Central Plains Water Trust

Annual Sustainability Report 2019-20

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- December 2020

Report prepared by

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List of Abbreviations

CCC	Christchurch City Council
CLG	CPW Community Liaison Group
CWMS	Canterbury Water Management Strategy
CPW	Collective reference to CPWL and CPWT
CPWL	Central Plains Water Limited
CPWT	Central Plains Water Trust
ECan	Environment Canterbury
EMF	CPW Environmental Management Fund
EMS	CPW Environmental Monitoring Strategy
FEP	Farm Environmental Plan
GSWERP	Ground and Surface Water Expert Review Panel
GSWMP	Ground and Surface Water Monitoring Plan
LWRP	Canterbury Land and Water Regional Plan
SDC	Selwyn District Council
TWEMF	Te Waihora Environmental Management Fund
TLI_3	Trophic Level Index
ZIP	CWMS Selwyn Waihora Zone Implementation Plan

Executive Summary

The initial stage (Stage 1) of the Central Plains irrigation scheme (the Scheme) commenced operations in 2015, with the final stage (Stage 2) being commissioned in October 2018. The completed scheme supplies water to a command area of approximately 70,000 hectares between the Waimakariri and Rakaia rivers.

Stage 1 of the Scheme covers an area of approximately 30,300 hectares between the Rakaia and Selwyn rivers, approximately 22,500 hectares of which is irrigated using CPW water. Stage 1 incorporates a 17km long headrace canal to supply water from the Rakaia River intake to 130 farm turnouts via a 130 km distribution network comprising pressurised underground pipes. Stage 2 of the CPW Scheme covers an area of approximately 32,000 hectares between the Selwyn and Waimakariri Rivers, 18,200 hectares of which is irrigated using CPW water. Stage 2 extends from the end of the Stage 1 headrace canal and supplies 156 farm turnouts via a pressurised distribution network approximately 200 kilometres long. The 7,000 ha Sheffield Scheme is a stand-alone project along the northern margin of the Central Plains area that commenced operations in November 2017 utilising water from the Kowhai and Waimakariri Rivers in combination with a large storage pond constructed near Springfield. Approximately 4,200 hectares of the Sheffield Scheme area is irrigated using CPW water.

Between 1 October 2019 and 31 May 2020, the CPW scheme supplied 172.7 million m^3 of water to 285 shareholder properties. A total of 97.4 million m^3 of water was supplied to 97 Stage 1 properties, while 128 Stage 2 properties received a further 62.4 million m^3 of water from the CPW Scheme. Of the combined Stage 1 and 2 volume of 159.8 million m^3, 106.5 million m^3 was supplied from run-of-river abstraction via the Rakaia River intake, with the balance (53.3 million m^3 or 33% of total abstraction) derived from stored water (Lake Coleridge). A total volume of 12.9 million m^3 was supplied to 30 properties in the Sheffield Scheme area during 2019-20, comprising 8.4 million m^3 of run-of-river abstraction from the Waimakariri River and 4.5 million m^3 from pond storage.

During the 2019-20 year, direct run-of-river abstraction from surface water totalled 38 and 11 percent of the volume potentially available under resource consents held by CPW for abstraction from the Rakaia and Waimakariri Rivers respectively. In combination with the use of stored water, this provided a reliable supply of irrigation water to shareholders, while having no measurable effect on naturally occurring discharge in the Rakaia or Waimakariri Rivers during periods of mid to low flows (when CPW abstraction is restricted or cut-off). Due to the use of CPW water, groundwater usage by CPW shareholders during 2019-20 was less than 24% of the total volume authorised by existing water permits across the Scheme area.

Water quality monitoring results recorded for the CPW monitoring programme during the 2019-20 year show surface water quality, groundwater quality and lake water quality trigger levels established for the CPW Scheme[1] were exceeded at a number of monitoring sites located both up-stream, within and down-stream of the CPW Scheme area. The recorded trigger level exceedances are consistent with the historical range and/or background trends observed prior to commencement of CPW operations. No obvious effects on water quality, groundwater levels or surface water flows attributable to operation of the Scheme were observed during the 2019-20 year.

[1] These trigger levels are consistent with equivalent environmental limits established in the Canterbury Land and Water Regional Plan

Implementation of Farm Environment Plans (FEPs) for all CPW Shareholder properties, combined with ongoing improvements in farm management practices, has resulted in significant reductions in nutrient losses across the Scheme. Based on farm nutrient budgets, 2019-20 nutrient losses were 28% below the 2017 baseline, exceeding the 2022 nutrient reduction target for properties in the Selwyn-Te Waihora zone specified in the Land and Water Regional Plan (LWRP).

Key Statistics for the CPW 2019-20 Irrigation Season

	Stage 1	Stage 2	Sheffield
Number of Properties Supplied	97	128	30
Number of Turnouts Supplied	130	156	35
Farm Enterprise Property Area	30,300 Ha	32,000 Ha	7,000 Ha
Irrigated area	22,500 Ha	18,200 Ha	4,200 Ha
Total Volume of Water Delivered	97.4 million m^3	62.4 million m^3	12.9 million m^3
Total Volume of Run-of River Take	63.8 million m^3	42.7 million m^3	8.4 million m^3
Total Volume of Water from Storage	33.6 million m^3	19.7 million m^3	4.5 million m^3
Total Volume of Groundwater Used	17.5 million m^3	26.6 million m^3	1.5 million m^3
Length of 2017-18 Irrigation Season	260 days	260 days	260 days
Available Surface Water Allocation Taken	38%	38%	11%

1. Scheme Background

1.1. History

The Central Plains Water Trust (CPWT) was established jointly in 2003 by Christchurch City Council (CCC) and Selwyn District Council (SDC) to implement the Central Plains Water Enhancement Scheme (the Scheme) which was intended to supply irrigation water to an area of approximately 60,000 hectares between the Waimakariri and Rakaia Rivers.

In July 2012, the CPWT was granted resource consents by Environment Canterbury (ECan) and SDC to take and use water for irrigation purposes, as well as to construct and operate the Scheme. Central Plains Water Limited (CPWL) was subsequently established to implement the Scheme, and CPWT has licensed the use of the consents to CPWL. CPWL is responsible for the construction and operation of the Scheme, and for all consent compliance and reporting. For the purposes of this report, CPWT and CPWL are referred to collectively as CPW.

1.2. Scheme Development

As shown on Figure 1, development of the Scheme was undertaken in three stages.

Stage 1 provides irrigation water to an area of approximately 30,300 hectares between the Rakaia and Selwyn rivers and was completed in September 2015. Stage 1 is supplied from the Rakaia River via a 17km headrace that extends from the river intake as far as Leeches Road. From the end of the headrace, water is conveyed to individual shareholder properties via a pressurised pipe network approximately 130 kilometres in length. Construction of the Rakaia River intake and distribution network for Stage 1 was undertaken between early 2014 and mid-2015, with the first irrigation water supplied on 1 September 2015.

Stage 2 supplies a command area of approximately 32,000 hectares between the Selwyn and Waimakariri rivers. Construction of Stage 2 commenced in early 2017, with the scheme becoming operational on 2 October 2018. This component of the Scheme is a fully piped network that is integrated with the Stage 1 reticulation, utilising water from the Rakaia River intake (including Lake Coleridge storage). Stage 2 is supplied by a 23-kilometre, large diameter (2.5 m) Glass Reinforced Plastic (GRP) pipe which extends from the end of the Stage 1 headrace canal and feeds a pressurised distribution network approximately 200 kilometres long.

The Sheffield scheme, covering approximately 7,000 Ha commenced operations in November 2017. This component of the scheme is physically separate from Stages 1 and 2, supplying irrigation water, stock water, firefighting water and supplementary town supply water for Springfield and Sheffield from the Waimakariri and Kowai Rivers. The Sheffield scheme includes a 2 million m^3 pond constructed near Springfield to provide storage during periods of low flow when run-of-river abstraction is restricted.

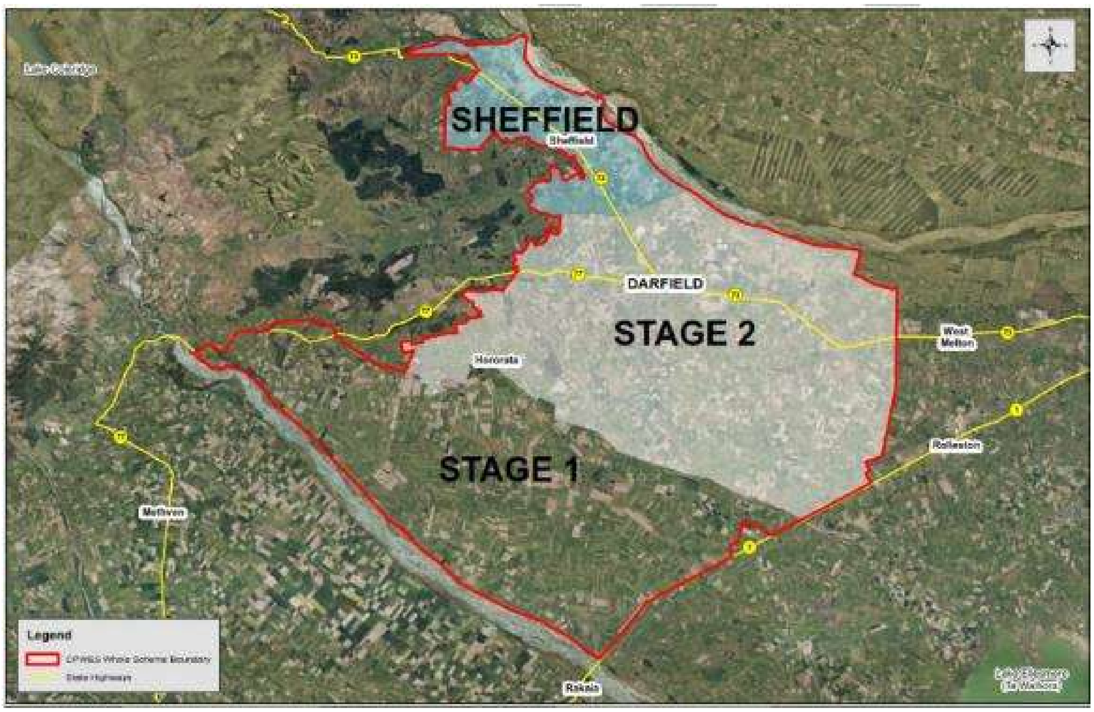

Figure 1. *Layout of the CPW scheme.*

1.3. Water Sources

Stage 1 and Stage 2 of the Scheme derive water from the Rakaia River via an intake constructed approximately 8 kilometres downstream of the Rakaia Gorge (SH77) bridge. Conditions of resource consents authorising the taking of water from the river are subject to minimum flow conditions which require the rate of abstraction to progressively reduce as river flows decline.

The Rakaia River Water Conservation Order establishes a minimum flow at Rakaia Gorge which varies depending on the month between 90 cubic metres per second (cumecs) in September and 139 cumecs in December. When flows are below the minimum flow, no water can be taken from the river. When flows are higher than the minimum flow, water can be taken from the river by resource consents assigned to multiple allocation 'Bands' which have varying minimum flow restrictions. Water permits assigned to individual Bands can take water on a 1:1 basis above the specified minimum flow (i.e., for every 2 m^3/s of flow above the specified minimum, 1 m^3/s can be taken from the river).

The bulk of allocation held by CPW is assigned to flow Bands which require abstraction to cease when river flow falls to less than 70 cumecs above the WCO minimum flow, resulting in relatively modest supply reliability (i.e., it is cut-off first as river flows decline). Due to constraints imposed by the minimum flow restrictions, the full volume of allocation held by CPW can only be taken on average for around 63 percent of the time during the irrigation season. To provide an adequate reliability of supply for irrigation, CPW have an agreement with TrustPower Ltd to access water stored in Lake Coleridge. Under this agreement, water is released from Lake Coleridge as river flows decline. This enables CPW to continue to take water from the river without having any adverse effect on natural flows in the river. The use of stored water increases the reliability of supply for Stage 1 and 2 to approximately 98 percent.

The Sheffield Scheme utilises water from the Kowai and Waimakariri Rivers which are subject to similar low flow restrictions to those applying on the Rakaia River. The storage pond constructed for the Sheffield Scheme holds sufficient water to maintain reliability of supply at a similar level to Stages 1 and 2. It is noted that the Waimakariri River intake is only constructed to accommodate a flow of 2 m^3/sec which is equivalent to 8% of the allocation held by CPW. As a result, the maximum rate of take possible under the current Scheme configuration is significantly lower than that authorised by existing resource consents.

Table 1 below provides a summary of the average utilisation of water available to CPW under existing resource consents via the Rakaia River and Waimakariri River intakes since the Scheme commenced operation. The proportion of total river flow available for abstraction by CPW varies from year-to-year reflecting temporal variation in river flows and the resulting effect of minimum flow cut-offs on water available for abstraction by CPW. The figures show that, to date, CPW has utilised less than 40% of the total allocation available to it from the Rakaia River and less than 12% of the water available from the Waimakariri River.

Table 1. *Average water availability and utilisation of by CPW consents, 2015-16 to 2019-2020.*

Source		2016-16	2016-17	2017-18	2018-19	2019-20
Rakaia River	Percentage of river flow available for CPW abstraction	7.7%	6.2%	9.1%	4.8%	6.1%
	Percentage of river flow used by CPW	1.8%	1.5%	1.5%	1.6%	2.3%
	Percentage of CPW allocation utilised	23%	24%	17%	33%	38%
Waimakariri River	Percentage of river flow available for CPW abstraction	n/a	n/a	2.2%	3.1%	2.8%
	Percentage of river flow used by CPW	n/a	n/a	0.25%	0.14%	0.31%
	Percentage of CPW allocation utilised			11%	5%	11%

1.4. Regulatory Environment

The Canterbury Land and Water Regional Plan (LWRP) establishes objectives, policies and rules relating to the management of land and water resources across the Canterbury region. The plan divides the region into ten geographic zones and establishes a set of objectives, policies and rules which apply uniformly across the entire region. In addition, each Zone has a set of specific policies, rules and limits which address localised or sub-regional resource management issues particular to that Zone, which either over-ride or add to the region-wide rules.

The specific management provisions for each Zone are developed and overseen by a Zone Committee comprising a range of community representatives. The Zone Committee is responsible for developing strategies, targets and activities outlined in a Zone Implementation Plan (ZIP) that outlines recommendations for short and long-term water management in each Zone.

The Scheme is located in the Selwyn - Te Waihora Zone and forms an integral part of measures outlined in the ZIP (also referred to as the "Solutions Package") for delivering the Canterbury Water Management Strategy (CWMS) outcomes adopted by the Selwyn - Te Waihora Zone Committee in October 2013. These measures anticipate that the Scheme will provide additional recharge to the catchment from alpine water, a reduction in the volume of groundwater used for irrigation and provide opportunities for targeted stream augmentation. This is expected to result in increased volumes of water in aquifers and flows in lowland streams, as well as dilution of nitrogen concentrations in Lake Ellesmere/Te Waihora, thereby improving water quality and quantity across the wider Zone.

