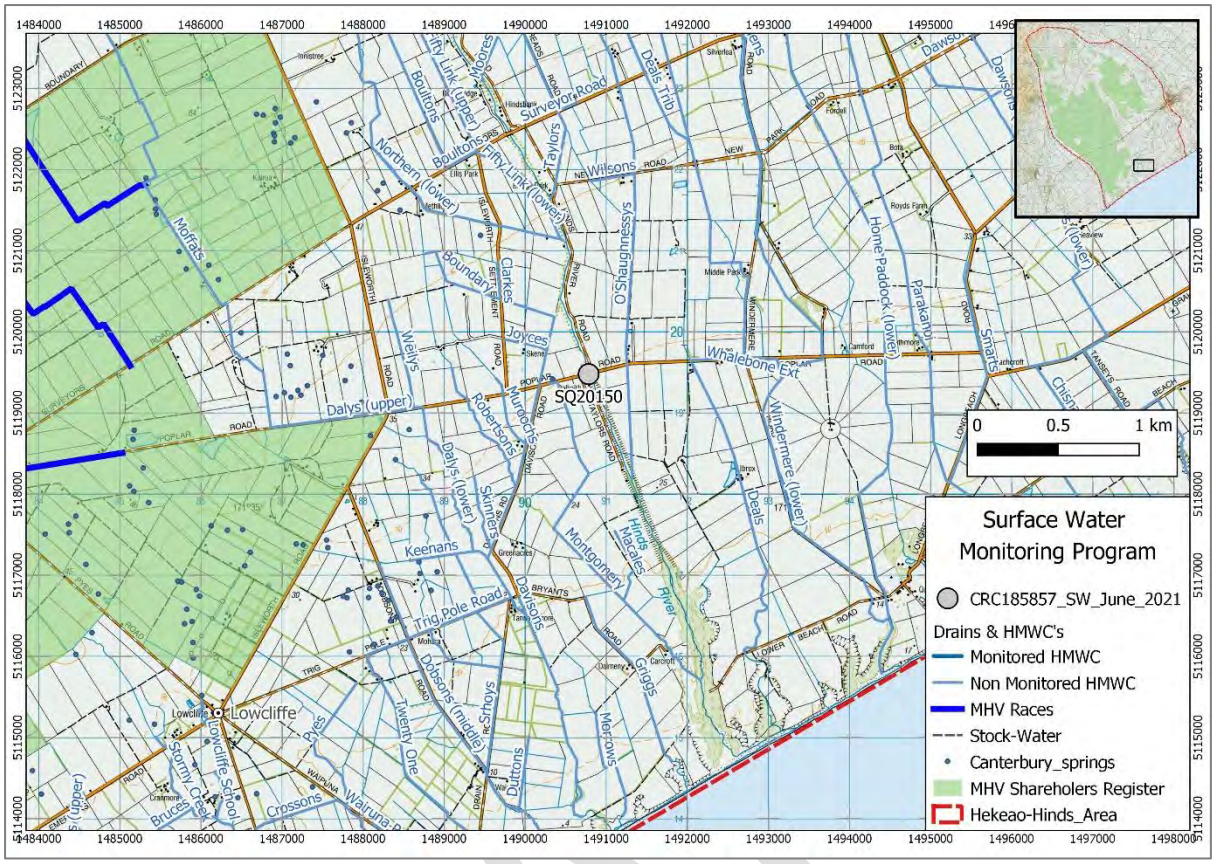

Figure 17 Surface Water Monitoring Location – Hinds River

6. Reporting Requirements

6.1. Annual Reporting requirements

The results of the monitoring program will be reported on an annual basis to the Regional Leader - Monitoring and Compliance, ECan beginning on 1 December 2022 and will cover the period of 30 September to 30 Sept the preceding year.

This report will be prepared by MHV and present the data accumulated through the year as well as a discussion once the Base Attributes States have been established regarding;

i. the extent to which there has been any identified Deterioration in surface water; and

ii. for contaminants where a Deterioration is not defined (being Periphyton and Macrophytes percent covers, the nature of any changes over time, including any unexpected declines.

The report will be independently reviewed prior to submission by suitably qualified professionals.

When considering the results from the monitoring program, it is important to consider the data in temporal hydrological context.

Hence the following considerations will be incorporated into any reporting of the results.

6.1.1. Rainfall Data

Rainfall / precipitation information for the Hekeao/ Hinds Catchment will be obtained. Data from weather stations specified in Table 9 and Figure 188, or other suitable locations across the catchment, will be incorporated into the findings of the monitoring report.

Table 8 Summary of Rainfall stations to be used as part of the MHV-EMP

Name	Owner	NZTM mE	NZTM mN	Agent No	Network No.
Mt Somers	NIWA	1471169	5159537	4734	H31736
Ashburton Council	NIWA	1499367	5138850	4778	H31971
Arundel Simla	NIWA	1463799	5133724	39315	H31824
Lismore, Racemans House CWS	NIWA	1478454	5135820	39845	
Wakanui 2 CWS	NIWA	1504627	5130586	41200	
Coldstream No 3	NIWA	1483412	5109766	5065	H41153
Mayfield At Ruapuna Forecast	NIWA	1463300	5142395	43538	
Longbeach Road	ECan	1494235	5129860	319602	

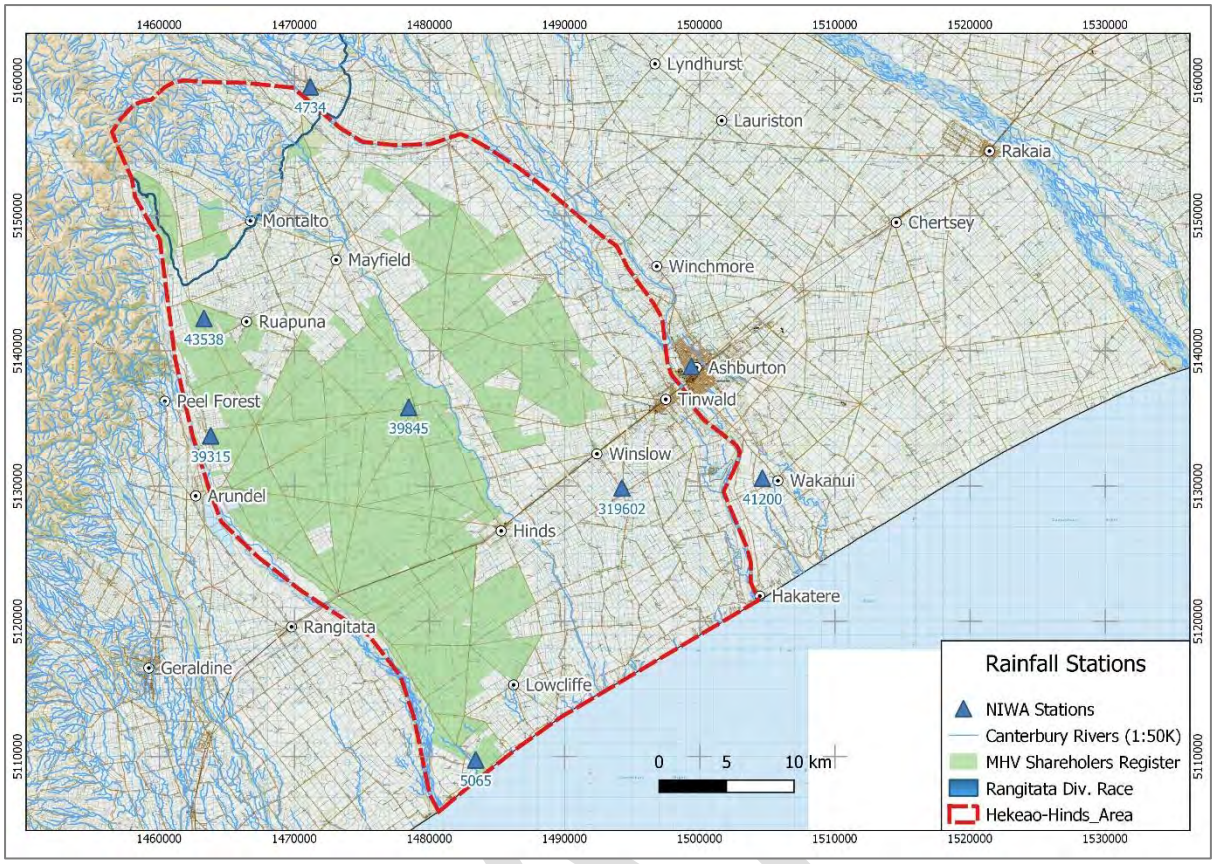

Figure 18 Locations of Rainfall stations to be used as part of the MHV-EMP

6.1.2. River Flow Data

River and HMWC flows will be obtained for the flow stations in Table 10 and Figure 19 and incorporated into the findings of the monitoring report. These stations were chosen based on their proximity to:

i. the surface water monitoring locations (refer to section 5); and,

ii. the main rivers (i.e. the Rangitata, Hekeao/ Hinds and Hakatere/ Ashburton)

Table 9 Summary of River flow stations to be used as part of the MHV-EMP

SITE NUMBER	Waterway	NZTMX	NZTMY
68801	Ashburton River	1499836	5135283
68833	North Ashburton River	1497506	5140172
69302	Rangitata River	1456745	5153178
69106	Hinds River South Branch	1468370	5149775
69102	Hinds River	1490732	5119694
2316	Oakdale Drain	1482743	5110026
68832	Taylors Stream	1481936	5156485
2314	Harris Drain	1485046	5109794
2312	Crows Drain	1486035	5110594
1693065	Oakdale Drain	1483474	5108844

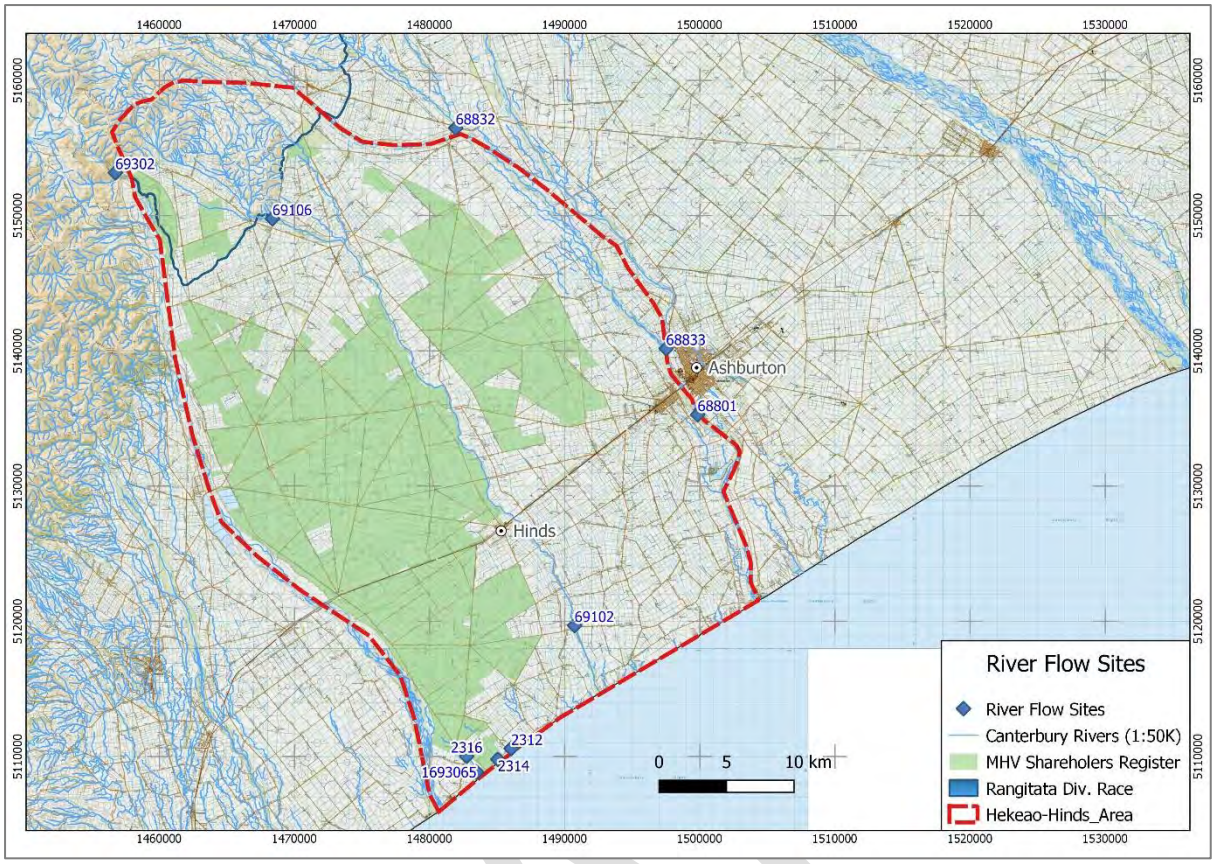

Figure 19 Locations of River flow stations to be used as part of the MHV-EMP

6.2. Response and Remediation Plan

6.2.1. Confirmation of a Deterioration

- A Deterioration is identified in Table 2 for each of the Contaminants measured under CRC185857 for surface water.
- The Base Attribute State to which a Deterioration is measured will be established for each monitoring site based on 5 years of monitoring, as no current qualified water quality data exists for these sites.
- Where a Deterioration is identified as part of the water monitoring required under CRC185857, within one month of the Deterioration being identified, MHV will prepare a draft Response and Remediation Plan to enable consultation with Te Rūnanga o Arowhenua.
- Within six months of the Deterioration the Response and Remediation Plan shall be confirmed and a copy provided to ECan.
- Notwithstanding the consent conditions, MHV will keep Te Rūnanga o Arowhenua informed of water quality monitoring results throughout the course of the 5 year Base Attribute State determining period.