Recommendations in the Selwyn - Te Waihora Solutions Package were formally adopted by ECan via Plan Change 1 to the Canterbury Land and Water Regional Plan (LWRP) in February 2016. Updated provisions for the Selwyn - Te Waihora zone in the LWRP include:

- Prohibiting new groundwater takes in over-allocated water management zones and reducing the total volume of water allocated within the Zone
- Revised surface water allocation limits to deliver ecological and cultural flows, particularly in lowland streams
- Introduction of a fixed allocation or "cap" on nitrogen losses in the catchment (including the Scheme). Progressive reductions in cumulative nitrogen losses are required over time
- A requirement for all farming properties to prepare a farm environment plan (FEP) and implement a range of good management practices. This includes specific requirements for individual landholdings to reduce nitrogen leaching losses by specific amounts (depending on land use type) by 2022
- A reduction in legacy phosphorus in Lake Ellesmere/Te Waihora by 50 percent and improved management of lake-level and opening.

The Selwyn-Waihora provisions of the LWRP make specific provision for nitrogen losses from the Scheme. These provisions set a threshold for cumulative losses from the land irrigated from the Scheme which enables conversion of some existing dryland farms to irrigation, while requiring land uses within the scheme to implement good management practice to achieve the overall reduction in nitrogen losses required by 2022.

2. 2019/20 Annual Summary

2.1. Climate

During the 2019-20 year, cumulative rainfall totals were generally close to, or slightly below, the long-term average across the Central Plains area. As illustrated on Figure 2, a total of 768 mm of rainfall was recorded at NIWA weather station 4702 (located approximately 4km west of Hororata) between July 2019 and June 2020, 58 mm (7%) less than the long-term average of 826 mm. The figure also illustrates cyclical variations in medium-term (5-year moving average) rainfall, with multi-year periods of above and below-average rainfall observed in the historical record. Since 2000, despite individual dry seasons (e.g., 2014-15 and 2015-16), medium-term average rainfall totals at Hororata have remained close to, or slightly above, the medium-term average.

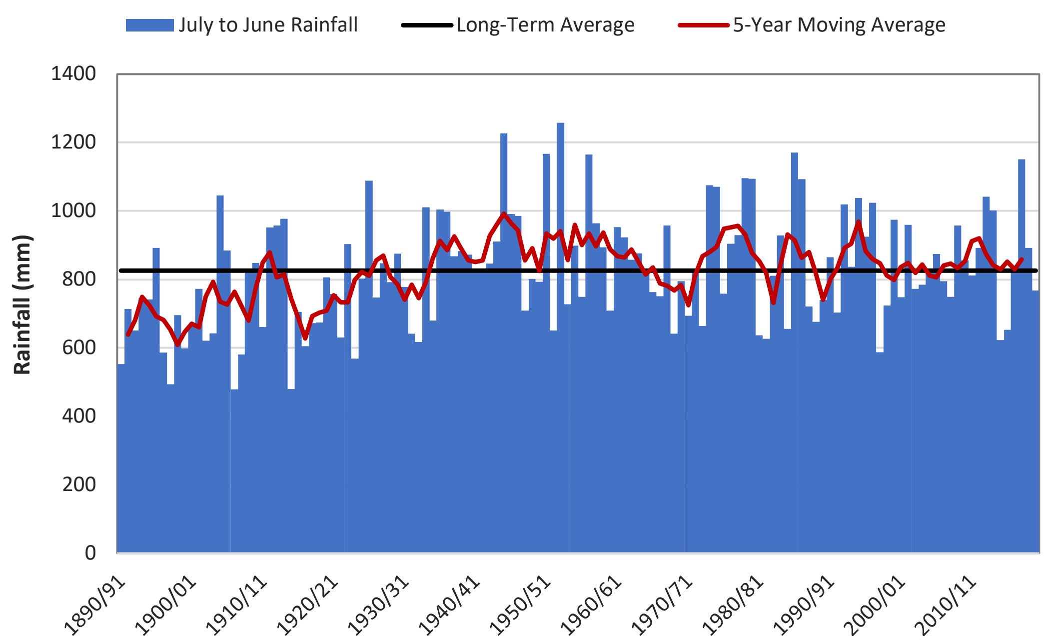

Figure 2. *Historical July to June rainfall at Hororata (4702), 1890-91 to 2019-20 (Data from NIWA CliFlo database).*

As shown on Figure 3 below, monthly rainfall totals exhibited a cyclical pattern during the 2019-20 season. Rainfall was consistently above average in July 2019, average to slightly above average from August to November 2019, then below average from December to May before returning to above average in June 2020. Rainfall during the months of January, April and May 2020 was appreciably (>35 mm) lower than average.

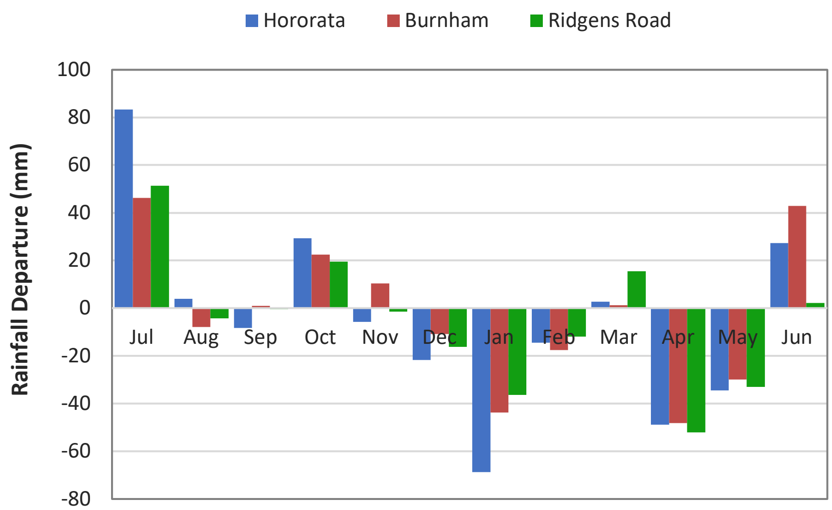

Figure 3. *Departure from average monthly rainfall at Hororata, Burnham and Rigdens Road during the 2019-20 year (Data from NIWA CliFlo database and Environment Canterbury).*

Temporal variation in rainfall during the 2019-20 year is reflected in the accumulated soil moisture deficit. As shown on Figure 4, soil moisture deficit was above average from July to December 2019 when it declined appreciably and remained below average until late June 2020. As illustrated, temporal variation in soil moisture during 2019-20 followed a similar pattern to that observed during the 2018-19 season, but with a marked reduction in soil moisture occurring around two months earlier. Differences in the timing of soil moisture deficit between individual irrigation seasons significantly influence overall water demand in the CPW Scheme.

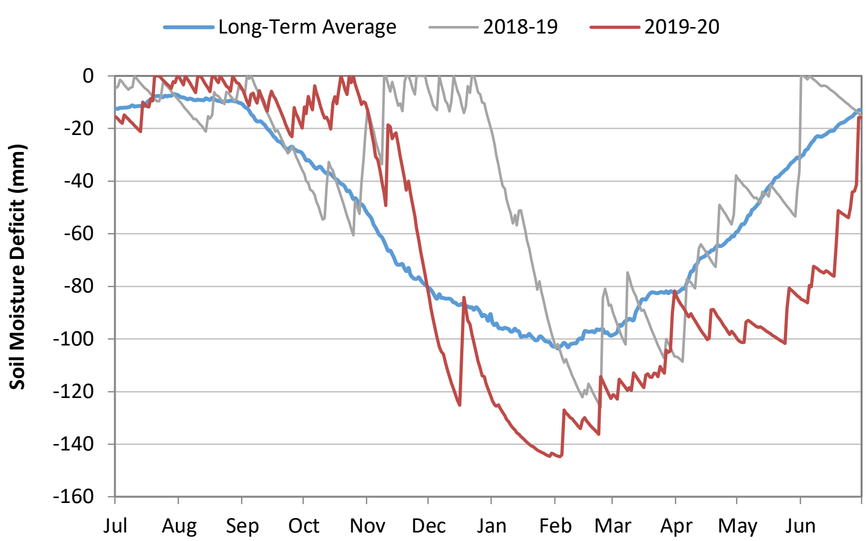

Figure 4. *Soil moisture deficit at Hororata during 2018-19 and 2019-20, compared to the long-term average (Data from NIWA CliFlo database, Station No. 4702).*

While requirements for irrigation reflect short-term variation in rainfall, the overall quantity of groundwater and surface water resources in the Central Plains area generally reflect longer-term trends in climate. As illustrated on Figure 5, cumulative rainfall during the 2019-20 year was slightly above normal for the first half of the season (July to December) before falling appreciably below normal for the remainder of the year (January to June). In contrast, cumulative rainfall was close to normal during the 2018-19 season after having been significantly above normal during the 2017-18 year.

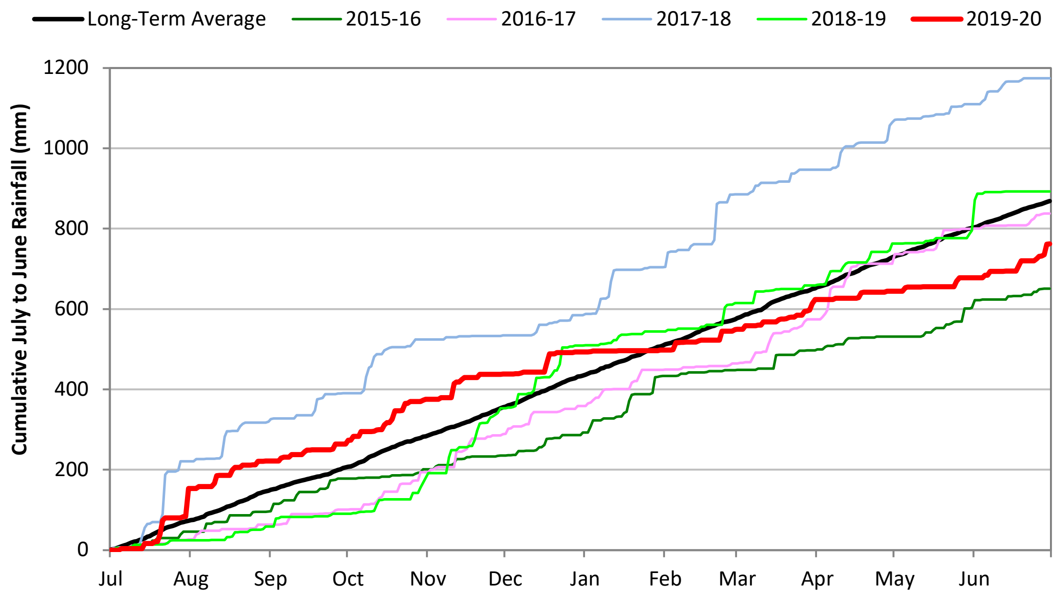

Figure 5. *Cumulative (July to June) rainfall at Hororata, 2015-16 to 2019-20.*

Both short and medium-term variations in rainfall departure from average were reflected in groundwater levels and stream flows across the wider Central Plains area during the 2019-20 year. While surface water flows are generally influenced by individual rainfall events over the short-term, variations in groundwater levels and discharge in lowland streams are more strongly influenced by seasonal to inter-annual variations in rainfall.

Figure 6 shows a plot of groundwater levels in representative ECan long-term monitoring wells located in the Central Plains area. During the 2019-20 year, groundwater levels were generally above the long-term median from July to December 2019, declining to, or slightly below, median through the remainder of the year. This decline reflects equilibration of groundwater levels to average rainfall after consecutive winters of above average recharge during 2017-18 and 2018-19.

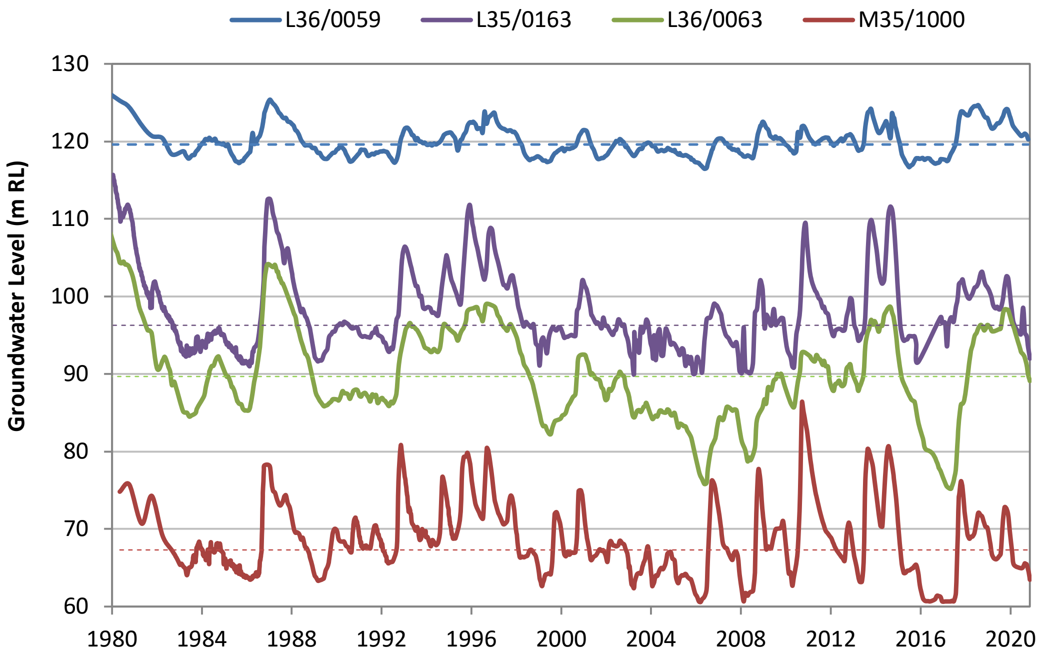

Figure 6. Long-term groundwater levels recorded in L36/0059 (Hororata), L35/0163 (Kirwee), L36/0063 (Greendale) and M35/1000 (West Melton) from 1980 to 2019 (Data from Environment Canterbury). Dotted lines indicate long-term median groundwater levels at each site.

Flows in rivers and streams draining the Central Plains area are influenced by both rainfall and groundwater levels (particularly during periods of limited rainfall). Figure 7 compares flow in the Selwyn River at Coes Ford during the 2019-20 year with the long-term average for this site. The figure shows flows during August 2019 were well above the long-term average due to significant rainfall, but remained below average for the remainder of the year reflecting average to below average rainfall over this period, particularly during autumn and early winter 2020.

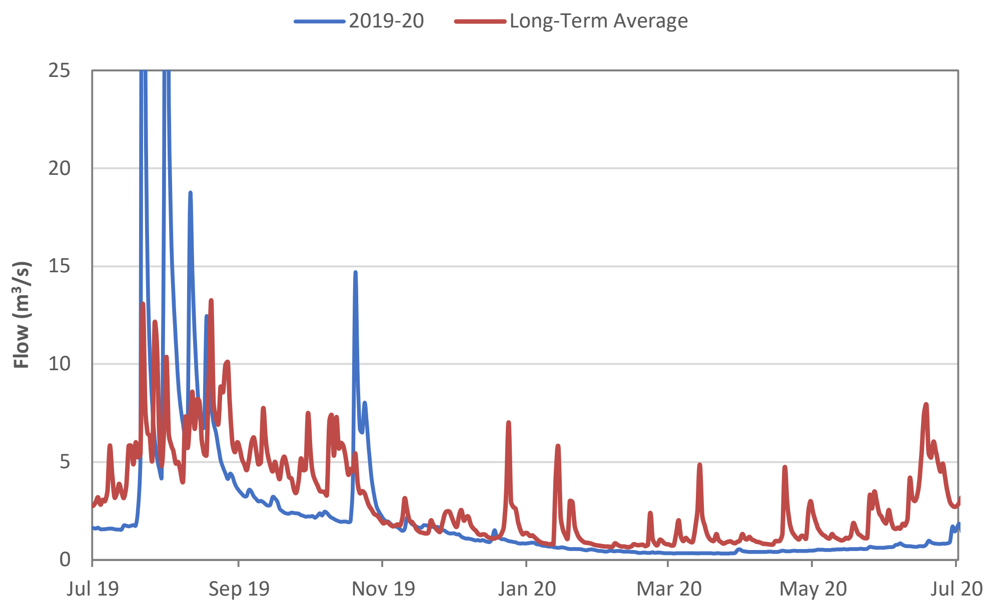

Figure 7. *Mean daily flow in the Selwyn River at Coes Ford during 2019-20 compared to the long-term average. Note: scale only shows flows below 25 m³/s. (Data from Environment Canterbury)*

Large recharge or high flow events following heavy rainfall can have a significant short-term influence on groundwater and surface water quality. Groundwater quality may also be influenced by inter-annual rainfall variability where extended periods of above average rainfall following similar periods of below average rainfall and can act to flush contaminants accumulated in the soil and unsaturated zone into underlying groundwater. Such short to medium-term climate variability can act to obscure underlying water quality trends.

Overall, the 2019-20 irrigation season can be characterised as being average to slightly wet from June to December 2019, then dry to very dry for the remainder of the year.

2.2. Scheme Operation

Between 1 October 2019 and 31 May 2020, the CPW scheme supplied a total of 172.7 million m^3 of water to a total of 285 shareholder properties.

A total of 97.4 million m^3 of water was supplied to 97 Stage 1 properties, comprising 63.8 million m^3 of run-of-river abstraction from the Rakaia River, with an additional 33.6 million m^3 of stored water sourced from Lake Coleridge. A total of 128 Stage 2 properties received a further 62.4 million m^3 of water from the CPW Scheme, comprising 42.7 million m^3 of run-of-river abstraction and 19.7 million m^3 of stored water. Of the combined 2019-20 Stage 1 and 2 volume of 159.8 million m^3, 53.3 million m^3 (33%) was derived from stored water.

A total volume of 12.9 million m^3 was supplied to 30 properties in the Sheffield Scheme area during 2019-20, comprising 8.4 million m^3 of run-of-river abstraction from the Waimakariri River and 4.5 million m^3 (54%) from pond storage.

CPW scheme shareholders also utilised a total of 17.5 million m^3 of groundwater (18% of available allocation) in the Stage 1 area, 26.6 million m^3 (25% of available allocation) and 1.5 million m^3 of groundwater (28% of the available allocation) in the Sheffield Scheme area during 2019-20. Cumulative groundwater on CPW shareholder properties across the whole CPW Scheme area during 2019-20 was equal to 24% of current allocation.

Figure 8 provides a summary of water use across the CPW Scheme during the 2019-20 season.

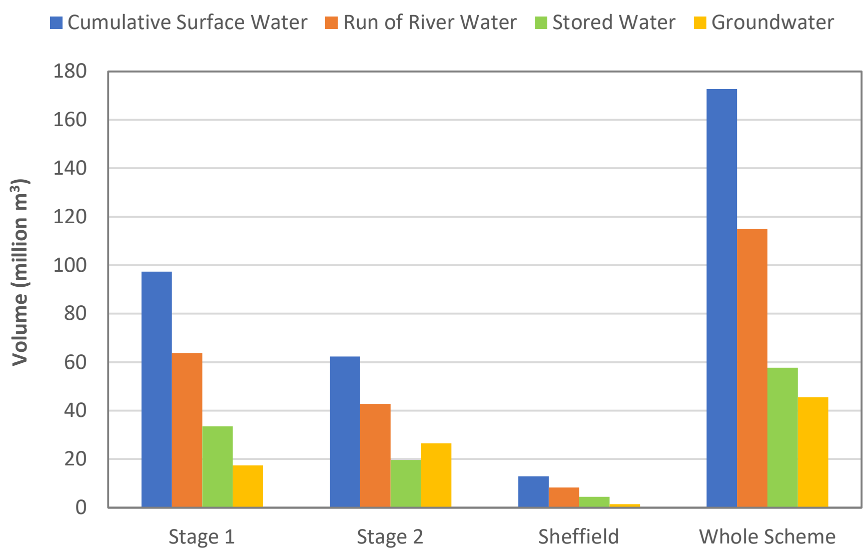

Figure 8. *Water use in individual stages and across the whole CPW Scheme, 2019-20*

Figure 9 provides a breakdown of seasonal water use for Stage 1 since operations commenced in 2015-16. The figure shows total water use in 2019-20 was the highest recorded (approximately 3% higher than 2015-16), while use of stored water in 2019-20 (33% of the total volume) was lower than 2018-19 (46%) but similar to pervious years (31% in 2017-18). Run-of-river abstraction during 2019-20 was the second highest (behind 2015-16) since Stage 1 commenced operations.

Total water use in Stage 2 during 2019-20 was approximately 24% higher than 2018-19 (the first year of Stage 2 operations), a majority of which was derived from increased run-of-river abstraction[2]. Water use in the Sheffield Scheme in 2019-20 was approximately 45% higher than 2018-19, derived from an approximately equal increase in run-of-river abstraction and use of stored water.

[2] It is noted that commissioning of Stage 2 was delayed until 15 October 2019, approximately 6-weeks following the commencement of operations 2018-19 in the Stage 1 and the Sheffield Scheme areas.

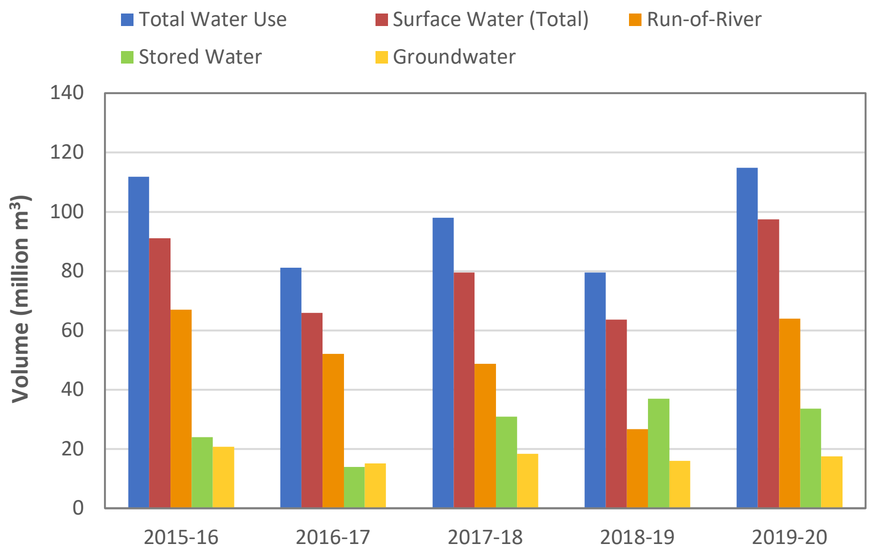

Figure 9. *Water use in CPW Stage 1, 2015-16 to 2019-20*

Figure 10 shows a plot illustrating the combined operation of Stages 1 and 2 of the CPW scheme during the 2019-20 year. The figure shows irrigation demand (black line) was relatively modest (generally <5 m^3/s) until early November 2019. Demand then increased to between 15 to 20 m^3/s and remained relatively constant through to early March 2020 when it began to taper off through to mid-May (declining to near-zero during the initial COVID lockdown in late March/early April 2020). The figure shows a significant proportion of demand between January and April 2020 was supplied from stored water (denoted by red area) due to Rakaia River flows declining below CPW minimum flow cut-offs.

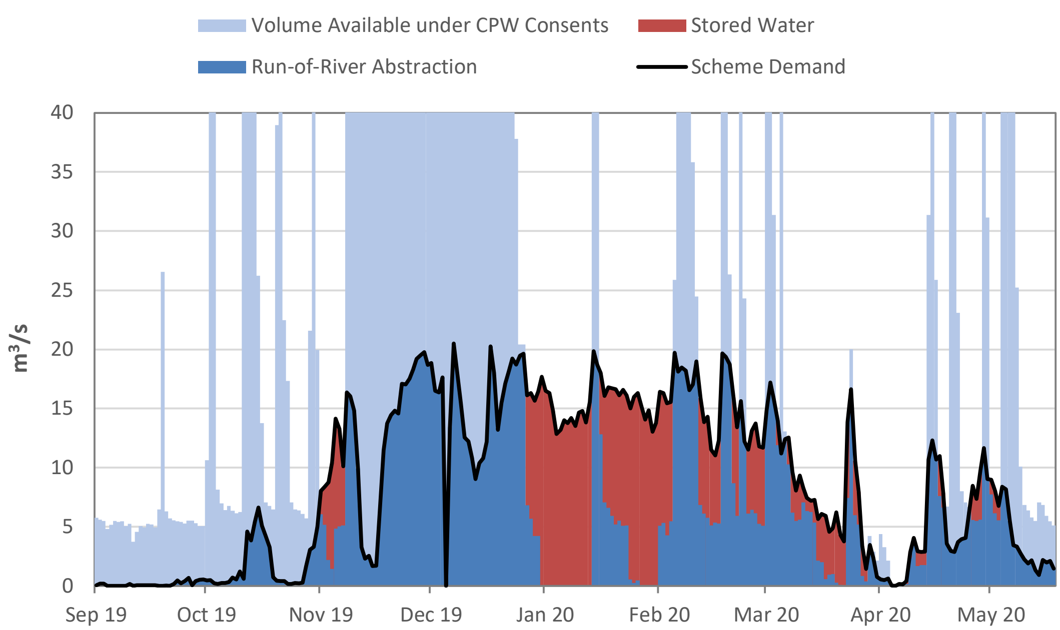

Figure 10. *Schematic illustration of Stage 1 and 2 operations during the 2019-20 year.*

Figure 11 illustrates operation of the Sheffield Scheme during the 2019-20 season. The figure shows water demand increasing from late October through to early-December 2019, remaining high through to late January 2020 before taping-off through to mid-May (again dropping to near-zero during the initial COVID lockdown period in late March/early April 2020). Water was sourced from run-of-river abstraction, aside from periods in early November to mid-December 2019, late January 2020 and March to May 2020 when river flows were low, when a majority of demand was met from storage. By the end of the irrigation season (mid-May 2020) pond storage had declined to around 25% of capacity.

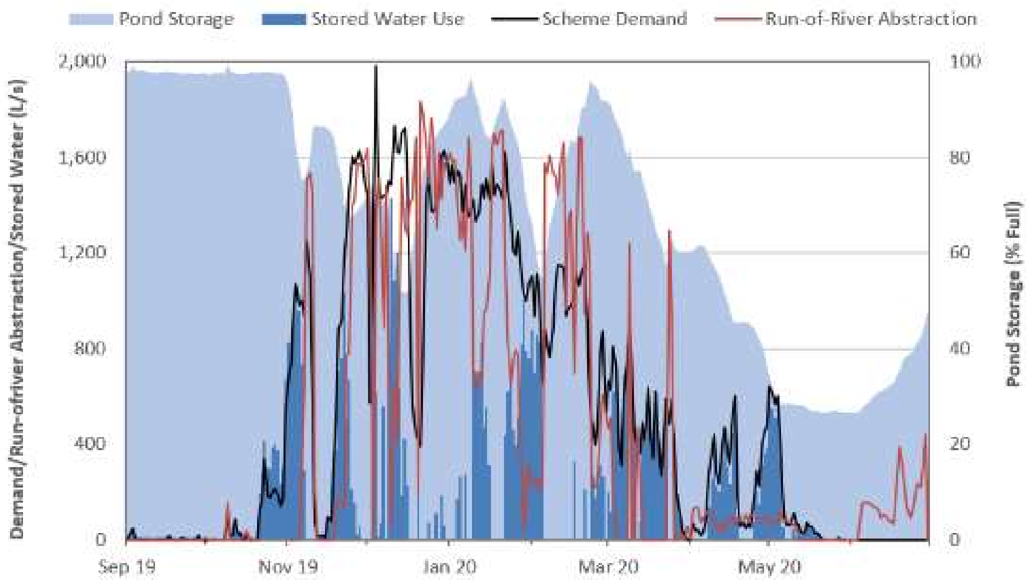

Figure 11. *Schematic illustration of run-of-river abstraction, Scheme demand and storage volumes for the Sheffield Scheme during the 2019-20 year.*

2.3. Positive Benefits

Development of the CPW Scheme was forecast to provide a range of economic and social benefits to the wider community. Limited data has been collated to accurately quantify these effects as operation of the full scheme has only recently commenced. Specific positive benefits resulting from Scheme that have been identified to date include:

- $592 million in increased agricultural output from land irrigated using the CPW Scheme
- Long-term employment for staff on farms where land use has changed to higher value use
- Support for the supply of raw materials to food processing facilities (e.g., Fonterra, McCains, Watties, Synlait)
- Upwards of 1,000 direct and indirect jobs in the wider Christchurch region as a result of the Scheme
- Provision of opportunities for landowners to convert land use to higher value options
- Conversion of unsustainable groundwater use to surface water use – to date CPW Shareholders have reduced their usage of groundwater by more than 50% across the scheme

- Provision of supplementary/backup water supplies for the Springfield and Sheffield communities
- Construction of 20 turnouts (connections to the scheme) to provide contingency for rural fire fighting (8 in Stage 1, 7 in Stage 2 and 5 in the Sheffield Scheme area).