6.2.2. Components of the Response and Remediation Plan

The Response and Remediation Plan shall:-

a. Be completed by a suitably qualified person;
b. discuss the potential causes of the Deterioration, and the extent to which they might be attributable to the activities on farmland under the management of CRC185857;

c. advise on any changes that might be made to a Farm Environment Plan or Schedule 24a Plan for the Properties included in Schedule CRC185857A, on the basis that any changes will be proportionate to the relative contributions of those Properties to the Deterioration;
d. advise how nutrient discharges may be further managed to ensure improving water quality over time;
e. advise on any further or amended monitoring that may be required to better understand the Deterioration (and the timeframes for that monitoring); and
f. remain in place and be subject to regular reviews for the duration of any Deterioration, as might be identified through further monitoring.

6.3. Amendments to the EMP

Variations to the EMP with respect of the explicit consent conditions of CRC185857 require written confirmation from the Regional Leader – Monitoring and Compliance, Canterbury Regional Council. For the avoidance of doubt, any of the following changes within the EMP can be made without written confirmation from the Canterbury Regional Council and will be advised in the Annual Report following the change being made;

- Internal MHV Operating Procedures
- The timing of the monitoring schedule throughout the year (notwithstanding the minimum consented requirements)
- Changing the Independent Technical Reviewers, for an equivalently qualified person
- Changing the locations of weather stations used to inform the reporting

Appendix 1

Application and integration of the National Environmental Management Standards

NEMS		Response	SOP / Doc No.
1.0 Preparatory Work in the Office			
1.1	Field and Office Manual	MHV utilises the SOP's, JSEA's, a cloud based digital data logging system (Assura®) and a site register (referred to in house as the bore hole Information Register)	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP Bore hole information Registry
1.2	Health and Safety	MHV has a comprehensive Health and Safety Management Plan (HSMP) aligned with AS/ NZS: 4801 – 2001 that utilises a risk mitigation and management strategies – specifically Job Safety & Environmental Analysis (JSEA), SOP's and Take 5's. Assura is used for Monitoring and reporting of Audits, Inspections, Safety Observations via: • Incident reporting, investigation and maintenance of an incident register; • Hazard reporting and maintenance of a Risk Register; • Analysis of incident and hazard data; and • Meetings and reports	Water Sampling JSA
1.3	Quality Assurance	Refer to section 3.2.3 of this document Samples will be collected via a standard methodology Instrumentation will be calibrated weekly during sampling Calibration records will be collected and stored in Assura Sampling data will be collected and stored in Assura	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
	Quality Control	Sample chain of custody protocols 1:10 duplicate samples field samples will be tested in-house 1:10 samples will be submitted as blind duplicates to the laboratory 1:10 samples will be distilled water used as blanks. 1 Certified Reference Material (CRM) will be inserted into the sample stream on a 1:10 ratio	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
1.4	Field Record Forms	All field information is recorded in Assura. This data is based on information and photographs	

		within a borehole information registry. This registry records information such as:		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP Borehole Information sheets Data logged in Assura
		• Site / BHID	• Location (mE, mN)	
		• Address	• Owner Details	
		• Bore Depth	• Bore Diameter	
		• Bore Type	• Sample Type	
		• Well head security	• Access & operation of bore	
1.5	Water Quality Variables	The following variables will be monitoring to meet the objectives of the program		
		Nitrate toxicity	NO_3-N mg/L	Captured in Assura at the time of logging
		Dissolved reactive phosphorous	DRP mg/L	
		Escherichia coli	E. coli/100ml	
		Macroinvertebrates	(% cover)	
		Deposited fine sediment	(% cover)	
		Periphyton	(% cover)	
		Macrophytes	(% cover)	
1.6	Monitoring Equipment	The following instruments (or equivalents) will be used for monitoring purposes		
		GPS	Garmin eTrex 10	
		Dip Meter	Solinst 101 P2 Water Level Meter	
		YSI	Professional Plus (Pro Plus)	
		Pump	Envico Monsoon 12v 4 stage-pump	
1.7	Field Meters	The following variables will be recorded via a YSI Professional Plus water quality meter (or equivalent).		
		Calibration	Fortnightly	Results recorded in Assura MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
		Water temperature	°C	
		Specific conductance	µS/cm	
		Conductance	µS/cm	
		Dissolved Oxygen	%L	
		Dissolved Oxygen	mg/l	
		Turbidity	NTU	
		REDOX Potential	mV	
		pH		
1.8	Sample Bottles	Only clean unused laboratory-specific polyethylene sample bottles are to be used for sampling		MHV Groundwater Sampling SOP

		All samples will be labelled with • Sample ID • Date • Time of Sample		MHV Surface water Sampling SOP
1.9	Sample Filtering	Where required, samples will be filtered with via a 45 µm paper filter.		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
1.10	Sample Storage and Transport	Samples will be chilled in a suitable thermally insulated container (e.g., a *chilli bin*) with endothermic packing materials (e.g., ice) so maintain a temperature range between 4° and 10°C. Samples will be delivered to the laboratory <24 hrs after sampling		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
1.11	Chain of Custody	All samples will have a Laboratory Submission Sheet with Chain of custody documentation		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
1.12	Managing Measurement Method Changes	Not relevant		
2.0 Monitoring Site Location				
2.1	Site (Point) Location	Site locations and conditions are recorded in Borehole Information Registry		
2.2	Site Metadata	The following information is recorded whilst sampling into Assura:		
		Location / Bore ID		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
		Well Head Security	Collar present	
			Concrete Pad	
			A secure well head cap	
			Proximity to pollution	
		Weather Conditions	Basic descriptors	
		Recent (last 24 hrs) rainfall	Basic descriptors	
		Standing Water Level	m	
		Flow Rate (Bore)	l/ sec	
		Flow Rate (River)	Descriptor	
		Purge time	Hrs:min	
2.3	Monitoring Platforms	Groundwater samples are taken directly from bores		MHV Groundwater Sampling SOP

		Surface water samples will be obtained via bucket grab samples from culverts or bridges		MHV Surface water Sampling SOP
2.4	Monitoring Strategies	Sample locations are specified in the Borehole Information sheet register		
2.5	On-Site Risk Assessment	All sampling is to be undertaken under the limits of the Water Sampling JSEA September 2021. If the situation changes such that sampling will contravene the Water Sampling JSEA September 2021, then the current JSEA will be revised		
2.6	Visit Metadata	The following information is recorded whilst sampling into Assura:		
		Date	Time	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
		Well Head Security	Collar present	
			Concrete Pad	
			A secure well head cap	
			Proximity to pollution	
		Weather Conditions	Basic descriptors	
		Recent (last 24 hrs) rainfall	Basic descriptors	
		Standing Water Level	m	
		Pump Rate	l/ sec	
		Purge time	Hrs:min	
2.7	Decontamination	All equipment is cleaned and decontaminated between sites as follows • Wash with clean with a solution of potable town water and laboratory detergent (e.g., DECON90) using a brush as necessary to remove particulates. • Rinse with town tap water. • Air dry for as long as possible. • Pumps are to be cleaned via a solution of potable town water and laboratory detergent (e.g., DECON90)		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
3.0 Field Measurements				
3.1	Field Meter Sensors, Calibration and Validation	• Water Quality sensors will be calibrated on a fortnightly basis as per manufacturer's instructions. • Dip meters will be calibrated annually • Calibration data will be recorded in Assura		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
3.2	Field Meter Maintenance	Field meters shall be maintained in accordance with the manufacturer's instructions.		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP

3.3	Field Measurement Collection	Data captured in 'Sample Type' in the Assura Platform		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.0 Water Sample Collection				
4.1	Purging	Purge calculations are undertaken in Assura. Water volume is calculated via the recorded bore hole depth, diameter, and stick up as well as the standing water level (SWL) at the time of sampling. The purge time is estimated on the time taken to fill a 20-litre bucket If a SWL is not able to be obtained, then a value of '0' is assumed (i.e., that the water is at surface level)		MHV Groundwater Sampling SOP
4.2	Sample Collection Point	All bores have a tap installed at the manifold Information regarding the location of the bores is recorded in the Bore Hole Information Registry		Borehole Information Registry MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.3	Sample Bottles and Filling	Only clean unused laboratory-specific polyethylene sample bottles are to be used for sampling All samples will be labelled with • Sample ID • Date • Time of Sample Samples are collected as per SOP's to minimise contamination Where required, samples will be filtered with via a 45 µm paper filter.		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.4	Visit Metadata (Observations)	The following information is recorded whilst sampling into Assura:		
		Location ID	Address	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
		Date	Time	
		Well Head Security	Collar present	
			Concrete Pad	
			A secure well head cap	
			Proximity to pollution	
		Weather Conditions	Basic descriptors	

		Recent (last 24 hrs) rainfall	Basic descriptors	
		Standing Water Level	m	
		Pump Rate	l/ sec	
		Purge time	Hrs:min	
		Date	Time	
		Well Head Security	Collar present	
		Water Colour	Basic descriptor	
		Appreciable Smell	Yes / No	
		Staff Member who took sample		
4.5	Site and Visit Identifiers	The key identifier in the system is the Location ID (Borehole ID or Site ID) Each record entered into Assura has a unique ID linking it to the site ID, time and date the sample was taken As sample bottles and documentation have sample ID, date and time information, linkages can be made in Assura		
4.6	Time Records	All sample records are time stamped in Assura		
4.7	Finishing at the Site	All equipment is cleaned and decontaminated between sites as follows • Wash with clean with a solution of potable town water and laboratory detergent (e.g., DECON90) using a brush as necessary to remove particulates. • Rinse with town tap water. • Air dry for as long as possible. • Pumps are to be cleaned via a solution of potable town water and laboratory detergent (e.g., DECON90)		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.8	Sample Transport and Handling	All sample bottles will be labelled with: • the site ID • sample date • Time of sample Samples will be chilled in a suitable thermally insulated container (e.g., a *chilli bin*) with endothermic packing materials (e.g., ice) so maintain a temperature range between 4° and 10°C. Samples will be delivered to the laboratory <24 hrs after sampling		MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.9	Chain of Custody	All samples will have a Laboratory Submission Sheet with Chain of custody documentation		MHV Groundwater Sampling SOP

			MHV Surface water Sampling SOP
4.2	Sampling Method	Data captured in 'Sample Type' in the Assura Platform	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
4.3	Sample Bottle Filling and Transport	All sample bottles will be labelled with: • the site ID • sample date • Time of sample Samples will be chilled in a suitable thermally insulated container (e.g., a *chilli bin*) with endothermic packing materials (e.g., ice) so maintain a temperature range between 4° and 10°C. Samples will be delivered to the laboratory <24 hrs after sampling	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP

5.0 Laboratory Measurements on Water Samples			
5.1	Laboratory Certification	All samples will be sent to Hill Laboratories Hill Laboratories is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.	
5.2	Sample Receipt	Hill Laboratories sample submission forms will be used at all times A photocopy of the sample submission form (with the corresponding job no.) will act as receipt.	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
5.3	Sample Preparation	As per Hill Laboratories SOP's	
5.4	Sample Measurement	Test	Analytical Technique
	Testing & Analysis undertaken by Hill Laboratories	Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (modified) 23rd ed. 2017.
		Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.
		Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO3- I (modified) 23rd ed. 2017.
		Escherichia coli	MPN count using Colilert 18 (Incubated at 35°C for 18 hours) and 97 wells. APHA 9223 B 23rd ed. 2017.
		Dissolved Reactive Phosphorus	Filtered sample from Christchurch. Molybdenum blue colourimetry. Flow injection analyser.