The CPW Scheme has also provided a range of other positive benefits including:

- Implementation of Farm Environment Plans (FEP) on all scheme properties including a reduction in nitrogen losses in advance of LWRP requirements
- Long-term security of water supply for Shareholders (given current resource consents expire in 2047)
- Reliable irrigation which has supported cultivation of alternative, high value crops such as chrysanthemum, hemp, sunflower etc
- Long-term environmental funding to ecological projects and programmes in the Selwyn/Waihora catchment.

3. On-Farm Monitoring

Conditions of the CPW consents and provisions of the LWRP require both CPW and individual Shareholder farmers to undertake an extensive range of environmental monitoring, management and reporting activities.

3.1. Environmental Management Strategy

Prior to commencement of operations, CPW developed an Environmental Management Strategy (EMS) which established a range of protocols, policies and procedures for operation and management of the Scheme to ensure it achieves high environmental standards, sustainable outcomes and complies with all consent and Regional Plan requirements.

The EMS outlines specific responsibilities for operation of the Scheme including:

- Ensuring that all water users implement on-farm environmental management requirements related to achieving sustainable irrigation
- Monitoring and reporting of environmental performance
- Provision of education and training initiatives
- Funding and management of environmental initiatives, including those required by resource consent conditions, such as Community Liaison Group (CLG), the CPW Environmental Management Fund (EMF) and CPW Te Waihora Environmental Management Fund (TWEMF).

To facilitate adoption of best practice land management, the EMS required a Farm Environment Plan (FEP) to be developed and implemented on each CPW shareholder property supplied with water. Following Plan Change 1 to the LWRP in February 2016, the requirement for FEPs was formally extended to include a majority of agricultural properties larger than 10 Ha where nitrogen loss exceeds 15 kg/ha/year in the Selwyn Waihora zone.

Key components of FEPs include:

- Identification of environmental risks and potential adverse impacts associated with farming activities
- Development and implementation of measures to avoid or minimise identified environmental risks and implement good management practice farming methods
- Development and implementation of monitoring to inform good decision making on-farm
- Calculation and recording of nutrient loss rates and documentation of management practices to maintain, and where required, reduce, losses over time.

All FEPs are audited by a qualified Farm Environment Plan Auditor to provide an independent check that appropriate systems and practices are in place to minimise environmental risks associated with agricultural land use within the Scheme. Auditing is conducted on-farm and is based on sighting of evidence to document and support how FEP objectives and targets are being met. FEP audit results are reported to CPW, individual water users, and to ECan. After the first two years, audits are conducted based on the last grade received. A property receiving an A-grade is audited every three years, a B-grade every 2 years, a C-grade within one year and D-grade within 6 months of the previous audit.

3.2. Irrigated Area and Types

Use of water under by the CPW Scheme is limited by resource consent conditions to a designated area of approximately 60,000 hectares, within a total land area of 100,000 hectares. The total land area (i.e., Farm Enterprise Properties[3]) managed under CPW for 2019-2020 irrigation season was approximately 70,000 hectares.

The total area managed under CPW in the Stage 1 area during 2019-20 totalled approximately 30,300 Ha (including Farm Enterprise properties), of which around 22,500 Ha was irrigated using water supplied by CPW. Stage 2 properties cover a cumulative area of approximately 32,000 Ha, approximately 18,200 Ha of which was irrigated with CPW water. The total land area managed under CPW in Sheffield Scheme area during 2019-20 totalled approximately 7,000, of which around 4,200 Ha was irrigated using water supplied by CPW. The total area of new irrigation under the CPW Scheme is approximately 21,500 hectares, with the remaining irrigated area converted, either wholly or partially, from other water sources (e.g., groundwater) to CPW supply.

The extent of land included in the Stage 1 and Stage 2 areas, including Farm Enterprise Properties that are either dryland or irrigated using non-CPW sources (i.e., groundwater), is shown on Figure 12. The figure shows a majority of this area is irrigated using either centre pivot irrigators (75 percent of total irrigated area) or travelling irrigators (21 percent of total irrigated area) with a relatively small area of sprayline and solid set irrigation (4%). It is noted a majority of travelling irrigators are used on properties which were irrigated prior to CPW, while new irrigation development predominantly utilises centre pivot irrigators.

The extent of land included in the Sheffield Scheme area (including Farm Enterprise Properties) and the distribution of irrigation system types is shown on Figure 13 below. The figure shows most of the land in the Sheffield Scheme area is irrigated using centre pivot irrigators with approximately 15% of the total area irrigated using travelling irrigators or spraylines.

[3] Farm Enterprise Properties represent the total area of shareholder land parcels included within the CPW Scheme, only a portion of which may be irrigated using CPW water.

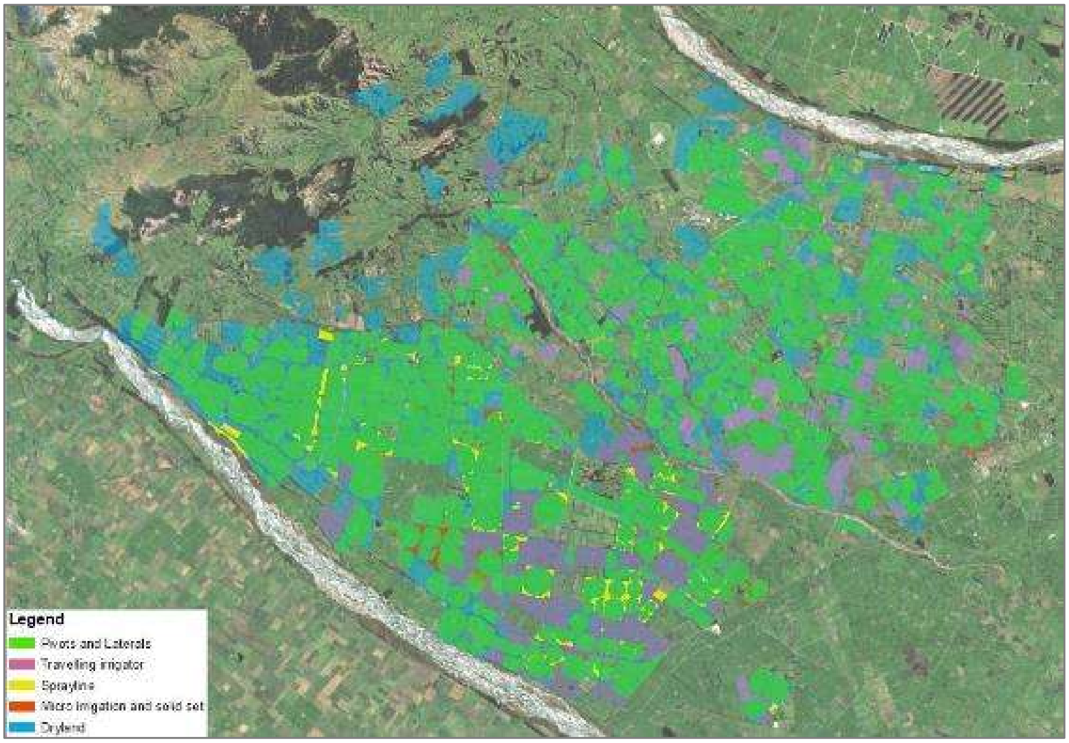

Figure 12. *Irrigated area and irrigation types for CPW Stages 1 and 2, 2019-20*

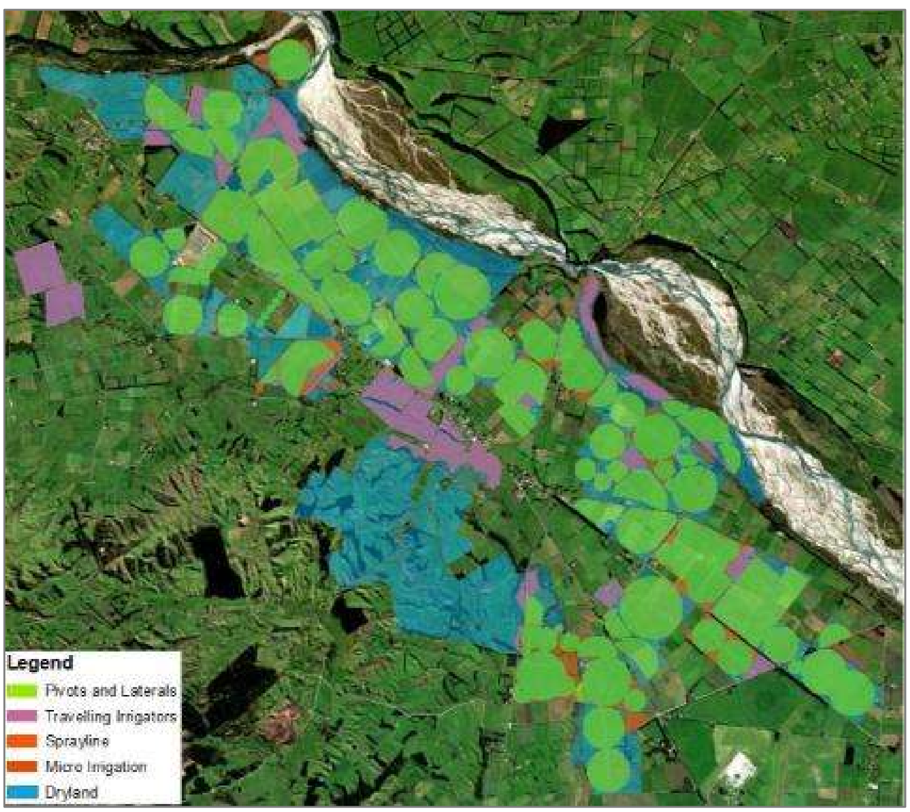

Figure 13. *Irrigated area and irrigation types for the Sheffield Scheme area, 2019-20*

3.3. Land Use

Figure 14 provides a breakdown of land use (enterprise) types in the CPW Scheme area during the 2019-20 year based on the categories defined in the OverseerFM® (V6.1.3) nutrient budget model. The data shows that dairy and various combinations of sheep, dairy and beef grazing accounted for a majority of overall land use. From a farm systems perspective these enterprises can be divided into two types: dairy systems, and mixed systems. Approximately 60% of the total area comprise mixed systems that provide flexibility for farmers to respond to changes in market demand without the higher capital investment required to establish a dairy operation Properties covering approximately 40% of the total Scheme area also have an interest in arable farming[4].

Since individual scheme stages became operational, sixteen additional dairy platforms have been commissioned within the CPW Scheme area (8 in Stage 1, 6 in Stage 2 and 2 in Sheffield), while 2 properties (in Stage 2) have converted from dairy to alternative land uses.

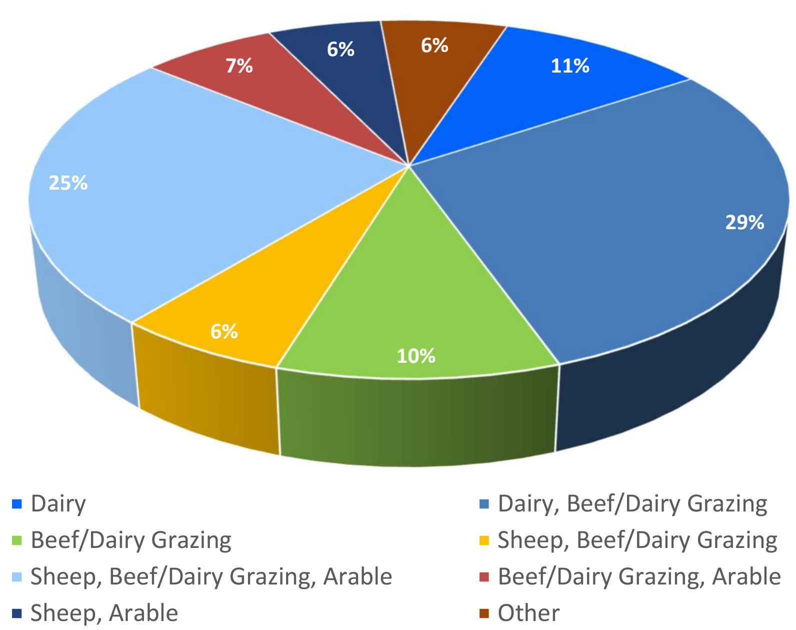

Figure 14. *Land use types in CPW Scheme area, 2019-20*

Figure 15 provides a comparison between baseline land use (i.e., pre-CPW) and 2019-20 land use across the CPW area based on based on FEPs. The data show that land use has remained relatively since the Scheme commenced operations, with the major change being a 44 % (3,583 Ha) reduction in the area of Sheep and Sheep and Arable enterprises which is balanced by an increase in Dairy, Beef/Dairy grazing enterprises. The overall expansion of dairy enterprises following commencement of Stage 1 operations equates to around 5% of the total scheme area.

[4] This is highest in the Stage 2 and Sheffield Scheme areas where approximately Farm Enterprises comprising 60 percent of the total area have an interest in arable farming.

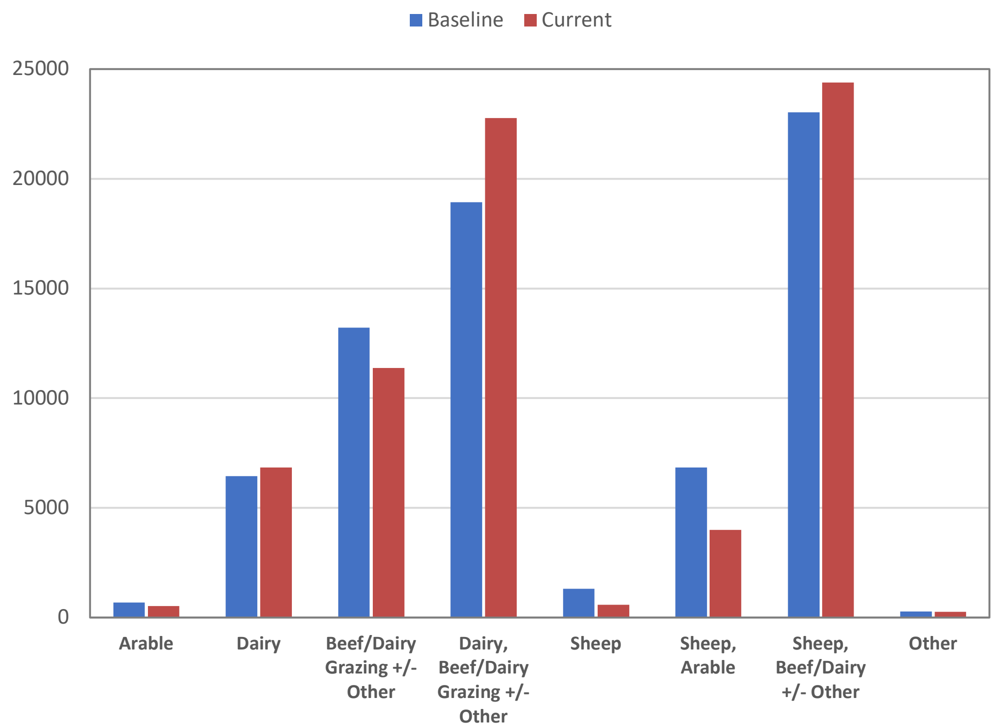

Figure 15. *Comparison of baseline land use (blue bars) and 2019-20 enterprise types (red bars) for CPW Farm Enterprise Properties.*

3.4. Irrigation Water Use

The Scheme-wide average seasonal application rate during the 2019-20 season was 1.50 mm/ha/day. As illustrated on Figure 16, no individual property exceeded a seasonal application rate of 5.18 mm/ha/day, which is the maximum limit specified in CPWs consent to take and use Scheme water[5].

[5] It is noted that some groundwater taken is used for purposes other than irrigation, so the rates shown are considered conservative

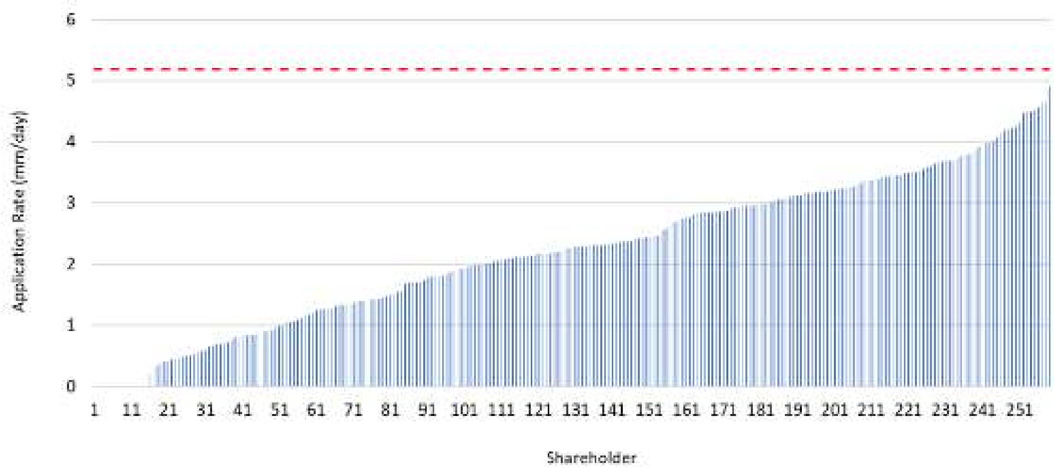

Figure 16. *Seasonal application rate application for Shareholder properties during the 2019-20 season. Red line denotes the maximum seasonal application rate specifies in CPWs consents. (Reproduced from CPWL, 2020[6]).*

Table 2 provides a summary of seasonal water use (including CPW water and groundwater) across the CPW Scheme area (including Farm Enterprise Properties) for the 2018-19 and 2019-20 years. Cumulative water use during the 2019-20 season totalled 3,150 m^3/ha (equivalent to a seasonal application depth of 315 mm), comprising 658 m^3/ha of groundwater and 2,492 m^3/ha of CPW water. This total was approximately 25% higher than seasonal application during the 2018-19 year due to the earlier onset of low soil moisture conditions during the 2019-20 year (refer to Figure 4 above).

Table 2. *Average seasonal irrigation application rates across the Scheme area (including Farm Enterprise Properties), 2018-19 and 2019-20*

Year	Water Source	Stage 1 (m^3/Ha)	Stage 2 (m^3/Ha)	Sheffield (m^3/Ha)	Whole Scheme (m^3/Ha)
2019-20	CPW	3,215	1,949	1,843	2,492
	Groundwater	577	832	212	658
	Total	**3,792**	**2,781**	**2,055**	**3,150**
2018-19	CPW	2,627	1,575	1,279	2,005
	Groundwater	528	578	93	507
	Total	**3,155**	**2,153**	**1,372**	**2,512**

3.4.1. Groundwater Conversion to CPW Scheme

One of the key benefits associated with the Scheme identified in the Selwyn - Te Waihora Zone Solutions Package was a reduction in the volume of groundwater utilised for irrigation across the Central Plains area, due to substitution with water derived from alpine sources (i.e., run-of-river and

[6] CPWL, 2020; Annual Compliance Report – Central Plains Water Limited. Report submitted to Environment Canterbury, August 2020.

storage takes from the Rakaia and Waimakariri Rivers). The reduction in groundwater abstraction was expected to result in positive benefits associated with an increase in groundwater storage and correspondingly higher flows in lowland streams. A target of an 80% reduction in the volume of groundwater abstraction across the Rakaia-Selwyn and Selwyn-Waimakariri allocation zones was identified in the Selwyn-Waihora Zone ZIP Addendum.

Figure 17 shows the percentage of total groundwater allocation utilised by farms in the CPW Scheme area between 2015-16 and 2019-20. The data show groundwater use in Stage 1 declined appreciably after CPW commenced operations in 2015-16, remaining between 14 and 18% of total allocation between 2016-17 and 2019-20. Cumulative groundwater in the Stage 2 area declined from between 28 and 48% of total allocation prior to Stage 2 commencing operations in 2018-19[7] to between 20 and 28% of total allocation over the following two seasons[8]. Across the whole CPW Scheme area, groundwater use in 2019-20 was approximately 24% of total allocation, slightly above the ZIP target.

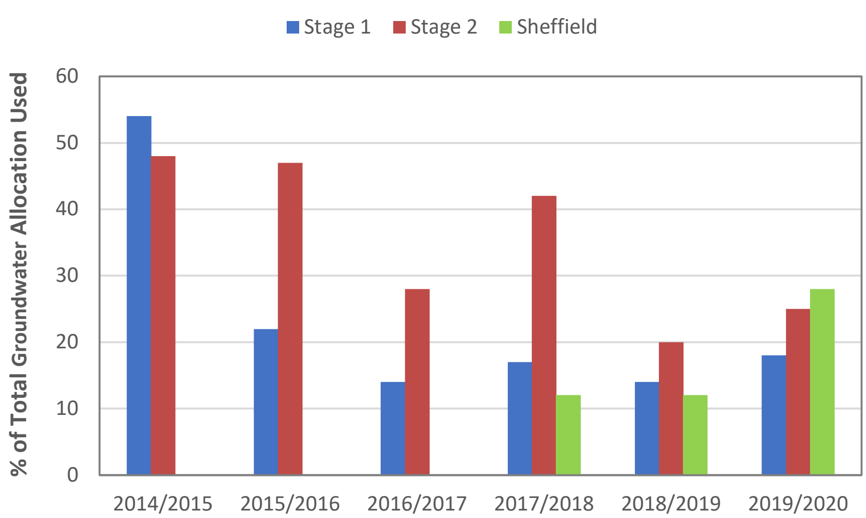

Figure 17. *Percentage of total groundwater allocation used by farms in the Stage 1, Stage 2 and Sheffield Scheme areas, 2014-15 to 2019-20*

It is noted that estimates of the percentage of total groundwater allocation used are complicated by the expiry, partial replacement or surrender of individual water permits over time. The volume of groundwater used across the wider CPW scheme area is expected to continue to decline over coming seasons as on-farm irrigation systems are modified or replaced and confidence in the reliability of supply for of the CPW Scheme increases.

Figure 18 provides a comparison of actual and consented groundwater use on properties within the CPW Scheme area which hold existing groundwater abstraction consents. The figure shows that approximately half of properties holding existing groundwater consents used little to no groundwater

[7] Groundwater usage during the 2016-17 year in the Stage 2 area was significantly reduced by above average rainfall during late summer and autumn 2017.

[8] Groundwater use data for properties in the Sheffield Scheme area is incomplete prior to CPW operations commencing in this area.

during the 2019-20 season. For these properties, irrigation water was derived solely from the CPW Scheme and groundwater use typically comprised stock, dairy shed and/or household water supply. With few exceptions, groundwater usage was significantly below consented volumes for the remaining properties.

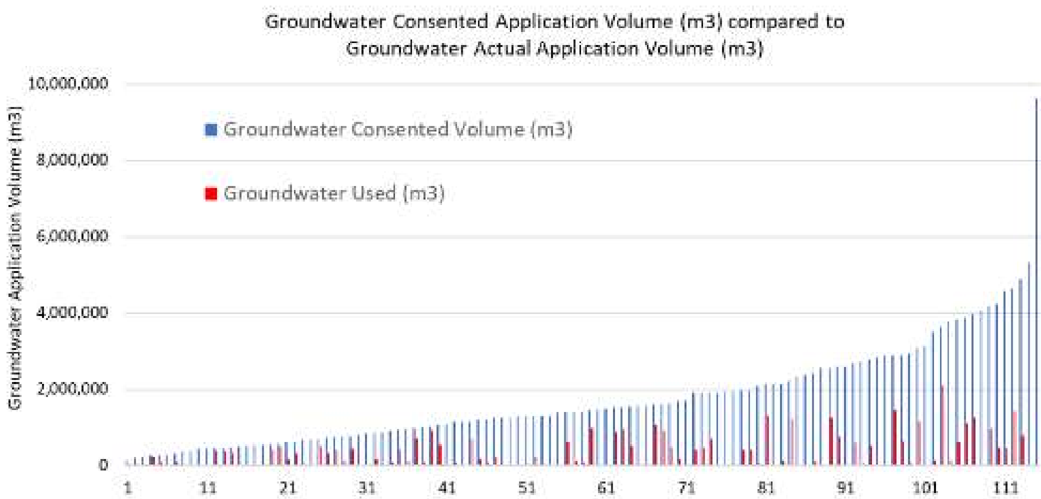

Figure 18. *Comparison of consented and actual groundwater use within the CPW Scheme, 2019-20 (blue bars indicate groundwater allocation volumes per shareholder property, red bars actual volumes used). Reproduced from CPW (2020).*

3.5. Farm Environment Plans

A FEP is the key environmental management tool that helps farmers recognise on-farm environmental risks and sets out a programme to manage those risks. It is also a mechanism which has been adopted in the LWRP to enable water quality objectives in the Selwyn - Te Waihora zone to be achieved.

FEPs are unique to a property and reflect the type of farm operation, the local climate and soil type, and the goals of the land user. The FEP covers management areas including:

- Irrigation management, including efficient water use
- Nutrient management
- Soil management
- Point source management (offal holes, farm rubbish & silage pits etc)
- Collected animal effluent management
- Native plants and animals
- Waterbodies - riparian drains, rivers, wetlands and lakes
- Water use (excluding irrigation water)

Under CPWs EMS all irrigators were required to have an FEP in place before they can take water from the Scheme. FEPs form a key component of the overall environmental compliance requirements for the CPW Scheme. The FEP must be updated if anything on-farm changes e.g., a farm system or manager.

During 2019-20 Farm Environmental Plan (FEP) audits were undertaken on 183 properties in the CPW Scheme. Seven audits were delayed due to Covid-19, with a further 10 delayed due to changes in farm ownership, management, or farming system. Two properties new to the CPW Scheme will be audited within one year of joining. Remaining properties (53) were not audited during the 2019-20 year due to having previously received an A or B grade and being assigned to a 2- (B-grade) or 3-year (A-grade) audit cycle.

Of the CPW properties audited in 2019-20, 109 (60%) received an A-grade, 66 (36%) a B-grade and 8 a C-grade. No properties received a D-grade during the 2019-20 season. Of the 8 properties receiving a C-grade the primary issues identified were irrigation management, nutrient management and collected animal effluent management. All properties receiving a C-grade during the 2019-20 season were provided with a detailed list of actions required to improve their audit grade and will be assisted by CPW with the aim of achieving a B-grade (or better) when audited during the 2020-21 season.

Figure 19 compares audit grades received for CPW properties between the 2016-17 and 2019-20 years (noting inclusion of different groups of Shareholder properties in each year). The figure shows a consistently low proportion of properties (<6%) assigned either C or D-grades, with the largest change being the higher proportion of properties in Stage 2 and Sheffield receiving a B-grades in 2019-20 compared to B-grades in their first year of audit (2018-19).

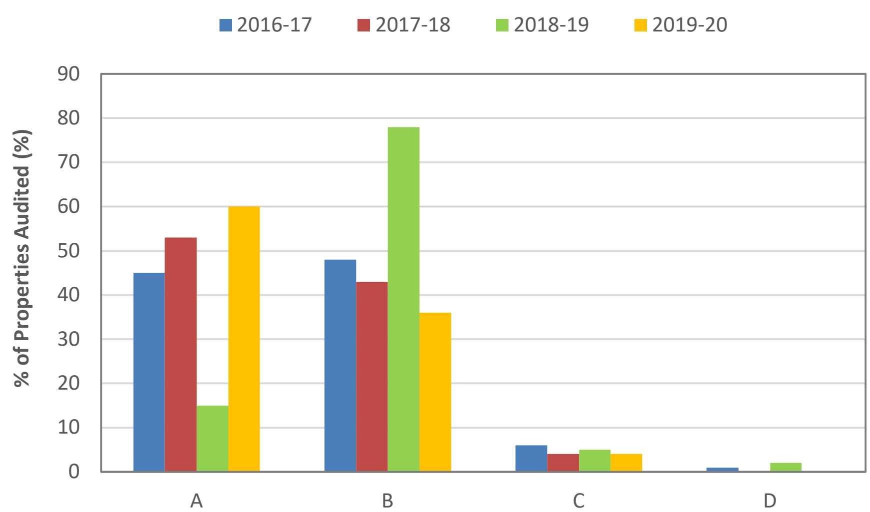

Figure 19. *Comparison of FEP audit grades for the 2016-17 (Stage 1 properties only), 2017-18 (Stage 1 properties only) and 2018-19 (11 Stage 1, all Stage 2 and Sheffield properties) and 2019-20 (All Stage 1 and Sheffield properties, 25 Stage 1) irrigation seasons.*

3.5.1. Nutrient Budgets and Nitrogen Allocation

Table 11(i) of the LWRP establishes a limit for nitrogen losses in Selwyn Waihora zone of 5,044.4 tonnes/year by 2037. Of this total, 358 tonnes/year (7% of the total under OverseerFM® version 6.1.3) has been allocated to CPW to provide for the conversion of dryland into irrigated land. This allocation is in addition to the assessed dryland nitrogen baseline of 621 tonnes (OverseerFM® 6.1.3), giving a total Nitrogen Allocation for the CPW scheme of 979 tonnes (OverseerFM® 6.1.3), as specified in

Table 11(j) of the LWRP[9]. Under OverseerFM® version 6.2.3 this is equivalent to 1,983 tonnes N/year.

Nutrient losses for properties in the CPW Scheme are managed collectively by CPW. The cumulative nitrogen loss allowance for the Scheme is the sum of baseline losses for each individual Farm Enterprise Property, plus the allowance for new irrigation. This equates to a total nitrogen loss of 4,569 tonnes/year for the CPW Scheme under the 2017 LWRP baseline. In order to achieve specified water quality outcomes, Policy 11.4.16(1) of the LWRP requires farming activities in the Selwyn Waihora catchment to achieve a 14% reduction in nitrogen losses beyond those that could be reasonable anticipated by adopting good management practices by 1 January 2022. Cumulatively across the CPW scheme this requires nitrogen losses to be reduced by 24 percent of the original nitrogen loss allowance (or 1,097 tonnes/year).