		APHA 4500-P G (modified) 23rd ed. 2017.	
5.5	Laboratory Reports	Laboratory Reports will be provided in both secure *.pdf and *.csv formats	
5.6	Laboratory Quality Checks	Laboratory Checks are undertaken by MHV as part of inhouse QAQC Internal laboratory request will be requested annually	
5.7	Managing Changes in Laboratory Methods	Not applicable	
6.0 Data Processing and Quality Assurance			
6.1	Site Metadata	Site metadata is recorded in the bore hole Register	
	Visit Metadata	Visit metadata is recorded in Assura via tick boxes and pre-populated drop-down menus	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
	Measurement Metadata	Measurement metadata is recorded in Assura with limitations on suitable values	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
6.2	Data Processing	Data processing is undertaken within Assura	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
6.3	Quality Coding	Quality coding is done within Assura with the values based on the visit metadata selections made	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
6.4	Data Preservation and Storage	All data is stored in Assura® - a cloud based digital data logging system with any changes to data being recorded.	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
6.5	Quality Assurance	Samples will be collected via a standard methodology Instrumentation will be calibrated weekly during sampling Calibration records will be collected and stored in Assura Sampling data will be collected and stored in Assura	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP
	Quality Control	Sample chain of custody protocols Duplicate field samples will be tested in-house 10% of samples (1/10) will be submitted as blind duplicates to the laboratory	MHV Groundwater Sampling SOP MHV Surface water Sampling SOP

		10% of samples (1/10) will be field blanks are samples obtained in the field using distilled water.	

Appendix 2

Discharge Permit CRC185857

Discharge Permit CRC185857

Scope

1. This consent authorises the discharge onto or into land where contaminants may enter water arising from farming activities on Properties:

   a) listed in Schedule CRC185857A, or any subsequent revisions thereof as provided for under Condition 8; and

   b) located within the area shown on Plan CRC185857A (the Command Area),

   and including the expansion of dairy support land and irrigated dairy farm land, the conversion of land to dairy farm land and the undertaking intensive winter grazing.

Definitions

2. Land types

Term	Definition
Dry Land	Land that is not irrigated but where nitrogen losses are managed under this consent.
Existing Scheme Irrigated Land	Land lawfully supplied with irrigation water supplied by an irrigation scheme or principal water supplier prior to 26 May 2014.
Lawfully Irrigated PC2 Land	Land that was previously not irrigated and which was first supplied with irrigation water by an irrigation scheme or principal water supplier under the authorisation of resource consent(s) CRC121664 or CRC162882 (or replacements and subsequent variations).
Other Irrigated Land	Land that is irrigated from any source and which is not Existing Scheme Irrigated Land or Lawfully Irrigated PC2 Land and which is on a Property that receives irrigation water from the MHV Water irrigation scheme.

Advisory note: All land on a Property managed by the Consent Holder under this resource consent shall fall in one or more of the land types listed. All properties must be fully or partially irrigated with water from the MHV Water irrigation scheme.

Other definitions

Term	Definition
Authorised Properties	Properties that the consent holder has elected to treat as Authorised Properties for the purposes of Conditions 9 and 10.
Certified Freshwater Farm Plan	A freshwater farm plan certified under section 217G of the Resource Management Act 1991 (as amended from time to time in accordance with section 217E(2) or (3)), or as provided for by the Resource Management (National Environmental Standards for Freshwater) Regulations 2020
CDWPZ Impacted Land	Land that is included in a Community Drinking Water Protection Zone, plus any other land within the same paddock where it is not possible to treat such further land on a different management basis for the purposes of condition 21. Advisory note: For example: • it will typically not be possible to provide differential stock grazing within the same paddock; and

	• it may be possible to provide differential management for a cropping or horticultural operation in the same paddock.
Commencement Date	The date that this resource consent (CRC185857) is given effect to, without limiting any amendment to the reporting requirements as may be agreed in accordance with Condition 30.
Community Drinking Water Protection Zone	A Community Drinking Water Protection Zone as identified in Schedule 1 of the Canterbury Land and Water Regional Plan.
Farming activity	All Agricultural and Horticultural landuses (whether irrigated or not) and including but not limited to dairy farming, dairy support, winter grazing, sheep and beef farming, deer, pig and goat farming, arable/cropping, fruit & vegetable productive landuses and other agricultural and horticultural land use and forestry/ineffective areas.
NES Equivalent Farm	A Property on which: a) 20 ha or more is in arable land use; or b) 5 ha or more is in horticultural land use; or c) 20 ha or more is in pastoral land use; or d) 20 ha or more is in a combination of any two or more of the land uses described above, provided that this definition shall not limit the consideration of, as a significant change application, any increase in the area used for dairy farming (being the use of land by milking dairy cows) by more than 10 hectares.
HPZ gmp	The farming practices described in Schedule 24a of the operative Canterbury Land & Water Regional Plan (at the Commencement Date), taking into account: i. the type of farming activity; and ii. the drainage characteristics of the soils; and iii. the climatic conditions and topography of the Property; and iv. the type of irrigation system used.
Nutrient Allocation Zone	A nutrient allocation zone within the area shown on Plan CRC185857A.
Nutrient Discharge Allowance (NDA)	The Nutrient Discharge Allowance as determined by Conditions 3 to 7.
Property	Any contiguous area of land, including land separated by a road or river, held in one or more than one ownership, that is utilised as a single operating unit, and may include one or more certificates of title.
Sensitive receptor	Areas of wetland, surface water bodies and riparian areas, sites of cultural significance (as may be further defined in consultation with Te Rūnanga o Arowhenua) and, in the case of any located within a Community Drinking Water Protection Zone, the Community Drinking Water Supply.
Significant change	In relation to the farming activity on a Property means: (a) an increase in the area irrigated by more than 10 hectares; (b) an increase in the area used for dairy farming (being the

	use of land by milking dairy cows) (whether irrigated or not) by more than 10 hectares; (c) any increase in the area used for intensive winter grazing (being the grazing of livestock on annual forage crop at any time in the period 1 May to the following 30 September); and (d) any increase in the area on a property of dairy support land (being the farming of non-milking dairy cows, including heifers), as compared to the maximum area used on that Property in any year (being the period of 1 July to 30 June) in the period 1 July 2014 to 30 June 2019.

Schedules of Properties covered by this consent

3. Schedule CRC185857A attached to and forming part of this consent, shall specify:

   (a) The Nutrient Allocation Zone(s) within which each Property is located; and

   (b) the load that has been calculated or deemed for each Property in accordance with Conditions 4 to 7; and

   (c) a total aggregated NDA for each Nutrient Allocation Zone, being the sum of the assessed nitrogen losses from all Properties provided for in Conditions 4(a) and (b) and identified in the relevant part of Schedule CRC185857A.

   Advisory note 1: Where a Property is located within more than one Nutrient Allocation Zone, the load shall be allocated on a pro rata basis against the relevant land area(s).Advisory note 2: Where a Property is supplied water by more than one scheme which also holds a discharge consent the load shall be allocated on a pro-rated basis proportionally on a contracted flow basis or on such other basis as may be determined inconsultation with the Canterbury Regional Council while ensuring all losses are accounted for (and not double counted) as between the schemes.

Requirement to meet HPZ gmp and to make further reductions

4. The nitrogen losses for each Property listed in Schedule CRC185857A shall:

   (a) For Existing Scheme Irrigated Land, Other Irrigated Land and Dry Land, be calculated on the basis of:

      i. *the farming activities which have been identified as occurring on the Property between 1 January 2009 and 31 December 2013; and*

      ii. *with nitrogen losses from such land being further limited to HPZ gmp; and*

      iii. *further reduced:*

         A. *from 1 January 2025, by 15%; and*

         B. *from 1 January 2030, by 25%*

         provided that the further reductions provided for in Condition 4(a)(iii)(A)and (B) will not be required:

         C. on any Property where the calculated nitrogen losses for that Property is less than 20kg N per hectare per year when modelled with OVERSEER® version 6.0; or

         D. when the nitrate-nitrogen concentration in any monitored river in the Lower Hinds/Hekeao Plains Area is below an annual median of 2.4 mg/L and an annual 95th percentile of 3.5 mg/L,

and the annual average nitrate concentration in groundwater in the Hinds/Hekeao Plains Area is at or below 6.9 mg/L.

(b) For Lawfully Irrigated PC2 Land, be a deemed loss rate of 27 kg N/ha/year, when modelled with OVERSEER® version 6.0.3,

(c) For Authorised Properties, be listed in a separate part of Schedule CRC185857A with a nominal value of 'zero', as deemed in accordance with Conditions 9 and 10,

except that where a load is modelled using OVERSEER®, the current version of OVERSEER® shall be used and the inputs shall be updated where relevant to reflect the current OVERSEER® Best Practice Data Input Standards, but they must still describe thesame baseline scenario.

Advisory note 1: Where a Property meets more than one of the above criteria, the nitrogen losses for the Property are calculated on a weighted average of the parcels which form the Property.

Advisory note 2: Authorised Properties are not subject to any individual nutrient loss limit (and nor do they contribute to or be deducted from the Scheme NDA for the purposes of Conditions 3 to 7). Their inclusion in Schedule CRC185857A is to ensure their inclusion and wider management by the Scheme is clear.

Advisory note 3: The effect of Condition 4(c) is to ensure the load from Authorised Properties cannot be aggregated with Properties managed under Conditions 4(a) and (b).

5. For the purposes of Condition 4(a)(iii)(D) above, the 6.9 mg/L specified is the groundwater quality determined by the Canterbury Regional Council as the median concentration across the Canterbury Regional Council's quarterly groundwater monitoring bores (screened less than 30 metres below the ground level) being:

(a) at the Commencement Date of this resource consent, the monitoring bores within the Lower Hinds Plains Area are those referred to in Appendix A in Technical Report R13/93 Hinds Plains water quality modelling for the limit setting process (Technical Report R13/93); and

(b) any additional or alternative monitoring bore (New Bore) that the Canterbury Regional Council determines to use when assessing groundwater in the Hinds/Hekeao Plains Area subject to any transitional arrangements that might be agreed with the Canterbury Regional Council in relation to the use of the New Bore.

Advisory note 1: *The Canterbury Regional Council's quarterly groundwater monitoringbores are those referred to or consistent with Policy 13.4.14 and Table 13(i) of the Canterbury Land and Water Regional Plan. If there are any changes to these monitoring bores, the Canterbury Regional Council will inform the Consent Holder anddiscuss transitional arrangements if the changes may affect compliance with reportingand monitoring obligations under this consent.*

6. The maximum annual amount of nitrogen that is lost to water from the Properties described in Condition 4(a) and (b) and listed in Schedule CRC185857A shall not exceed the combined and aggregated NDA of those Properties for each Nutrient Allocation Zone.

Advisory note: Authorised Properties do not contribute to the load limits described in this Condition 6.

7. The NDA to be determined in accordance with Conditions 4 and 6:

(a) shall be calculated using the Matrix Method (as approved by the Chief Executive of the Canterbury Regional Council on 29 April 2020) and as included in Schedule CRC185857B, or any other equivalent method approved by the Chief Executive of Environment Canterbury (together Matrix Method), provided that:

i. if OVERSEER® is used, the current version of OVERSEER® shall beused and the inputs shall be updated where relevant to reflect the current OVERSEER® Best Practice Data

Input Standards, but they must still describe the same baseline scenario; and

ii. the nitrogen loss calculation for any dairy farming operation where a building consent and effluent discharge consent was granted for a newor upgraded dairy milking shed in the period 1 January 2009 to 31 December 2013, shall be on the basis that the dairy farming activity isoperational.

(b) for land listed within Schedule CRC185857A at the Commencement Date, maybe updated within the 12 months following, provided that:

i. the update is consistent with the assessment methodology describedfor the Matrix Method;

ii. information on the changes (including information on the actual landuse and irrigation system) is recorded to support each change, including confirmation that the change remains consistent with Condition 4;

iii. a revised Schedule CRC185857A including any updates is to be provided to Regional Leader - Monitoring and Compliance, CanterburyRegional Council and any assessments undertaken are provided to theCanterbury Regional Council on request.

Addition and removal of Properties from Schedule CRC185857A

8. Properties (or land) may be added or removed from Schedule CRC185857A, provided:

(a) the Consent Holder provides the updated schedule by 1 December in any yearthat a change occurs to Schedule CRC185857A, to the Regional Leader -Monitoring and Compliance, Canterbury Regional Council and Te Rūnanga o Arowhenua including

i. the revision number of the schedule; and

ii. an updated consent wide map showing all Properties managed underthis consent and the relevant Nutrient Allocation Zone boundary; and

iii. an electronic copy of the plan in Condition 8(a)(ii) above, in a commonly used Geographic Information System (GIS) format.

and

(b) in the case of any Property (or land) joining the Scheme and described in Condition 4(a) and (b) and listed in Schedule CRC185857A, the Consent Holder shall, unless Condition 10(a) applies, apply to the Matrix Method to theProperty's (or land's) nitrogen baseline and make the assessment available tothe Canterbury Regional Council on request.

Obligations in relation to Authorised Properties

9. Any Property that is:

(a) less than five hectares in area; or

(b) greater than five hectares, and where the nitrogen losses for the Property areless than 15 kg N/ha/year,

may be treated by the Consent Holder as an Authorised Property for the purposes of this consent.