Nutrient Budgets and FEPs have been prepared and audited for all Stage 1, Stage 2 and Sheffield Scheme properties. Table 3 compares the calculated N loss from CPW properties against the calculated Scheme baseline load and the total N discharge allowance (including the allowance for additional CPW irrigation). The figures show the current 2019-20 N load is 28% below the total original nitrogen discharge allowance for the Scheme, thus meeting nitrogen loss reduction targets established in the LWRP. Cumulatively, the entire Scheme (including 21,500 Ha of new irrigation) is achieving a nitrogen loss approximately 10% lower than that estimated for the baseline period.

Table 3. *Nutrient discharge allowance and 2019-20 nutrient losses for the CPW Scheme.*

	Stage 1 kgN/year	**Stage 2 kgN/year**	**Sheffield kgN/year**	**Total kgN/year**
Baseline N Load	1,840,702	1,449,812	303,225	3,643,739
Allocation for New Irrigation	295,851	543,132	136,148	925,131
Total N Discharge Allowance	2,136,553	1,992,944	439,373	4,568,870
Current Load	1,597,372	1,352,838	325,533	3,275,743
Reduction below Total N Discharge Allowance	*24%*	*32%*	*26%*	*28%*
Reduction below Baseline Load	*13%*	*10%*	*-7%*	*10%*

3.6. Environmental Initiatives

CPW provides ongoing training and assistance to shareholders related to a range of irrigation and environmental management issues, including development and implementation of FEP requirements. Additional training has also been provided in terms of irrigation management and FEPs via workshops for all users within the Scheme area.

Instead of focussing on FEP audit results or OVERSEERFM© nutrient loss results, CPW is encouraging shareholders to focus on improving farm practices between now and 2022, with a emphasis on:

[9] This allowance is for 22,991 ha of new irrigation, of which approximately 21,500 ha has been taken up.

- Irrigating only when needed
- Implementing soil moisture monitors, flow meters and using weather forecasting
- Making sure each irrigation systems are working properly, through providing resources to ensure the owners/managers can undertake testing of their irrigation infrastructure and understand what the results mean
- Ensuring pre-season inspections are undertaken. Irrigation infrastructure is regularly inspected, maintained and calibrated
- Ensure effluent is stored, managed and applied properly and that appropriate contingency plans are in place.

To assist efficient management of irrigation within the Scheme area CPW has also:

- Developed a daily reference evapotranspiration system (ET_o) where the shareholders can track ET_o has been for the previous 10 days and what the forecast values are for the next three days
- Installed a weather station in Sheffield.

4. Environmental Monitoring

Requirements for extensive monitoring of environmental effects resulting from operation of the Scheme are specified in conditions of CPWs resource consents for the take and use of water. Details of this monitoring programme are outlined in a Ground and Surface Water Monitoring Plan (GSWMP) which consists of two parts:

- Part I: an outline of the CPW monitoring programme (e.g., monitoring sites, parameters measured, monitoring frequency etc.)
- Part II: specification of trigger levels for the monitoring programme, along with procedures to be followed in the advent that trigger levels are exceeded.

Results and interpretation of environmental monitoring undertaken for the Scheme are provided in an *Annual Ground and Surface Water Monitoring Report* (GSWMP), which forms one component of the overall resource consent compliance monitoring for the Scheme.

Development of the GSWMP and the subsequent monitoring process is overseen by the Ground and Surface Water Expert Review Panel (GSWERP) which was established in 2013. This panel is responsible for overseeing and directing the ground and surface water monitoring program undertaken by CPW, as well as response to trigger level exceedances and/or public complaints. As required by CPW's consents, GSWERP members include representatives from SDC, ECan and Ngai Tahu, alongside independent experts with knowledge and skills specific to hydrogeology and groundwater quality, hydrology and surface water quality, land drainage and cultural values.

4.1. Environmental Baseline

Ongoing operation of the Scheme has resulted in changes to historical land use, recharge and water abstraction patterns across the mid to upper sections of the Central Plains area. These changes have the potential to alter water quality and quantity parameters in downstream receiving environments (groundwater, rivers and streams, and Lake Ellesmere/Te Waihora).

Increased groundwater recharge from irrigation using water from alpine rivers across the CPW Scheme area, coupled with a reduction in the volume of groundwater used for irrigation, is anticipated to result in an overall increase in groundwater levels and flows in lowland streams. While such effects can have a positive impact on environmental values associated with these waterways, increased groundwater levels and stream flows also have the potential to result in higher water tables and associated drainage issues around the margins of Lake Ellesmere/Te Waihora.

Groundwater flowing through the Central Plains aquifer system is ultimately discharged to lowland rivers and streams around the margins of Lake Ellesmere/Te Waihora so changes to the quality and quantity of groundwater potentially impact on ecological and environmental values associated with these waterways, as well as the lake itself. However, due to the slow rate of groundwater flow (which varies spatially and with depth) it takes between 10 to 30 years depending on location, for water recharged on the Central Plains area to drain to Lake Ellesmere/Te Waihora. These variable time lags complicate interpretation of water level, flow and quality monitoring results, particularly when the period of historical information available is short, and monitoring results can also be influenced by factors external to the scheme (such as non-CPW land use and modifications to hydrological environments).

Interpretation of monitoring results is also complicated by climatic variability. For example, the above average rainfall recorded during the 2017-18 and 2018-19 seasons contrasts with significantly below average rainfall during the 2014-15 and 2015-16 seasons. Such intra-seasonal variability in rainfall, groundwater recharge and surface water flows can result in short-term effects that obscure longer-term, underlying trends in groundwater levels, groundwater quality, streamflow and surface water quality. In addition, as noted in Section 2.1 above, variations in the timing of rainfall during individual seasons (such as 2019-20) may also contribute to short-term variability in water quantity and quality in receiving environments.

Given the Scheme has recently commenced operations in an area with an extensive history of agricultural development, the existing state of water quality and quantity differs significantly from its 'natural' state. Consequently, environmental effects arising from the Scheme are assessed in terms of a pre-Scheme 'baseline' (i.e., the state (and underlying trends) in water quality and quantity in the absence of the Scheme). To better quantify 'baseline' water quality and water quantity prior to Scheme development, a review of all available monitoring data for the Central Plains area was commissioned by GSWERP in 2013. In addition, conditions of consents operated by CPW also required monitoring of groundwater and surface water quantity and quality 2 years prior to individual Scheme stages becoming operational.

4.2. Environmental Monitoring Programme

The CPW environmental monitoring programme is specified in Part 1 of CPW's Ground and Surface Water Monitoring Plan. In summary, the monitoring programme consists of four components:

1. 29 surface water quality monitoring sites
2. 4 lake water quality monitoring sites
3. 20 groundwater quality monitoring sites
4. 12 groundwater level monitoring sites.

As illustrated on Figure 20, the surface water quality monitoring sites include:

- 4 sites upstream of the Scheme (US1 to US4)
- 4 sites within the Scheme area (IS1 to IS4)
- 1 site on downstream boundary of the Scheme (SWSH)
- 8 sites in the headwaters of lowland streams (SF1 to SF8)
- 8 sites near the confluence of lowland streams and Te Waihora/Lake Ellesmere (T1 to T8)
- 4 sites in the SDC stock water race system at the downstream boundary of the Scheme.

Surface water quality sites are monitored monthly for a range of water quality parameters including dissolved and particulate nutrients, indicator bacteria (*E.coli*) and physical parameters such as pH, temperature and dissolved oxygen concentrations. A sub-set of the CPW surface water quality monitoring sites are monitored by Environment Canterbury, with the remainder monitored by CPW.

The monitoring network also includes 4 sites located in Lake Ellesmere/Te Waihora (3 around the lake margins and one mid-lake site). These sites are monitored monthly by ECan for a range of parameters including nutrients and chlorophyll-*a* which enable calculation of Trophic Level Index (TLI_3). TLI is an overall measure of lake water quality which allows comparison between individual waterbodies and lake types[10].

As shown on Figure 21, the CPW groundwater quality monitoring network comprises twenty monitoring bores (8 within or down-gradient of the Stage 1 area, 10 within or down-gradient of the Stage 2 area and 2 in the Sheffield Scheme area). These groundwater quality sites are sampled quarterly for a range of chemical and microbial water quality indicators.

It is noted that the CPW groundwater quality monitoring bores are constructed with long screened intervals to enable collection of water quality samples from close to the water table (within 1 metre). In contrast, typical water supply bores in the Central Plains area are constructed with screens placed at depth below the water table so they do not necessarily draw water from the upper levels of the aquifer. This aspect of construction is important to note when interpreting CPW groundwater quality monitoring results, as contaminants associated with overlying land use are typically concentrated near the water table, reducing at deeper levels in the underlying aquifer. Collection of samples from close to the water table in the CPW monitoring bores is therefore inferred to provide a conservative (or '*worst case*') assessment of groundwater quality at any given location, which may differ from results of monitoring undertaken on conventionally screened bores in the local area.

Increased groundwater flow resulting from Scheme operation has the potential to result in an increase in groundwater levels in lowland areas of the Central Plains as groundwater flows toward coastal discharge areas. Depending on the magnitude and spatial distribution of groundwater mounding associated with the Scheme, the increase in groundwater levels has the potential to result in a range of environmental effect ranging from increased baseflows in lowland streams to adverse effects on land drainage around the margins of Lake Ellesmere/Te Waihora. Trigger levels have been established for 12 groundwater level sites down-gradient of the Scheme. These sites are monitored on a monthly basis as part of the ECan State of the Environment groundwater monitoring network and have a long monitoring history to enable any changes in groundwater levels to be evaluated in an appropriate historical context.

[10] see https://www.lawa.org.nz/learn/factsheets/lake-trophic-level-index/ for more information