10. In relation to any Property that the Consent Holder has elected to treat as an Authorised Property in accordance with:

(a) Condition 9(a):

i. any nitrogen losses shall not contribute to or be deducted from the Scheme NDA for the purposes of Conditions 3 to 7; and

ii. losses from that Property will be listed on Schedule CRC185857A witha nominal nutrient discharge allowance of '0'.

(b) Condition 9(b):

i. the Consent Holder shall require that each such Authorised Property maintain a Schedule 24a Plan or Certified Freshwater Farm Plan, as required by Condition 18(b);

ii. any nitrogen losses shall not contribute to or be deducted from the Scheme NDA for the purposes of Conditions 3 to 7; and

iii. losses from that Property will be listed on Schedule CRC185857A witha nominal nutrient discharge allowance of '0'.

Advisory note 1: This resource consent enables the Consent Holder to supply water to Properties that would otherwise be able to be farmed as or in similar circumstancesas permitted farming land use activities outside of the scheme ASM programme. The nutrient losses from such Properties are authorised by this consent but the consent holder may choose to either manage the losses on the basis of being an Authorised Property or in accordance with Conditions 3 to 7.

Audited Self-Management Programme

11. From:

(a) the Commencement Date, the consent shall comply with the Audited Self-Management Programme (ASM), including Environmental Management Strategy (EMS) that was developed in accordance with resource consent CRC183851 and operative immediately prior to that date. In complying with this Condition 11(a), the Consent Holder shall consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council to determine how compliance and the transitional regime for any replacement EMS as required by Condition 11(b) are to be implemented. Should a transitional regime be agreed then the Consent Holder shall comply with it on the basis that it forms part of the conditions of this consent; and

(b) Within 12 months of the Commencement Date, the Consent Holder shall update and comply thereafter with the revised EMS that is to be prepared inaccordance with Conditions 12 to 14.

12. The EMS required by Condition 11(b) shall:

(a) identify the roles and responsibilities of the persons and entities involved in the management of the Consent Holder's environmental programme and the implementation of this resource consent;

(b) implement environmental objectives and targets for all Properties described in Condition 4(a) and (b) to ensure:

i. this resource consent CRC185857 is complied with;

ii. Properties provided for in Conditions 4(a) and (b) implement HPZ gmp,and in the case of Properties provided for in Condition 4(a), the specified further reductions to achieve nitrogen loss reduces over time;and

iii. Properties required to hold a Farm Environment Plan are achieving or working towards the achievement of an 'A' Audit.

(c) ensure the Consent Holder has robust audit and reporting procedures in placeto ensure a high level of compliance with *Farm Environment Plans, Schedule 24a Plans or Certified Freshwater Farm Plans* (as might apply);

(d) have appropriate procedures in place (through the EMS and each *Farm Environment Plan, Schedule 24a Plan or Certified Freshwater Farm Plans*) toensure the identification of effects on neighbouring sensitive receptors are appropriately avoided, remedied or mitigated;

(e) be consistent with the Environmental Monitoring Plan and associated requirements provided for in Conditions 22 to 27;

(f) require that any Properties wanting to undertake a significant change will first need to obtain the approval of the consent holder, with the EMS providing details on how applications for significant change are to be assessed, including procedures to ensure applications for significant change are only approved where:

i. in the case of any NES Equivalent Farm, contaminant loads in the catchment and concentrations of contaminants in receiving waterbodies are, as a result of the significant change, likely to be no greater than that occurring at 2 September 2020, having regard to:

A. any assessed nutrient loss; and

B. the controls set out in any Farm Environment Plan, Schedule24a Plan or Certified Freshwater Farm Plan (as might apply),

provided that this Condition 12(f) shall not apply where the significantchange application relates to an increase in irrigated area that is not used for dairy farming (being the use of land by milking dairy cows).

Advisory note: Where it a Property can demonstrate a significant change willnot result in any increase in losses from the Property, it is not expected catchment-scale modelling or assessments will be required.

and

ii. effects on local sensitive receptors are avoided, remedied or mitigated.

(g) provide reproducible methodology on:

i. how the nutrient load limits are calculated, and the rationale for that nutrient load applied; and

ii. how nutrients from all land subject to this resource consent will be accounted for;

and

(h) provides detail on how the management of Properties joining or leaving thescheme is to occur (including the methodology for allocating nutrients).

13. The EMS shall provide for or require:

(a) effects on neighbouring sensitive receptors to be managed through further measures (in addition to Condition 12(b), including:

i. requiring that stock are excluded from waterbodies in accordance with Regional Council rules, any granted resource consent(s) and the Resource Management (Stock Exclusion) Regulations 2020; and

ii. encouraging the establishment of vegetated riparian strips to minimise nutrient, sediment and microbial pathogen loss to waterbodies.

(b) the management of nutrient losses on Properties (which are not Authorised Properties) through a Farm Environment Plan or Certified Freshwater Farm Plan (as might apply) and audit process in accordance with the conditions of this resource consent.

(c) Properties provided for in Conditions 4(a) and (b) shall:

i. have their annual nutrient losses assessed in accordance with theMatrix Method identified in Schedule CRC185857B;

ii. be subject to an audit procedure in accordance with Condition 19 and 20 (with the EMS being required to specify the steps that will be taken(including consequences to *ensure future compliance) for Properties* where condition 12(b)(iii) applies and is not being met).

(d) with the Farm Environment Plan audit records for each Property undertaken in accordance with this Condition 13(d) being kept and made available for the Canterbury Regional Council to inspect, upon request; procedures to enable each Farm Environment Plan, Schedule 24a Plan or Certified Freshwater Farm Plan to be amended to address any changes that might be recommended following the preparation of a Remediation and Response Plan that is prepared in accordance with Condition 26.

(e) the monitoring and data required under this consent and the EMS to be collected and reported to the Canterbury Regional Council in accordance with Condition 28 (with a copy to be provided to Te Rūnanga o Arowhenua); and

(f) within 20 working days of the exit of any Property from Schedule CRC185857A (and the management of nutrient losses by the consent holder), the consent holder is to advise the Canterbury Regional Council of the authorised land use that is to apply to the departing Property.

14. When preparing the EMS or seeking amendments to any of the matters listed in Conditions 12 and 13, the Consent Holder shall:

(a) engage with the chair of Te Rūnanga o Arowhenua or their representative to discuss the finalisation of the EMS content listed in Condition 12 within reasonable timeframes. The purpose of the engagement is to consult with Te Rūnanga o Arowhenua and to enable Te Rūnanga o Arowhenua to participate in and have input into the preparation of the EMS or any amendment to the EMS. The Consent Holder shall, subject to any alternative procedure that might be agreed with Te Rūnanga o Arowhenua and advised to the Regional Council Leader - Monitoring and Compliance, Canterbury Regional Council:

i. provide drafts of the EMS or amendments to the EMS along with any relevant supporting materials to Te Rūnanga o Arowhenua at least six weeks prior to the documents being submitted to the Canterbury Regional Council for certification;

ii. Offer to meet with Te Rūnanga o Arowhenua representatives within the six week period referred to in Condition 14(a)(i), for the purposes of discussing the EMS or amendments to the EMS;

iii. Incorporate the comments or changes received from Te Rūnanga o Arowhenua into the EMS or the amended EMS, except that if the consent appropriate holder determines the comments or changes are not appropriate, it shall undertake further consultation with Te Rūnanga o Arowhenua to see if alternative further changes can be made. If the Consent Holder determines that further changes cannot be made then it shall prepare a document that records the comments or changes that have not been included and the reasons for not including them.

(b) The updated EMS along with any document to be prepared in accordance with condition 14(a) are to be provided to Te Rūnanga o Arowhenua at the time of seeking certification from the Canterbury Regional Council in accordance with Condition 15.

15. The EMS and any amendment to the EMS that has been prepared in accordance with Conditions 12 to 14 shall be submitted to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for certification. The EMS and any changes shall only be implemented following certification by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council.

16.

(a) Prior to the 1 December:

i. immediately after the second anniversary of the Commencement Date of this resource consent;

ii. immediately after the sixth anniversary of the Commence Date of this resource consent; and

iii. for each year that is after the second anniversary of the Commencement Date but not provided for by Conditions 16(a) (i) and (ii),

(or such other time as may be agreed to by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council), the Consent Holder shall engage a suitably qualified and independent expert to undertake a review of the EMS that shall include:

iv. for the reviews to be undertaken in accordance with:

A. Condition 16(a)(i) and (ii), a full review of the EMS;

B. Condition 16(a)(iii), a review of at least one third of the EMS (to be rotated annually at each EMS review to ensure the full EMS is reviewed at least once every three years), for the purpose of identifying and discussing the implementation of the EMS and any improvements that may be able to be made to better achieve the objectives developed in line with Condition 12(b);

and

v. for all reviews:

A. a review of any changes made to the use of the property irrigation, land use and management standards as applied through the Matrix Method when calculating the scheme nitrogen losses; and

B. a review of the process undertaken to update any changes made to the nutrient budget reference files used to calculate scheme nitrogen load limits and losses into the most recent version of OVERSEER®

(b) Following the review, the Consent Holder shall provide a copy of the review report to Te Rūnanga o Arowhenua and offer to meet with it for the purposes of discussing the findings of the review, and any amendments that might be made to the EMS.

(c) A copy of the review shall be provided to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council as a part of the annual report to be provided under Condition 16.

17. In the event that a Property is excluded from the ASM programme then the Consent Holder shall notify Monitoring and Te Rūnanga o Arowhenua and the Regional Leader Compliance, Canterbury Regional Council within 20 working days of the exclusion.

Farm Environment Plans, Schedule 24a Plans or Certified Freshwater Farm Plans

18. For all Properties where farming activities are undertaken, and unless Condition 10(a) applies, the Consent Holder shall ensure that:

(a) Properties provided for in Condition 4(a) and (b) maintain a Farm Environment Plan in the form set out in Schedule CRC185857C, as may be amended following agreement from the Regional Leader - Monitoring and Compliance, Canterbury Regional Council;

(b) Properties provided for in Conditions 4(c) and 9(b) maintain a Schedule 24a Plan in the form set out in Schedule CRC185857D, as may be amended following agreement from the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, provided that should the use of a Certified Freshwater Farm Plan be required or available on the basis it is certified and available for use then the Consent Holder may, as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council elect to use such a plan in place of the

plans provided for in Conditions 18(a) and (b).

Farm Environment Plan Audits

19. All Farm Environment Plans as required by Condition 18(a) shall be audited within the frequency determined by either:

(a) the audit grade received in the previous audit, as provided for in Table CRC185857-1 below:

Table CRC185857-1

Audit Grade	Audit Frequency	
	No change in management or significant change	Change in management or significant change
A	4 years	1 year
B	2 years	1 year
C	1 year	In the following year
A "year" is the period from 1 July to the following 30 June.		

provided that the Consent Holder may consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for the purposes of developing an agreed transitional regime for the audit frequencies provided for in Table CRC185857-1 (given the 10 September to the following 9 September reporting date being implemented by the Consent Holder at the Commencement Date). Any agreed transitional regime will apply in place of Table CRC185857-1.

or

(a) in the case of Properties added to Schedule CRC185857A, within one year of the Property being added to that Schedule; or

(b) in the case of a Property located within a Community Drinking Water Protection Zone where the risk level increased, within one year of the completion of the updated risk assessment; or

(c) where there are exceptional circumstances, and the Consent Holder is able to obtain an approved exemption (in writing) from the Regional Leader - Monitoring and Compliance, Canterbury Regional Council from the frequencies of audits identified in Conditions 19(a) and (b). For the purposes of this condition 'exceptional circumstances' may include any event or action that reasonably prevents an audit being undertaken - including but not limited toany event of force majeure, the death or serious illness of a shareholder or shareholder's representative(s) or their dependents, biosecurity or natural hazards, or recent Property sales or lease changes; or

(d) should a Certified Freshwater Farm Plan be certified and available for use in accordance with condition 18 then the Consent Holder shall comply with the required timings for audits provided for in that plan (and if no audit process is provided for then the Consent Holder shall comply with timeframes for audit set out in the conditions 19(a) to (d)).

20.

(a) Farm Environment Plans audits shall be conducted in accordance with the 'Certified Farm Environment Plan Auditor Manual', May 2020, or such other methodology (including any subsequent version of the 'Certified Farm Environment Plan Auditor Manual', May 2020) as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, including the timing and

implementation of such other methodology.

(b) The audit of Certified Freshwater Farm Plan shall be undertaken in accordance with any associated guidance manual, or if no audit process is provided for, or no such guidance material available, the audits shall be undertaken on the basis of applying the 'Certified Farm Environment Plan Auditor Manual' with any necessary modifications as may be mutually agreed with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council.

(c) If requested by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, the consent holder shall facilitate the Canterbury Regional Council undertaking spot checks of any Farm Environment Plan Auditors previously approved by Canterbury Regional Council. This shall include providing copies any audits and the relevant supporting information that are available to the consent holder.

Community Drinking Water Supplies

21. For any Property falling partly or wholly within a Community Drinking Water Protection Zone, the Consent holder shall ensure:

(a) Discharges from the Property are assessed and managed in discussion with the impacted shareholder(s) and the Community Drinking Water Supplier in accordance with Schedule CRC185857E, and in a manner that is consistent with the Resource Management (National Environmental Standard for Sources of Human Drinking Water) Regulations 2007, with the assessment completed:

i. within three months of the Commencement Date for all properties managed by the Scheme and falling partly or wholly within a Community Drinking Water Protection Zone at that date;

ii. at least once every three years for Properties with existing Community Drinking Water Protection Zone risk assessments;

iii. within three months of a Property within a Community Drinking Water Protection Zone being added to Schedule CRC185857A (including a new Community Drinking Water Protection Zone being added to Schedule 1 of the Canterbury Land and Water Regional Plan that includes Properties) that have not been previously assessed in accordance with Schedule CRC185857E);

iv. within three months of the Consent Holder becoming aware of information that may materially impact on any assessment previously undertaken; and

v. within three months of any change to the area of an existing Community Drinking Water Supply Protection Zone taking formal effect for the purposes of Schedule 1 of the Canterbury Land and Water Regional Plan.

(b) Where a Community Drinking Water Protection Zone Risk Assessment identifies the Property as:

i. Low Risk; there shall be no further management actions required in relation to the farming activities able to occur on the CDWPZ Impacted Land (subject to compliance with this resource consent and permitted activity rules related to Community Drinking Water Protection Zones);

ii. Medium Risk; the farming activities able to occur on the CDWPZ Impacted Land shall be managed to (in addition to compliance with this resource consent and permitted activity rules related to Community Drinking Water Protection Zones):

A. avoid the discharge of solid or liquid effluent (including animal based manures) within 20 metres of the Community Drinking

Water Protection Zone;

B. ensure all irrigation on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone is undertaken using good management practice to minimise drainage to groundwater; and

C. implement any other site-specific recommendations that are consistent with managing Medium Risk activities and that are identified in the Community Drinking Water Protection Zone Risk Assessment.

iii. High Risk; the farming activities able to occur on the CDWPZ ImpactedLand shall be managed to (in addition to compliance with this resourceconsent and permitted activity rules):

A. avoid the discharge of solid or liquid effluent (including animal based manures) within 20 metres of the CDWPZ;

B. avoid any winter grazing (as defined in the Canterbury Land and Water Regional Plan at the Commencement Date) within the CDWPZ Impacted Land;

C. ensure all irrigation on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone is undertaken using good management practice to minimise drainage to groundwater;

D. ensure there is no increase in stocking rate or fertiliser application on the CDWPZ Impacted Land in the Community Drinking Water Protection Zone; and

E. implement any other specific recommendations that are consistent with managing Medium and/or High Risk activities and that are identified in the Community Drinking Water Protection Zone Risk Assessment.

(c) All new Community Drinking Water Protection Zone Risk Assessments prepared after the commencement date are to be reviewed by a suitably qualified and experienced individual prior to implementation of the required actions set out in the risk assessment for the Property.

(d) Where a Community Drinking Water Protection Zone Risk Assessment review increases the risk status of a Property compared to previous assessments, the assessments are to be provided to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council prior to the implementation of the required actions set out in the risk assessment for the Property.

(e) as a part of the Farm Environment Plan, Schedule 24a Plan or Certified Freshwater Farm Plan (as might apply) for any Property located within the CDWPZ, there shall be additional requirements:

i. to include an objective that seeks to ensure land located within theCDWPZ is managed to prevent deterioration of drinking water fromactivities occurring on that land; and

ii. for the Property Owner to maintain records to demonstrate all agreed minimum actions are being implemented,

(f) without limiting Condition 21(b), the Consent Holder shall, as soon as practicable, and in all cases within two working days, notify relevant Community Drinking Water Supplier, and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, if it becomes aware of an “Event” that may have an adverse effect on the quality of the water in the community supply bore, with an “Event” for the purposes of this consent meaning, but not limited to, an incident within the well protection

zones of the relevant community supply bore that may contaminate the water supply from the community supply bore - such as accidental release of pollutants or excessive stock access, combined with the saturation of soil beyond the water retaining capacity (e.g. over-irrigation).

Advisory note: The level of mitigation required should apply based on whichever contaminant has the highest risk rating.

Environmental Monitoring

22. Within six months of the Commencement Date, the Consent Holder shall submit to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, an Environmental Monitoring Plan that satisfies Conditions 23 and 24 and which has been prepared by suitably qualified and experienced person(s).

23. The objectives of the Environmental Monitoring Plan shall be to:

    (a) obtain water quality information that may assist in better understanding the effects of nutrient discharges from properties within Schedule CRC185857A:

        i. on groundwater nitrate-nitrogen concentrations over-time; and

        ii. surface water quality over time; and

    (b) require the reporting of any water quality information gathered to the Canterbury Regional Council for the purpose of better informing future water resource management in the Hinds/Hekeao Plains Area;

    (c) require the Consent Holder to investigate and respond to changes in water quality attribute state(s) or band(s) (as might apply) for certain contaminants as to be identified based on five years of data in accordance with Condition 24 (a Deterioration) as specified in Table CRC185857-2; and

    (d) to require the Consent Holder to prepare a Remediation and Response Plan in consultation with Te Rūnanga o Arowhenua following any identified Deterioration that includes:

        i. requiring the Consent Holder to manage nutrient losses that are determined to be contributing to any identified Deterioration in a manner that is consistent with improving water quality over time; and

        ii. reviewing individual Property Farm Environment Plans or Certified Freshwater Farm Plans (as might apply) through the EMS programme where it is determined those farming activities are contributing to any identified Deterioration.

24. Catchment groundwater monitoring

    (a) Subject to Condition 27, the Consent Holder shall undertake (either directly or through a catchment group) water quality sampling on a minimum of 10 bores, with all bores being sampled quarterly for nitrate-nitrogen in accordance with the requirements of the National Environmental Monitoring Standards Water Quality – Part 1 Groundwater dated March 2019.

    Localised surface water monitoring

    (b) Subject to Condition 27 the Consent Holder shall undertake (either directly or through a catchment group) surface water quality monitoring in the following waterbodies with the final monitoring site in each waterbody to be determined in consultation with Te Rūnanga o Arowhenua and the Regional Leader Monitoring and Compliance, Canterbury Regional Council:

        i. Oakdale Drain

        ii. Harris Drain;

        iii. the Hinds River; and

iv. any further or alternative location(s) that may be determined through the review of the Environmental Monitoring Programme that is to be undertaken in accordance with Condition 27,

and such surface water monitoring shall include monitoring of the contaminants listed in Table CRC185857-2, with:

A. monitoring to occur at the frequencies included in column 2 ofTable CRC185857-2; and

B. where specified in column 3 of Table CRC185857-2, monitoringbeing undertaken for contaminants to determine a Base Attribute State, calculated for each monitoring site at the commencement of the consent for monitoring sites where adequate water quality data already exists, or after five years of monitoring where no current water quality data exists.

Table CRC185857-2

Contaminant	Frequency of sampling	Base Attribute State	Deterioration
Nitrate toxicity mg NO_3-N mg/L	Monthly	Median and 95th percentile of previous 5 years' data.	Where the annual (1 July to 30 June) median and/or 95th percentile NO_3- N mg/L are greater than the calculated base attribute state.
Dissolved reactive phosphorous DRP mg/L	Monthly	Median and 95th percentile of previous 5 years' data.	Where the annual (1 July to 30 June) median and/or 95th percentile NO_3- N mg/L are greater than the calculated base attribute state.
Escherichia coli E. coli/100ml	Monthly	The attribute band as calculated in accordance with the Table 9 of the NPSFM 2020 (August 2020) and using 5 years of data	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macroinvertebrates (percentage cover)	Annually between December and March (inclusive) (QMCI or MCI using NEMS 2020 methodology)	The median attribute band as calculated in accordance with Table 14 of the NPSFM 2020 (August 2020) and using 5 years of data.	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using annual data)
Deposited fine sediment (percentage cover)	Monthly	The attribute band as calculated in accordance with Table 14 of the NPSFM 2020	Where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state

		(August 2020) and using 5 years of data.	(using 5-year rolling data).
Periphyton (percentage cover and chlorophyll-a)	Monthly	Not applicable for percentage cover For Chlorophyll-a: the attribute band as calculated using 5 years of data in accordance with Table 2 of the NPSFM 2020 (August 2020).	Not applicable for percentage cover For Chlorophyll-a: where the attribute band (as per the NPSFM 2020) is worse than the calculated base attribute state (using 5-year rolling data).
Macrophytes (percentage cover)	Monthly	Not applicable	Not applicable

Advisory note 1: The Base Attribute State(s) are based on the attribute bands and attribute states in Appendix 2A of the National Policy Statement for Freshwater Management 2020 (August 2020).

Advisory note 2: Where water quality sampling is undertaken as part of a catchment group, members of the group may seek to rely on the same groundwater monitoring bores or surface water monitoring sites as part of their respective consent requirements.

Advisory note 3: The 'Base Attribute State' (numeric) for nitrate will be calculated as the maximum of annual median and the maximum of annual 95 percentiles from the first 5 years of numeric attribute states calculated from monthly data.

25. The Consent Holder shall implement the Environmental Monitoring Programme within 12 months of the Commencement Date. Following its implementation, the Consent Holder shall:

    (a) provide a summary within the annual report by 1 December 2022 and then annually thereafter that sets out the results of all sampling undertaken over the previous 12 month period, including a discussion on:

        i. the extent to which there has been an identified Deterioration; and

        ii. for contaminants where a Deterioration is not defined (being Periphyton and Macrophytes percent covers, the nature of any changes over time, including any unexpected declines.

26. In the event that there is a Deterioration that is identified as a part of the water monitoring required under Condition 24(b), the Consent Holder (either directly or through a catchment group) shall, within one month of the Deterioration being identified, engage a suitably qualified and experienced person to prepare a Remediation and Response Plan. The Remediation and Response Plan shall:

    (a) discuss the potential causes of the Deterioration, and the extent to which they might be attributable to the activities on farmland under the management of this resource consent;

    (b) advise on any changes that might be made to a Farm Environment Plan or Schedule 24a Plan for the Properties included in Schedule CRC185857A, on the basis that any changes will be proportionate to the relative contributions of those Properties to the Deterioration;

    (c) advise how nutrient discharges may be further managed to ensure improving water quality over time;

    (d) advise on any further or amended monitoring that may be required to better

understand the Deterioration (and the timeframes for that monitoring); and

(e) remain in place and be subject to regular reviews for the duration of any Deterioration, as might be identified through further monitoring.

The Remediation and Response Plan shall be prepared in consultation with Te Rūnanga o Arowhenua and shall be completed within six months of the Deterioration being identified (or such other time as may be agreed to by the Regional Leader - Monitoring and Compliance, Canterbury Regional Council) and the Consent Holder shall implement any recommendations. A copy of the completed Remediation and Response Plan shall be provided to Te Rūnanga o Arowhenua and to the Regional Leader Monitoring and Compliance, Canterbury Regional Council as a part of the annual reporting required under Condition 28.

27. The Consent Holder shall undertake a review of the groundwater and surface water monitoring required under Condition 24:

(a) within the six month period that begins on the date that is five years after the Commencement Date, being the date which the Base Attribute State has been determined for all listed contaminants, or

(b) at any other time that may be determined by the Consent Holder; or

(c) on making any change to Schedule CRC185857A that results in increasing the area managed by the scheme on a Property or adjoining Properties by more than 200 hectares over that occurring at the Commencement Date, provided that in the case of a review under this Condition 27(c), the review shall be limited to the effects of the change and the need to consider further groundwater and/or surface water monitoring sites.

27A. If the Consent Holder is required to or elects to undertake such a review under Condition 27, the Consent Holder will engage a suitably qualified and experienced person to:

(a) Advise on any changes that might be made to add, remove or amend:

i. Groundwater monitoring bores;

ii. Surface water monitoring sites;

iii. Contaminants;

iv. How a Deterioration is determined; and

v. Sampling frequency.

(b) Prepare a Water Monitoring Amendment Report that:

i. Outlines the reasons for the change(s) proposed; and

ii. Confirms that the additional, removal or amendment will continue to enable the Consent Holder to meet the objectives set out in Condition 23;

(c) Consult with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council in the preparation of the Water Monitoring Amendment Report; and

(d) Provide a copy of the of the Water Monitoring Amendment Report to the Regional Leader - Monitoring and Compliance, Canterbury Regional Council for certification that any change(s) proposed meet the requirements of this Condition 27A and the objectives outlined in Condition 23.