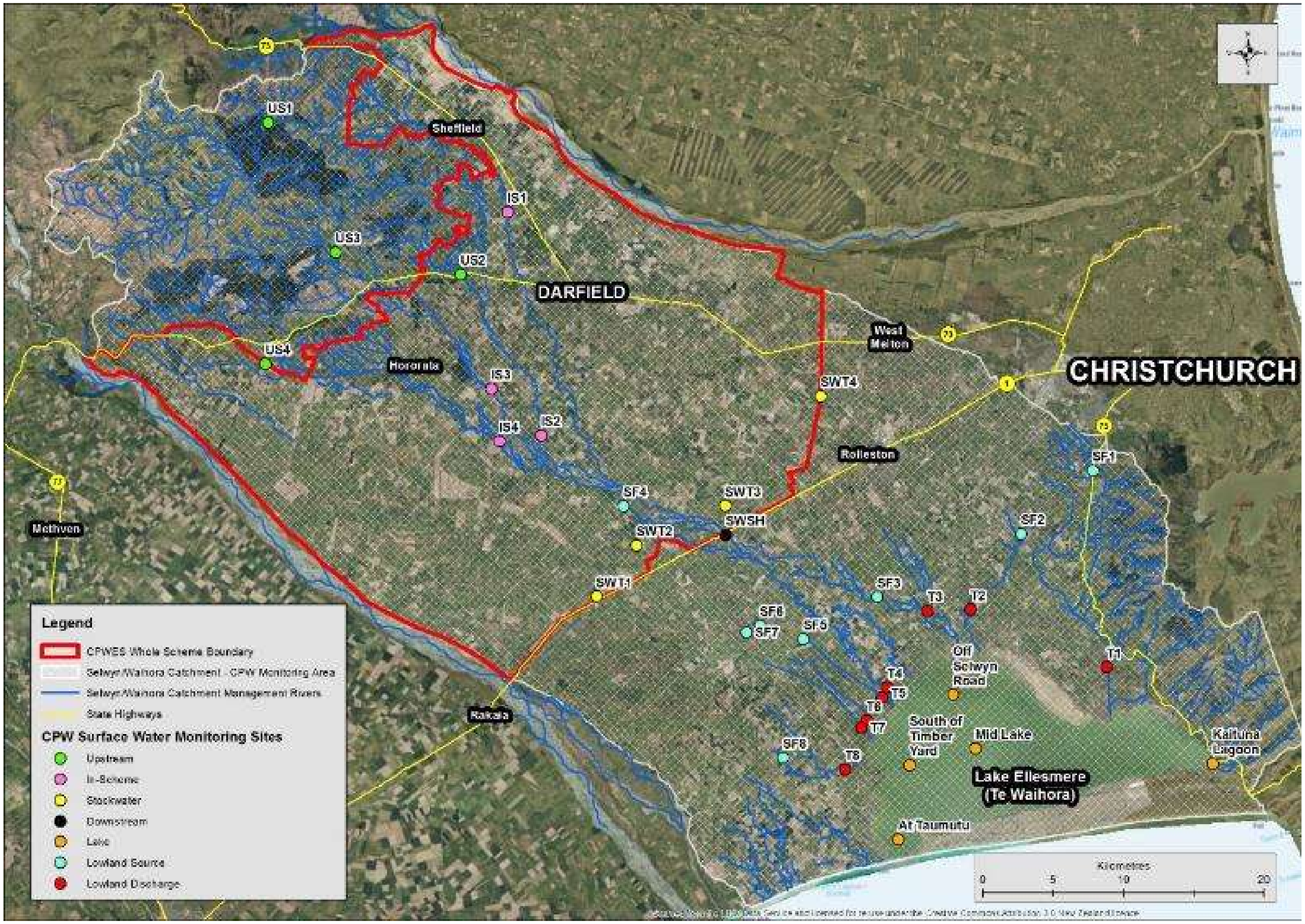

Figure 20. Surface water quality monitoring sites for the CPW scheme

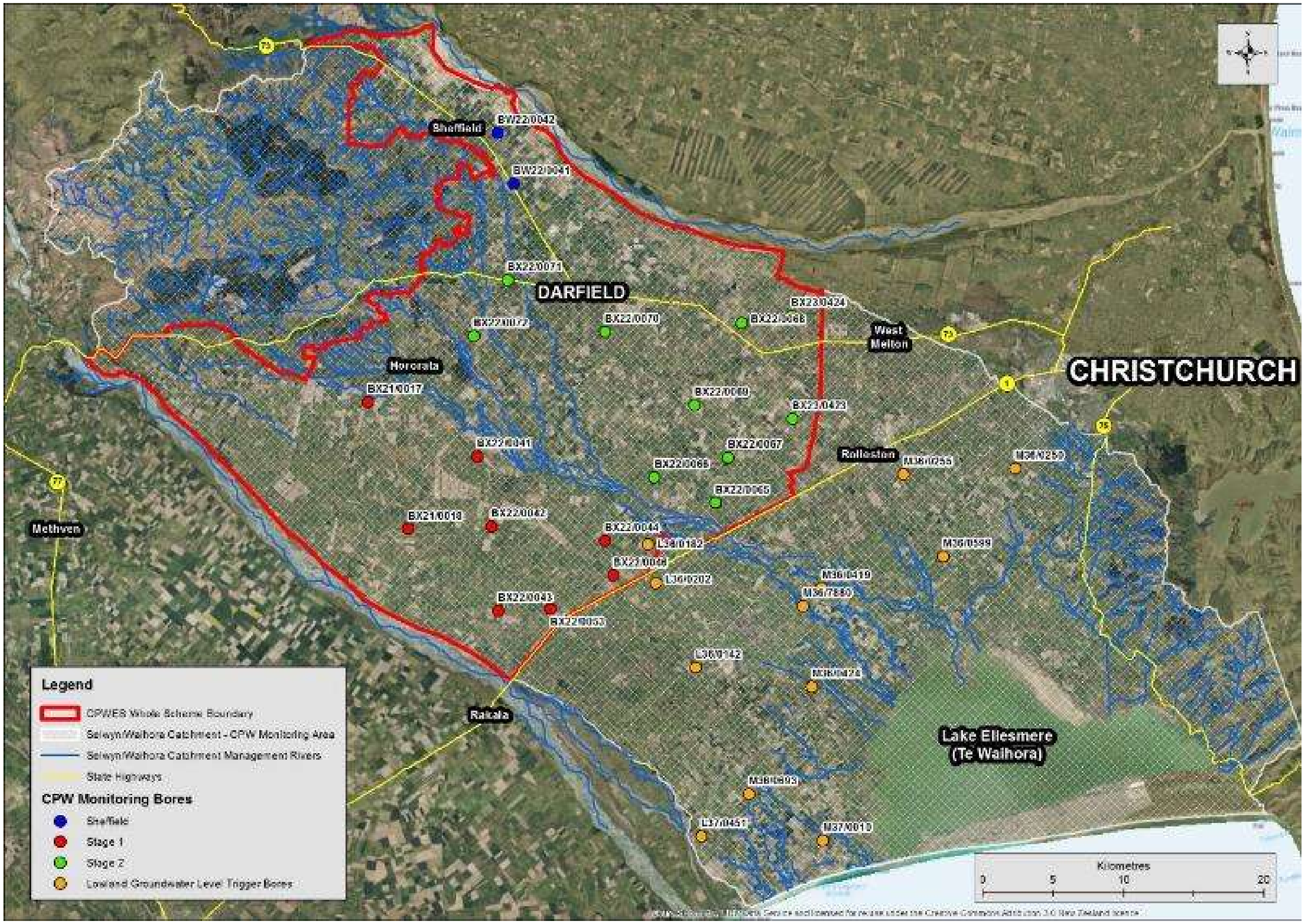

Figure 21. Groundwater quality and level monitoring sites for the CPW scheme

4.3. Environmental Management

Part II of the CPW GSWMP establishes trigger levels for nominated parameters including:

- Nitrate-Nitrogen concentrations at surface water sites
- Trophic Level Index (TLI_3), Total Phosphorus and Chlorophyll-*a* at lake monitoring sites
- Nitrate-Nitrogen and *E.coli* concentrations at groundwater quality monitoring sites
- Groundwater levels in lowland monitoring wells.

The nominated trigger levels are based on relevant water quality standards established in the LWRP or, in the case of groundwater levels, the range of historical measurements. The triggers provide a basis for evaluation of CPW environmental monitoring results. Once a nominated trigger level is exceeded, the GSWMP establishes a procedure which must be followed to firstly identify if the monitoring results represent a departure from 'background' concentrations, levels and/or trends and, if they do, specific steps which must be followed to investigate and mitigate the potential cause of the trigger level exceedance. This process is overseen by the GSWERP.

4.4. 2019-20 Monitoring Results

Results from the CPW environmental monitoring programme are summarised in the *Annual Ground and Surface Water Monitoring Report 2019/20* which was reviewed and approved by GSWERP in November 2020.

4.4.1. Surface Water Quality

Trigger levels for CPW surface water quality monitoring are summarised in Table 4 below. These triggers are equivalent to limits for surface water quality established in the LWRP. It is noted the trigger levels differentiate between hill-fed streams (those predominantly sourced from runoff in upper catchment areas) and spring-fed streams on the lower plains (which derive a majority of flow from groundwater drainage).

Table 4. *CPW Surface water quality triggers for Nitrate-Nitrogen (mg/L)*

River Type	CPW Surface Water Monitoring	
	Annual Median	Annual 95th Percentile
Hill-fed Lower	1.8	2.6
Spring-fed Plains	5.2	7.4

Table 5 summarises trigger level exceedances for Nitrate-N concentrations at CPW monitoring sites during the over the past four irrigation seasons. The data show that during the 2019-20 season, median triggers were exceeded at 4 hill-fed sites and 5 spring-fed sites, with a 3 hill-fed sites and 5 spring-fed sites exceeding the 95th percentile trigger. The number of hill-fed sites exceeding trigger levels during the 2019-20 year was the highest recorded since 2016-17, while the number of spring-fed sites exceeding trigger levels was the same as 2018-19 and lower than that recorded in the two previous seasons (2016-17 and 2017-18).

Table 5. *Summary of surface water quality Nitrate-N trigger level exceedances for CPW sites, 2016-17 to 2019-20.*

River Type	Year	Sites	Samples*	Sites exceeding annual Nitrate median	Sites exceeding annual 95th percentile
Hill-fed Lower	2019-20	9	74	4	4
	2018-19		80	1	1
	2017-18		93	3	4
	2016-17		71	2	1
Spring-fed Plains	2019-20	16	177	5	5
	2018-19		198	5	5
	2017-18		198	6	7
	2016-17		144	6	6

* The number of samples varies between years due to the presence/absence of flow at individual monitoring sites

As shown of Figure 22 below water median Nitrate-N trigger level exceedances during 2019-20 were recorded at 4 hill-fed sites within the Scheme area (Hawkins River (IS1), Waianiwaniwa River (IS2), Hororata River (IS4) and Selwyn River (SWSH), while 95th percentile exceedances were recorded at two in-Scheme sites (Hawkins River (IS1) and Hororata River (IS4)), and at one upstream site (Waianiwaniwa (US2). Median Nitrate-N and 95th percentile triggers were exceeded at five lowland sites (Selwyn River upstream and downstream (SF3 and SF4), Doyleston Drain source (SF7) and Harts Creek upstream and downstream (SF8 and T8)). Lowland sites recording trigger level exceedances during the 2019-20 year were the same as those exceeding trigger levels during the previous year.

Although exceeding triggers at some sites, 2019-20 Nitrate-N concentrations at hill-fed sites were within the range recorded historically. The single exception was at the Waianiwaniwa River site upstream of the CPW Scheme (US2) where the 2019-20 95th percentile Nitrate-N concentration was marginally higher than that previously recorded[11]. Annual median and 95th percentile Nitrate-N concentrations at all spring-fed sites during 2019-20 were within the historical range, except for the Selwyn River downstream (T3) site were median and 95th percentile concentrations were the highest recorded (but consistent with ongoing temporal trends, see Figure 25 below).

Several spring-fed streams also exhibit a consistent decrease in Nitrate-N concentrations between their headwaters (i.e., spring-source) and lower reaches. This decrease is generally attributed to

[11] Nitrate-N concentrations at the Selwyn River in-Scheme (IS3) site during 2019-20 were also the highest recorded in spring 2019. However, this site is frequently dry so cannot be sampled on a regular basis, so it is difficult to compare results over time.

uptake by of nutrients by periphyton and aquatic plants and/or the dilution by groundwater inflows that have been denitrified as they seep upwards through low permeability confining sediments.

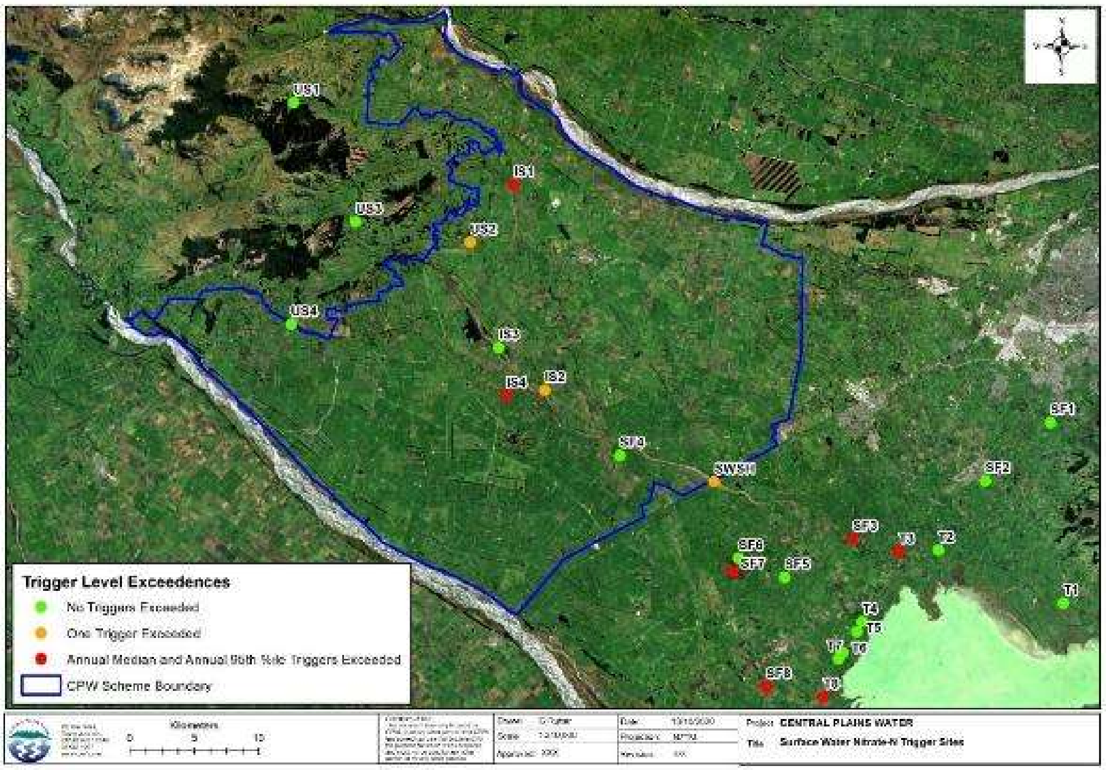

Figure 22. *Surface water nitrate trigger level exceedances during 2019-20*

Figures 23 and 24 below compare annual median nitrate concentrations from the 2015-16 to 2019-20 seasons with the relevant Nitrate-Nitrogen triggers for hill-fed and spring-fed streams. The data show both a wide range in both the magnitude and temporal variation of median nitrate concentrations at individual monitoring sites. For example, while upstream monitoring sites (including US1, US3 and US4) generally exhibit nitrate concentrations well below trigger values, many lowland sites (SF6, SF8, T3) exhibit concentrations consistently above the trigger values. Similarly, while nitrate concentrations are relatively stable at many sites, others either exhibit significant temporal variability between individual years (IS2, SF3, T7) or indicate consistent increasing (IS1, IS4, SF8, T8) or decreasing (IS2, SF6, T4) concentrations over time.

As a result, while surface water monitoring shows an overall increase in median nitrate concentrations from headwater to lowland areas, results from individual monitoring sites exhibit significant variability between individual catchments. This variability is inferred to reflect the complex interaction between multiple factors influencing water quality, including climate, local and upstream land use, time lags in the groundwater system (particularly important in spring-fed streams), as well as instream processes in different waterways. Such spatial and temporal variability inevitably complicates attribution of observed variations in water quality associated with the Scheme, from those reflecting background (i.e., pre-scheme) water quality or external influences.

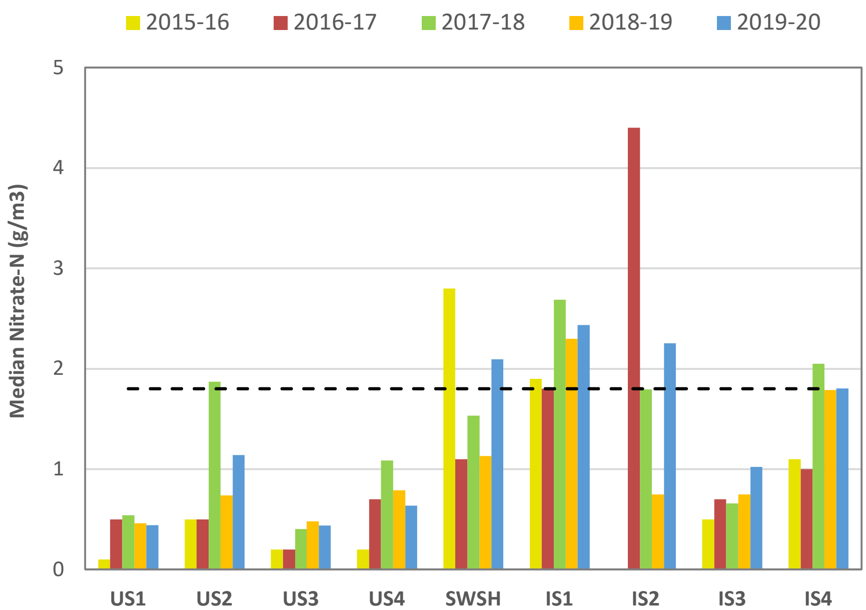

***Figure 23**. Annual median nitrate concentrations at hill-fed lower sites, 2015-16 to 2019-20 (black line denotes trigger level)*

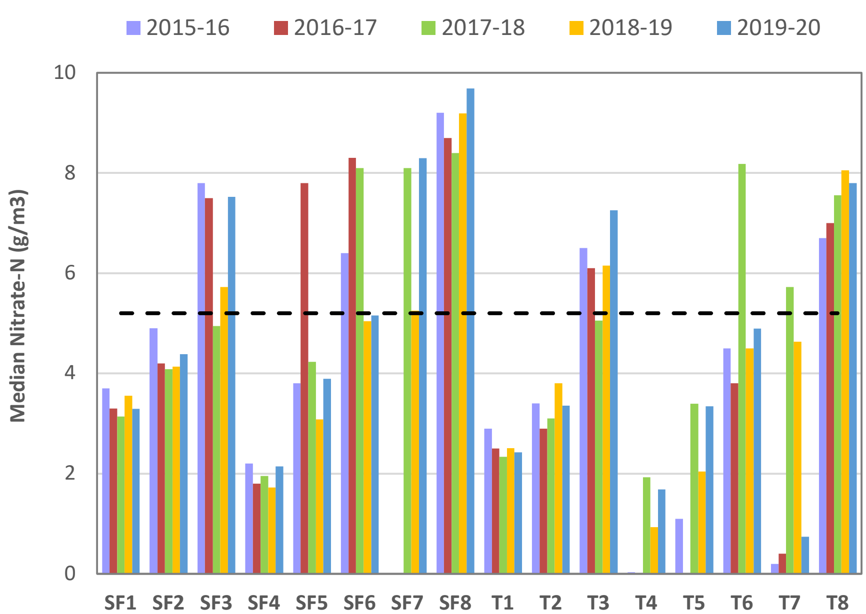

***Figure 24.** Annual median nitrate concentrations at spring-fed plains sites, 2015-16 to 2019-20 (black line denotes trigger level)*

It is noted that the GSWERP baseline water quality report identified historical nitrate concentrations (i.e., pre CPW) that would have exceeded triggers in the Hawkins River, Selwyn River, Boggy Creek and Harts Creek in. As illustrated in the examples from Harts Creek and the Selwyn River shown in Figure 25 and Figure 26 below, many of these waterways have a history of elevated and/or increasing nitrate concentrations that pre-dates CPW Scheme operations. Although 2019-20 concentrations were the highest (or close to) recorded historically at both sites, results are consistent with historical trends.