27B The Consent Holder shall only implement the change(s) proposed to the monitoring required in Condition 24 if written certification is provided by the Regional Leader – Monitoring and Compliance, Canterbury Regional Council.

General Reporting

28. The Consent Holder shall prepare an annual report describing the results of the ASM programme and the audits that have been conducted each year. The report shall include a summary of the FEP Auditing programme for the completed year preceding the reporting period, including the following:

    (a) the name of the FEP auditor(s);

    (b) a summary of the audit performance grading, including the predominant farming system on the properties graded;

    (c) the number of Properties receiving each audit grade;

    (d) the number of properties which have received repeated fail grades (being C or D grades in relation to a Farm Environment Plan or any fail grade as may be determined in consultation with the Regional Leader - Monitoring and Compliance, Canterbury Regional Council in relation to any Certified Farm Environment) in the past five years (including a summary of the reasons and actions taken);

    (e) the total annual calculated loss of nitrogen from all Properties within the Command Area over the reported year, in accordance with the method outlined in Schedule CRC185857B, and including information on:

        i. the load that has been calculated or deemed for each Property in accordance with Conditions 3 to 7;

        ii. the total aggregated NDA for each Nutrient Allocation Zone, being the sum of the assessed nitrogen losses from all Properties provided for in Conditions 4(a) and (b) and identified in the relevant part of Schedule CRC185857A; and

        iii. predicted changes in average nitrogen concentrations beyond the root zone.

    (f) the reporting on environmental monitoring required in accordance with Condition 25;

    (g) a summary of any significant change applications considered in accordance with Condition 12;

    (h) the performance of Properties in the scheme in meeting the environmental targets and objectives as specified in the Farm Environment Plans required by Condition 18(a); and

    (i) results of the review required by Condition 16.

29. A copy of the annual report required under condition 28 shall be provided to Te Rūnanga o Arowhenua and the Regional Leader - Monitoring and Compliance, Canterbury Regional Council, by 1 December 2022 and annually thereafter.

30. The reporting requirements in Conditions 28 and 29 may be altered with the agreement of the Regional Leader - Monitoring and Compliance, Canterbury Regional Council to reflect the timing of the consent implementation between this consent and existing consent CRC183851.

    Advisory note: The intention of Condition 30 is to ensure that the Consent Holder is able to rely on resource consent CRC183851, this consent, or a combination of the two for a transitional period, as might be agreed, for the purposes of ensuring the Consent Holder can avoid unnecessary duplication of reporting requirements and where necessary, complete or dispense with annual reporting requirements where they may be covered by one of more resource consent.

Requirement for legal obligation to secure reductions

31. Within six months of the Commencement Date, the Consent Holder shall ensure that as a part of any water supply agreement between the Consent Holder and any Property provided for in Conditions 4(a) and (b)

and where reductions are required in accordance with 4(a)(iii)(A) to (C), the water supply agreement shall specify that the Property owner be required to enter a legally binding obligation running with the land to secure the obligations set out in Condition 4(a)(iii) (A) to (C).

Review

32. The Canterbury Regional Council may once per year, on any of the last five working days of May or November, serve notice of its intention to review the conditions of this consent for the purposes of:

    (a) dealing with any adverse effect on the environment which may arise from the exercise of the consent; and /or

    (b) addressing the failure of any Remediation and Response Plan to achieve the improvements anticipated in the plan in relation to water quality.

33. The Consent Holder may, in consultation the Regional Leader - Monitoring and Compliance, Canterbury Regional Council combine the obligations in this resource consent with any other resource consent held by the Consent Holder that provides for similar or the same obligations.

Further Advisory Notes:

Addition and removal of Properties to and from the Schedule CRC185857A is at the sole discretion of the Consent Holder.

Appendix 3

Groundwater Bore Selection Criteria Memorandum

MEMORANDUM

To	Matt Dodson[1] Mel Brookc2
Company	ECan[1], MHV Water[2]
CC	
From	Justin Legg
Date	07 July 2021
Subject	Discharge Permit CRC185857 – Groundwater Monitoring
Doc. Ref	CRC185857_Groundwater_Monitoring_June_2021_Approved

Background

Section 24 (c) of Discharge Permit CRC185857 states:

> *"Subject to Condition 27, the Consent Holder shall undertake (either directly or through a catchment group) water quality sampling on a minimum of 10 bores, with all bores being sampled quarterly for nitrate-nitrogen in accordance with the requirements of the National Environmental Monitoring Standards Water Quality – Part 1 Groundwater dated March 2019."*

This document provides some context as to the justification for the bore selected to meet this requirement.

Selection Criteria

Where possible, the following selection criteria was used to determine the proposed bores:

i. The boreholes were selected from MHV's current (i.e. 2020) in-house groundwater monitoring program;
ii. The bores are situated on MHV shareholders properties;
iii. The bores have not gone dry in the last 18 months;
iv. The monitoring bores are greater than 2 km down gradient from the current Managed Aquifer Recharge (MAR) Site(s) so as not to be directly affected by MAR inflows;
v. The monitoring bores are greater than 500 m from a river or mapped drain;
vi. The bore has a geological log (as per https://www.ecan.govt.nz/data/well-search/);
vii. The bore had a single (or contiguous) recorded screen depth log (as per https://www.ecan.govt.nz/data/well-search/);
viii. The bore has an Initial Water Level (as per https://www.ecan.govt.nz/data/well-search/);
ix. Where possible, bores were drilled after 1999/2000;
x. The bore has suitable well head security;
xi. Bores have < 30m of water above the screens – in deference to c13.4.14 of the LWRP – based ECan's Initial Water Level and MHV Data and/ or;
xii. Bores were shallow (<30 m) and moderate in depth (<80 m) – in deference to 13.7.3 of the LWRP.

These criteria are summarised in ***Figure 20***.

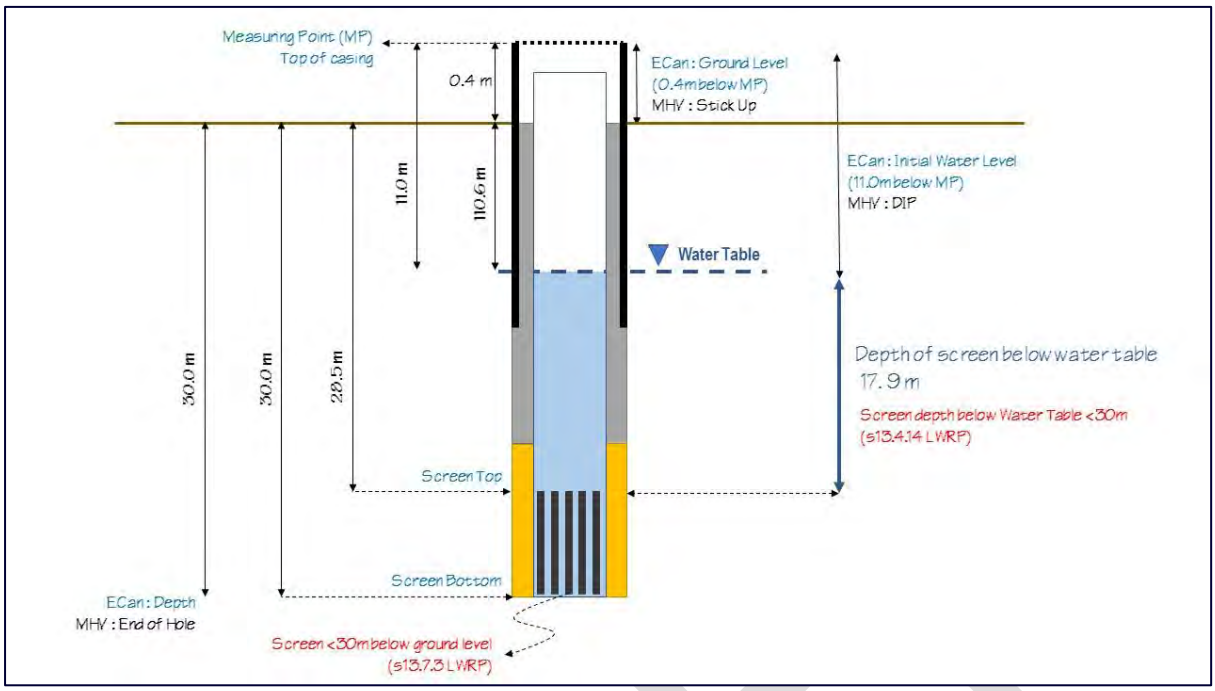

Figure 20 Schematic summary of the selection criteria used to select bores for monitoring

Proposed Bores

10 bores were selected based on these criteria, as shown in Table 10 and spatially in Figure 21 and Figure ***22***.

Table 10 Bores proposed for groundwater monitoring for CRC185857

WELL_NO	NZTM mE	NZTM mN	Drilled	Depth	Est Water Column	Use
BZ20/0079	1481717	5117008	2020	30.0	17.5 - 22.5	Domestic and Stockwater
K36/1072	1478173	5152240	2011	97.0	27.1 – 27 4	Domestic and Stockwater,
K37/0442	1476960	5131945	1991	24.0	13.2 - 16.6	Domestic Supply
K37/0948	1480897	5139885	1999	10.0	1.3 - 2.5	Water Level Observation
K37/1290	1466787	5134604	2001	53.0	12.2 -17.0	Domestic and Stockwater
K37/2162	1473649	5137895	2004	48.16	21.9 - 32.5	Domestic and Stockwater
K37/2766	1483493	5119767	2006	53.5	40.9 - 44.5	Irrigation
K37/3000	1481771	5144529	2007	77.25	25.9 – 47.3	Domestic and Stockwater
K37/3155	1488759	5144768	2008	38.0	21.3 - 36.5	Domestic and Stockwater
K37/3500	1480912	5128041	2010	42.0	29.7 - 35.1	Irrigation

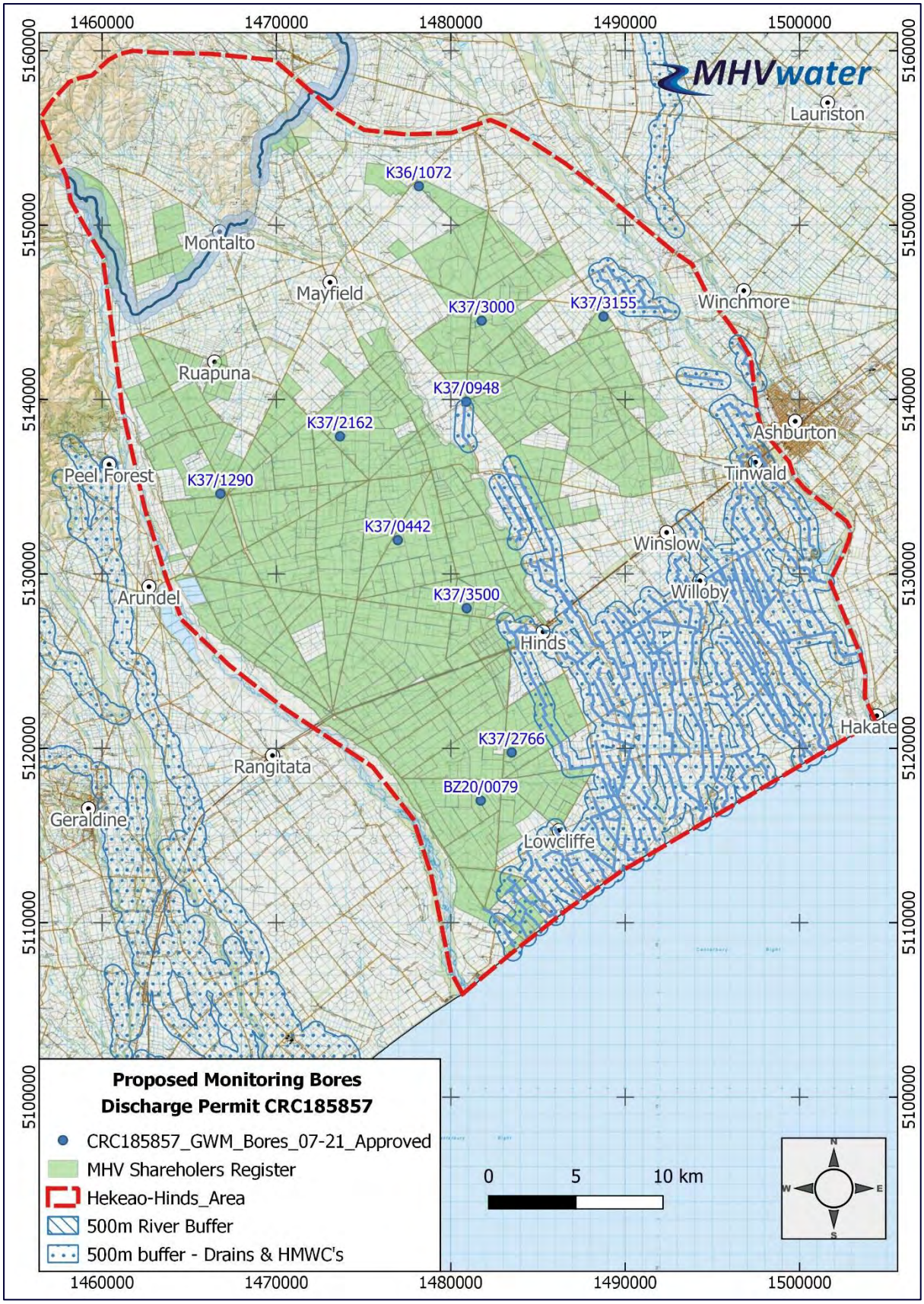

Figure 21 Locations of the proposed bores with respect surface hydrology

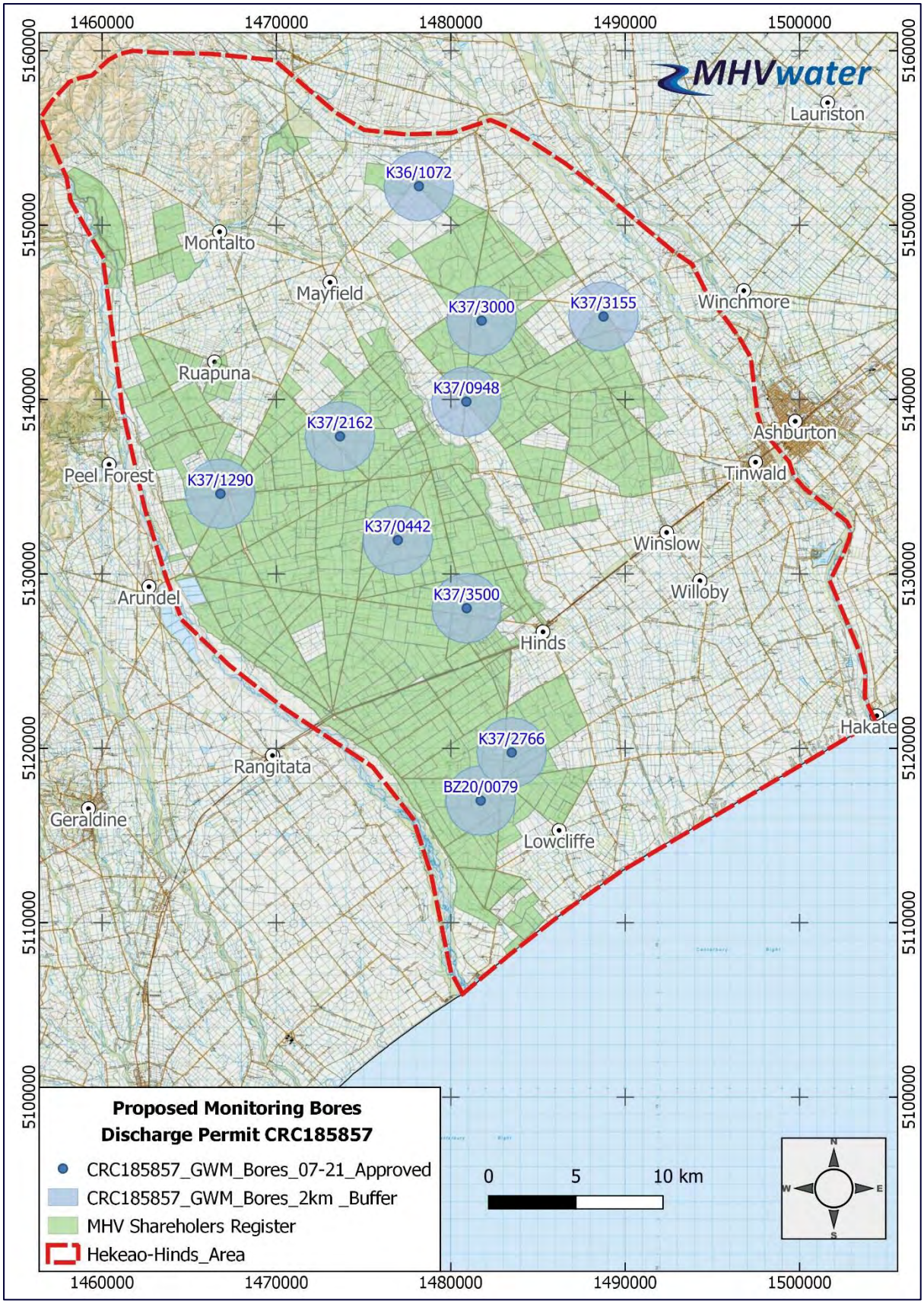

Figure 22 Spatial coverage of the proposed bores based on a 2km radius

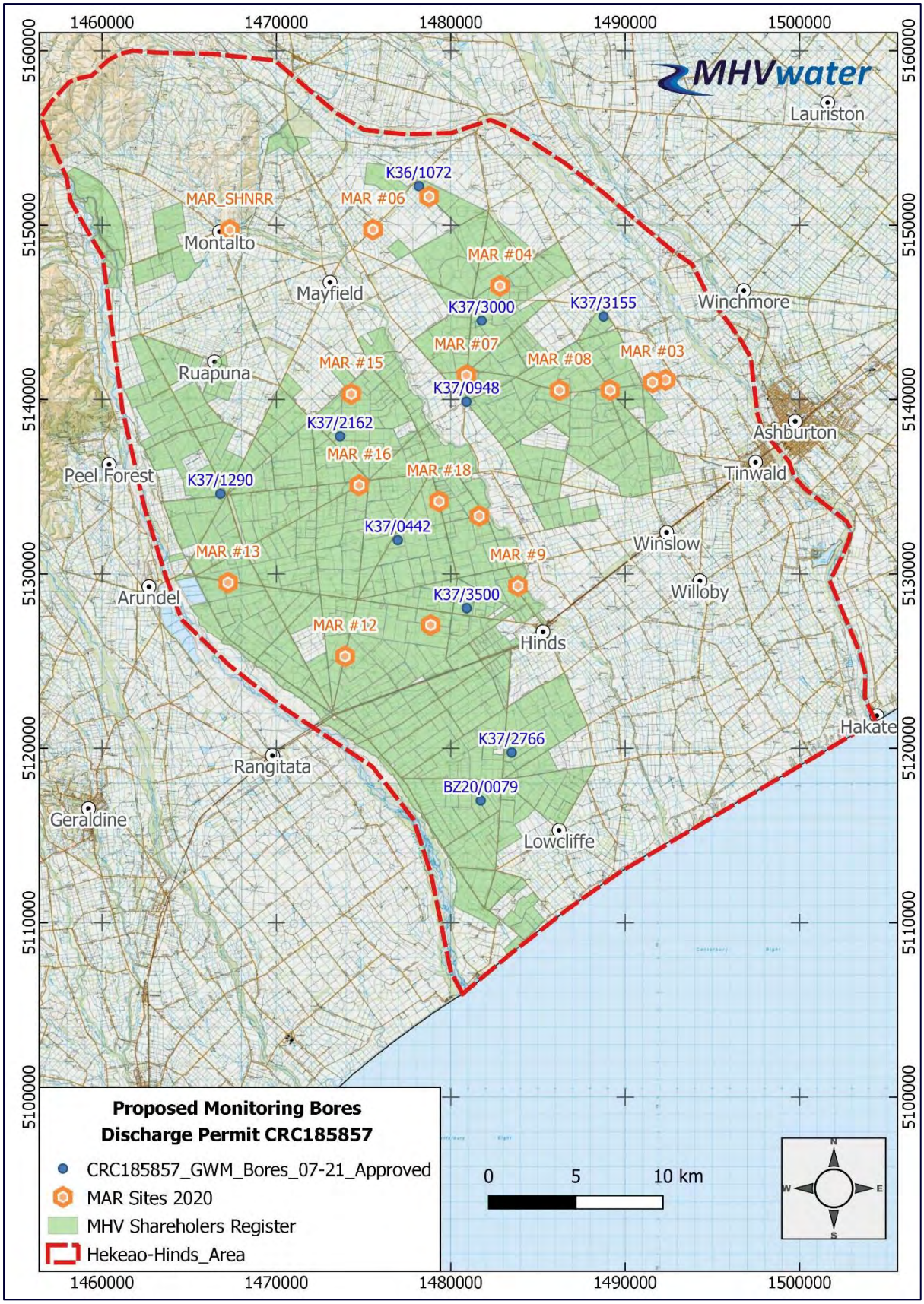

Figure 23 Locations of the proposed bores with respect to the current MAR Sites

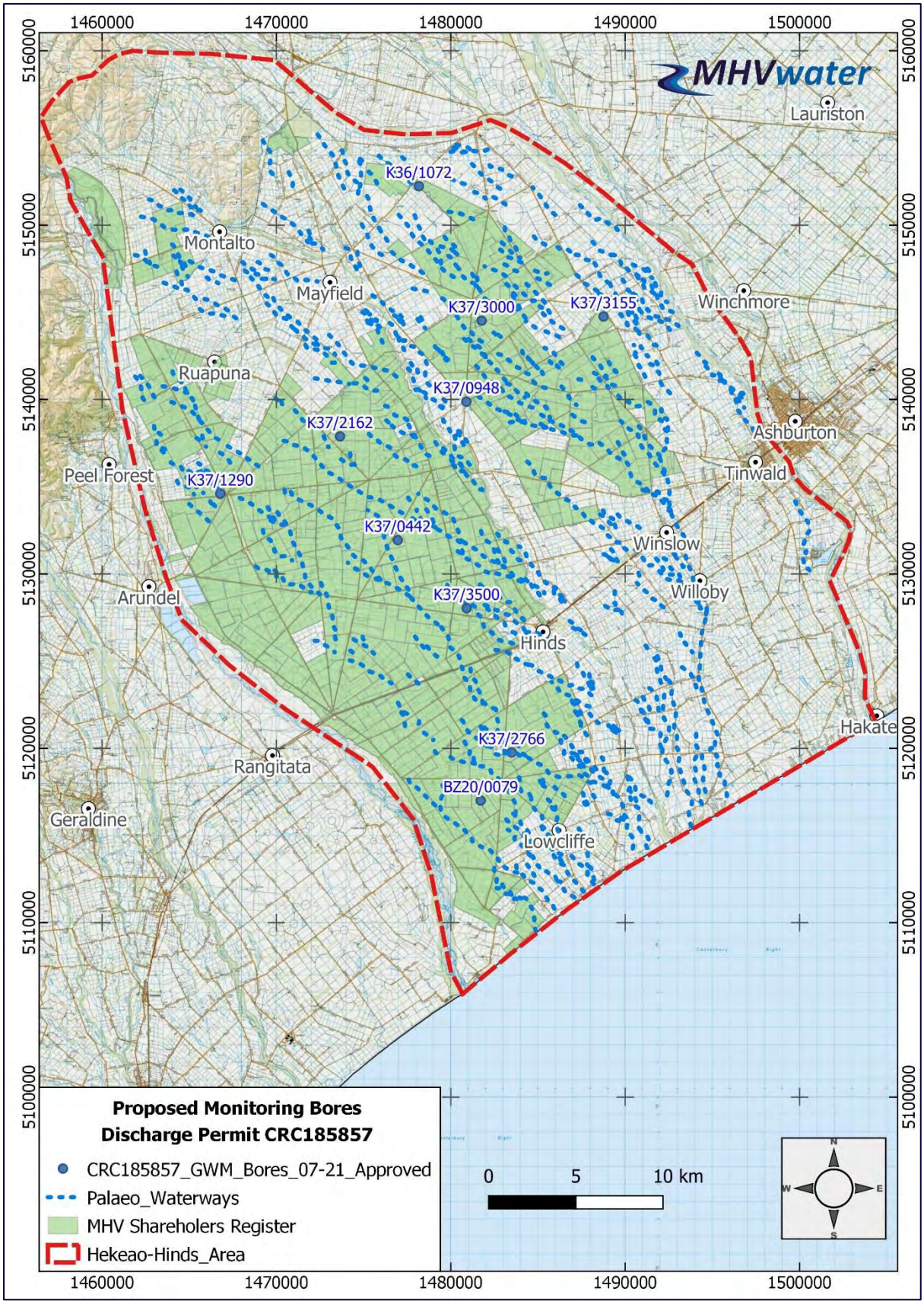

Figure 24 Locations of the proposed bores with respect to the interpreted paleo channels

MHV has been monitoring NO_3-N concentrations in groundwater within the MHV scheme area since 2016. As the focus of the monitoring programme has evolved over time, so too has the design of the programme. In this case, a full compliment of data for the proposed holes is not available until March 2021.

Subsequently there are considerable gaps in the continuity of the data prior to the monitoring program being reviewed in early 2020. Additionally, the absence of any QAQC protocols and supporting data prior December 2017 deems the 2016-2017 data invalid.

Contiguous data is presented in Table 11 and Table 12.

Table 11 Average NO_3-N concentrations of historical data for the bores selected

	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21	Average
BZ20/0079				8.04	8.8	8.42
K36/1072		3.31	3.3	3.33	2.42	3.09
K37/0442	10.84	11.05	10.78	9.59	11.61	10.77
K37/0948			8.27	9.28	6.53	8.03
K37/1290		10.52	11.05	10.05	9.03	10.16
K37/2162			9.6	9.16	10.04	9.60
K37/2766	7.8	6.4	6.82	7.57	7.6	7.24
K37/3000			10.47	10.57	11.11	10.72
K37/3155			9.23	9.01	10.16	9.47
K37/3500	10.43	12.04	13.38	11.8	9.86	11.50
Survey Total	**3**	**5**	**9**	**10**	**10**	**10**

Table 12 Details of the bores selected

WELL_NO	BZ20/0079	K36/1072	K37/0442	K37/0948	K37/1290	K37/2162	K37/2766	K37/3000	K37/3155	K37/3500
NZTM X	1481717	1478173	1476960	1480897	1466787	1473649	1483493	1481771	1488759	1480912
NZTM Y	5117008	5152240	5131945	5139885	5134604	5137895	5119767	5144529	5144768	5128041
Date Drilled	11/2020	03/2011	10/1991	1999	12/2001	04/2004	07/2006	03/2007	04/2008	09/2010
Depth	30.0	97	24.0	10.0	53.0	48.16	53.5	77.25	38.0	42.0
Screen Top	28.5	95.5	23	5	49	46.66	47.45	73.23	36.5	35.05
Screen Bottom	30	97	24	10	53	48.16	53.45	77.25	38	41.05
Stick Up	-0.4	-0.3	2	-0.17	-0.3	-0.35	-0.65	-0.5	-0.3	-0.45
Initial SWL	11	68.37	9.2	2.5	32	14.14	2.99	26.93	14.1	4.38
Av. SWL	11	68.07	6.425	3.685	35.465	17.565	6	27.4		
MHV SWL	5.98		9.765	3.32	36.81	24.805	6.4875	47.31	15.22	5.37
Diameter	150	150	125	200	150	150	300	200	150	250
Strata	4	23	4	2	7	14	6	11	10	10

MEMORANDUM

To	Matt Dodson
Company	ECan
CC	
From	Justin Legg
Date	08 September 2021
Subject	Response to MHV Water Environmental Monitoring Report
Doc. Ref	

Background

In compliance with Discharge Permit CRC185857, MHV submitted a draft Environmental Monitoring Programme (EMP) to ECan on31st August 2021.

ECan responded to this submission on 7th September 2021, with the following comments

> *"I do have a few comments and they are mostly about the National Environmental Monitoring Standards (NEMS) for Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data, March 2019.*
>
> *The intention of NEMS is to describe best practise groundwater sampling and it is a comprehensive document that covers all aspects of sampling, culminating in the ability for someone to assign a quality code to a piece of data (section 6.2.1 and Matrices A to C). Best practise includes using a IANZ accreditation laboratory and agreed methods (for nitrate that would be either APHA 4500-NO3 I or APHA 4110 B), calculating and documenting purging times and other aspects that are embedded in the sampling protocol within the standard.*
>
> *In my opinion, to meet the intention of condition 24 (a), you would need to quality code the data and justify that coding. I think how you would do that coding and justification should, be part of the EMP."*[1]

[1] Dodson, Matt. - *ECan Science Team Leader*. Email to Brooks, Mel. – *MHV CEO*. 07/09/2021 16:41

This document is intended to act as a record of a follow up meeting between Matt Dodson (*ECan Science Team Leader)* and Justin Legg *(MHV Senior Hydrogeologist)* regarding ECan's recommendations held 08/09/2021 at 08:15.

Supporting Documents

Document	Description & Relevance
MHV Bore Hole Information Sheet(s)	A standardised bore hole information sheet developed by MHV to records details such as: • Location • Access • Bore pump operation • Well head security in both written and photographic forms for all bores MHV monitors.
MHV Groundwater Sampling SOP Draft	MHV has developed a comprehensive groundwater SOP based on the guidelines described in the National Protocol for State of the Environment Groundwater Sampling in New Zealand[10]
Assura Water Quality Log	An online data logging platform used by MHV for water sampling[11]

Outcomes of the Meeting 8th September 2021

- The intention of the recommendations was to provide the reader of the EMP (and subsequent reports) with sufficient information to have confidence in the data being presented and remove the need to ask for additional information.
- The introduction of the EMP (and subsequent reports) should explicitly state that the NEMS system has been incorporated into the development of the EMP and thus follows industry standard guidelines and best practices.
- The introduction should also explicitly cite MHV SOP's and Field Notes to indicate to the reader the rigour of MHV's practices.
- The EMP (and subsequent reports) should explicitly state that all samples being submitted for compliance purposes will be sent to an accredited laboratory
- In the 'Sampling" section of the EMP (section 3 in the current draft), the EMP should explicitly specify how the NEMS protocols have been implemented, such as:
    - All bores to be purged for a minimum of 3x water column regardless of bore type
    - A function in Assura to confirm that if a bore is already running (at the time of sampling) that the farmer has been contacted to ascertain how long has it been running
    - Taps to be installed on all bores that are being used for reporting purposes so that direct bore samples can be obtained, i.e., no house tap or tank samples.
    - The use of a flow-cell to be used whilst water quality measurements are being taken
- A numerical code to be incorporated into Assura that provides an indication as to the veracity of the data being reported as outlined in section 6.2.1 of the NEMS for Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data, March 2019 – as outlined in Figure 25.

[10] Daughney, C.J., Jones, A., Baker, T., Hanson, C., Davidson, P., Zemansky, G., Reeves, R., Thompson, M., 2006. A National Protocol for State of the Environment Groundwater Sampling in New Zealand (No. GW/EMI-T-06/249 (ME number: 781)), GNS Science Miscellaneous Series 5. Ministry for the Environment, Wellington, New Zealand.

[11] https://mhvwater.assurasoftware.net

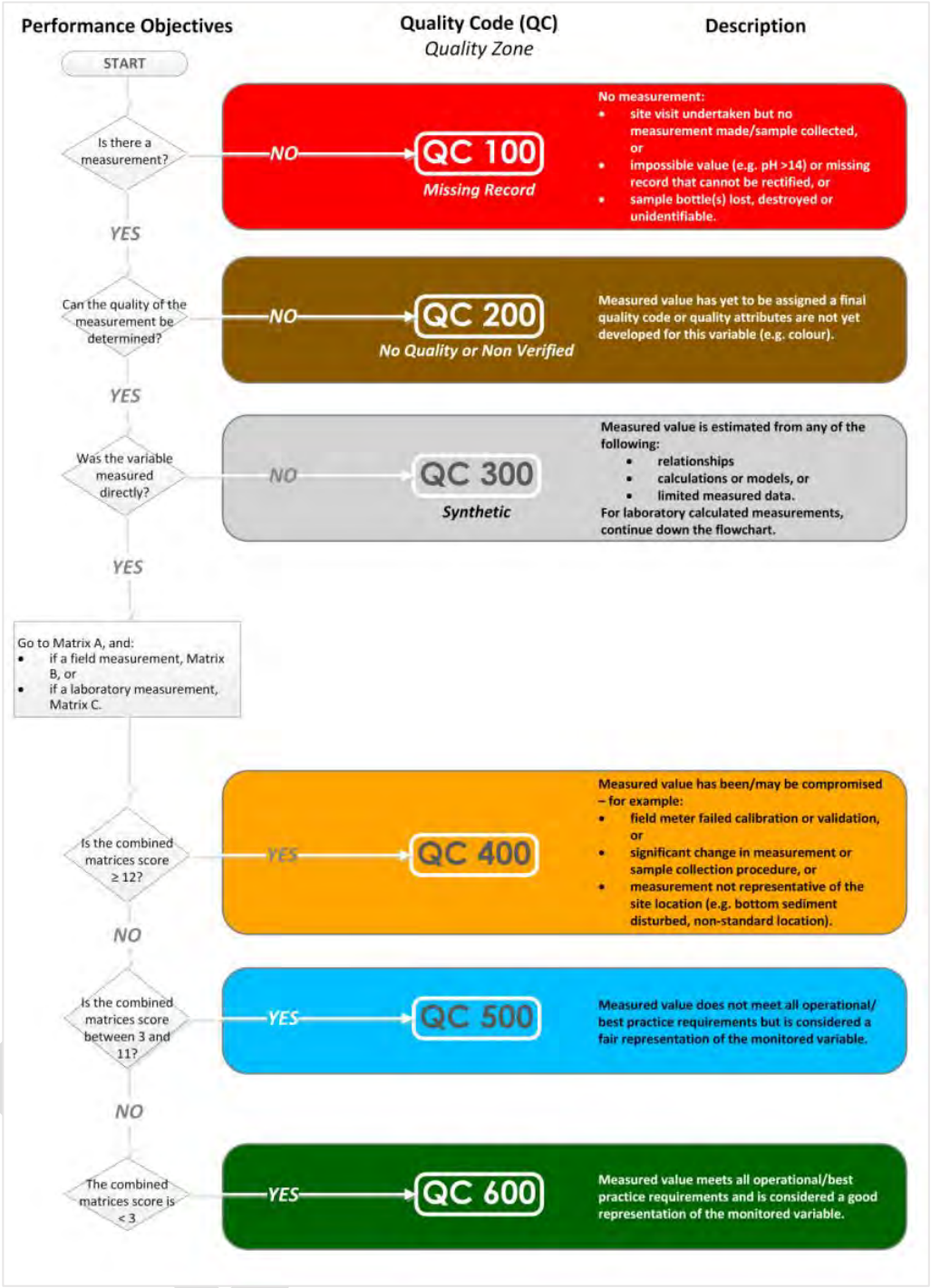

Figure 25 NEMS Quality Coding Schema

Bibliography

Aitchison-Earl, P., 2019. Sources of nitrate in groundwater in the Tinwald, Ashburton area (No. R19/85 (PU1C/8628)). Environment Canterbury (ECan), Christchurch, New Zealand.

Burbery, L.F., Moore, C.R., Jones, M.A., Abraham, P.M., Humphries, B.L., Close, M.E., 2018. Study of connectivity of open framework gravel facies in the Canterbury Plains aquifer using smoke as a tracer. Geol. Soc. Spec. Publ. 440, 327–344. https://doi.org/10.1144/SP440.10

Dommisse, J., 2006. Hydrogeology of the Hinds Rangitata Plain, and the Impacts of the Mayfield-Hinds Irrigation Scheme (Masters Thesis). University of Canterbury, Christchurch.

Durney, P., Ritson, J., Druzynski, A., Alkhaier, F., Tutulic, D., Sharma, M., 2014. Integrated catchment modelling of the Hinds Plains (No. R14/64 (PU1C/7864-1)). Environment Canterbury (ECan), Christchurch, New Zealand.

ECan, 2013. Living Stream: A Guide To Managing Waterways on Canterbury Farms (No. PU8C/5604). Environment Canterbury (ECan), Christchurch, New Zealand.

Hanson, C., Abraham, P., 2013. Cross sections of groundwater chemistry through the Ashburton Rangitata plain (No. R13/30 (PU1C/7705-1)). Environment Canterbury (ECan), Christchurch, New Zealand.

Hanson, C., Abraham, P., 2010. Nitrate contamination and groundwater chemistry – Ashburton-Hinds plain (No. R10/143). Environment Canterbury (ECan), Christchurch, New Zealand.

Jussel, P., 1989. Stochastic description of typical inhomogeneities of hydraulic conductivity in fluvial gravel deposits, in: Contaminant Transport in Groundwater. Presented at the International Synposium on contaminant transport in Groundwater, A.A. Balkema, Stuttgart, pp. 221–228.

Lunt, I.A., Bridge, J.S., 2007. Formation and preservation of open-framework gravel strata in unidirectional flows. Sedimentology 54, 71–87. https://doi.org/10.1111/j.1365-3091.2006.00829.x

Meredith, A., Lessard, J., 2014. Ecological assessment of scenarios and mitigations for Hinds Catchment streams and waterways (No. R14/72, PU1C/7872-1). Environment Canterbury (ECan), Christchurch, New Zealand.

Milne, J., 2019. Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data, in: National Environmental Monitoring Standards, Water Quality. National Environmental Monitoring Standards & Ministry for the Environment (MfE), Wellington, New Zealand, p. 104.

Ministry of Health, 2018. Drinking-water Standards for New Zealand 2005 (Revised 2018).

Rutter, H., Cox, S., Dudley Ward, N., Weir, J., 2016. Aquifer permeability change caused by a near-field earthquake, Canterbury, New Zealand. Water Resour. Res. 52, 8861–8878. https://doi.org/10.1002/2015WR018524