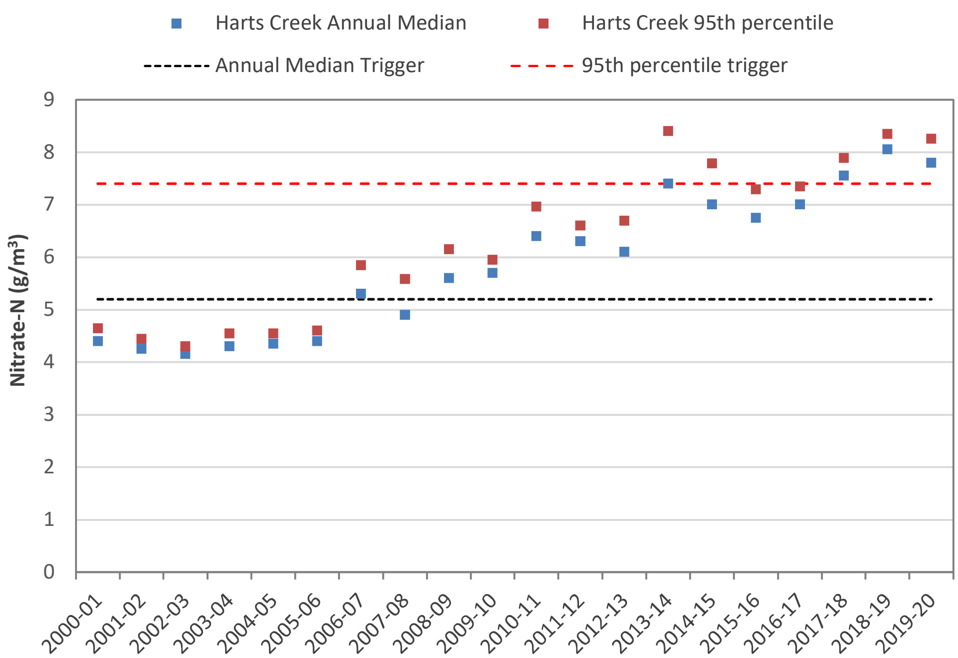

Figure 25. *Annual median and 95th percentile nitrate-nitrogen concentrations at the Harts Creek downstream site (T8), 2000-01 to 2019-20.*

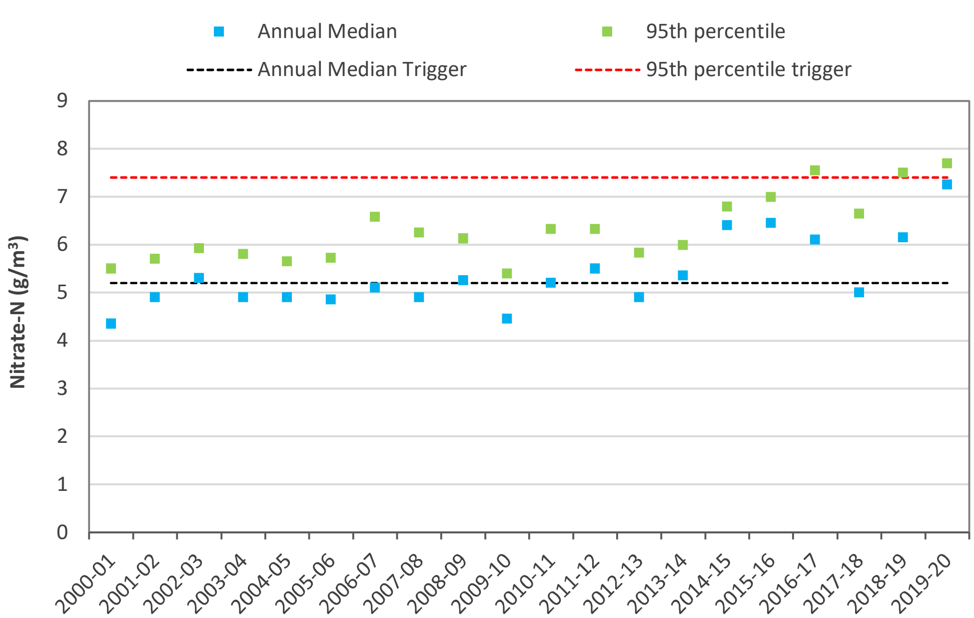

Figure 26. *Annual median and 95th percentile nitrate-nitrogen concentrations in the CPW Selwyn River downstream monitoring site (Coes Ford), 2000-01 to 2019-20.*

Overall, although surface water triggers were exceeded at nine sites in the CPW monitoring network during the 2019-20 year, observed concentrations are generally consistent with the historical baseline (either the observed range or historical trends). Consequently, monitoring data collected to date does not show any discernible effects of the Scheme on surface water quality either within, or down-gradient, of the Scheme area.

4.4.2. Lake Water Quality

Lake Ellesmere/Te Waihora is the ultimate receiving environment for a significant proportion of surface water and groundwater flows from the CPW Scheme area. Land use and land management activities in the Scheme area there have the potential to influence lake water quality. Trigger levels established by GSWERP for lake water quality are listed in Table 6. These trigger levels are equivalent to water quality limits contained in Table (l) of the LWRP.

Table 6. Lake water quality triggers

Monitoring Location	Chlorophyll-*a* (µg/L)[b]	Total Phosphorus (mg/L)[b]	Total Nitrogen (mg/L)[b]	TLI_3[a]
Mid-Lake	74	0.1	3.4	6.6
Lake Margins	no trigger	no trigger	no trigger	6.0

(a) TLI is calculated as TLI_3 (using TP, TN and Chl-a)

(b) As a maximum annual average determined from 12 (monthly) rounds of monitoring results.

Table 7 provides a summary of CPW lake water quality monitoring results for the 2019-20 year. The figures show CPW triggers were exceeded for Chlorophyll-*a*, Total Phosphorus and TLI_3 at the mid-lake site, and for TLI_3 at the three lake margin monitoring sites.

Table 7. *2019-20 CPW lake water quality monitoring results (figures in bold denote concentrations exceeding trigger levels)*

Site	Chlorophyll-*a* µg/L	Total Phosphorus mg/L	Total Nitrogen mg/L	TLI_3
Mid-Lake	**107**	**0.19**	2.44	**6.95**
Lake Margin Sites				
- Off Selwyn River Mouth	110	0.20	2.61	**7.00**
- South of Timber Yard	113	0.18	2.48	**6.96**
- Taumutu	116	0.17	2.41	**6.93**

Figure 27 shows Total Nitrogen, Total Phosphorus and Chlorophyll-*a* concentrations recorded at the mid-Lake monitoring site from 2000/01 to 2018/19. The figure shows 2019-20 Total Nitrogen concentrations were well below the trigger level, while both Chlorophyll-a and Total Phosphorus were above their respective trigger levels. Although elevated, concentrations of all three parameters during 2019-20 remained within the historical range.

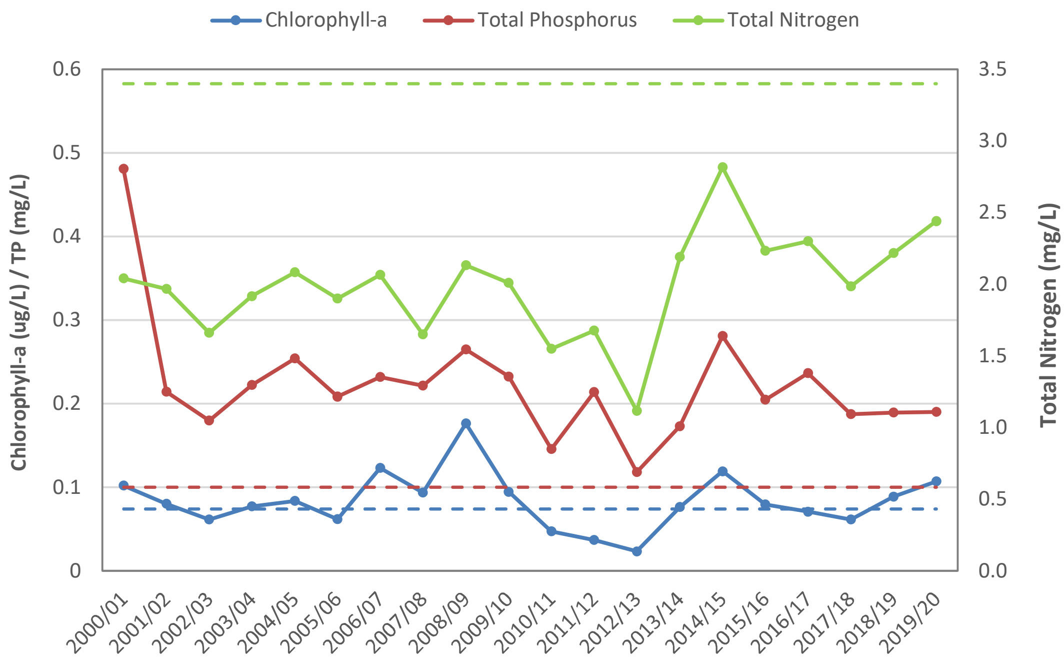

Figure 27. *Median Chlorophyll-a, Total Phosphorus and Total Nitrogen values at the mid-lake monitoring site, 2000/01 to 2019/20 (dotted lines indicate trigger levels for individual parameters).*

As shown on Figure 28 below, during 2019-20 TLI_3 values exceeded trigger levels at all monitoring sites, with values at lake margin monitoring sites similar to, or slightly higher than, values recorded at the mid-Lake monitoring site. All sites exhibit a similar temporal trend, with values recorded in 2019-20 higher than those recorded over the previous four seasons. However, as illustrated on Figure 29, although above the respective triggers, TLI3 values recorded at all sites during the 2019-20 year were within the historical range.

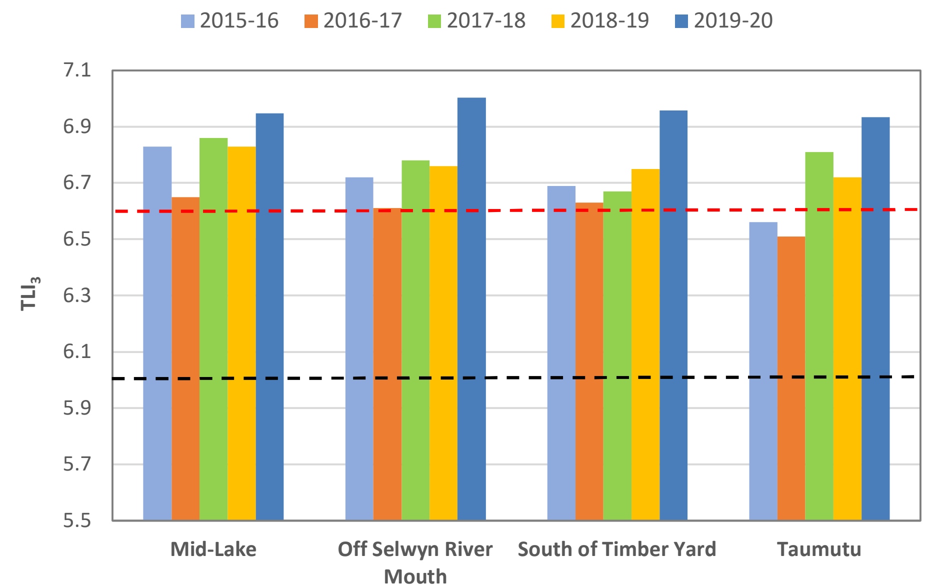

Figure 28. *Calculated TLI3 values at the four Lake Ellesmere/Te Waihora monitoring sites, 2015/16 to 2019/20 (red line = mid-lake trigger, black line = lake margin trigger).*

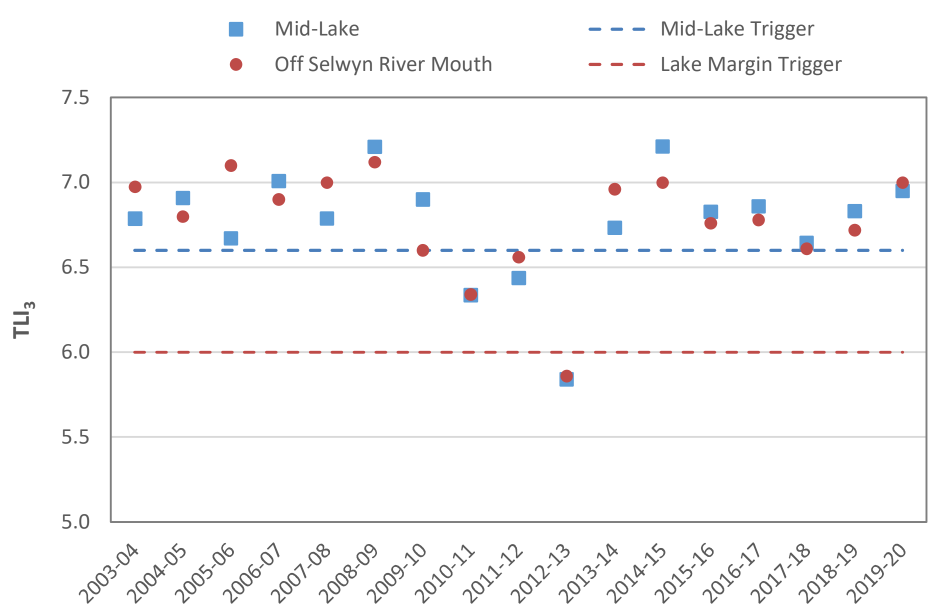

Figure 29. *TLI_3 values at the Mid-Lake and Off Selwyn River Mouth sites, 2002/03 to 2019/20*

Overall, during the 2019-20-year lake water quality triggers in Lake Ellesmere/Te Waihora were exceeded at both mid-lake and lake margin monitoring sites. However, concentrations of indicator parameters and calculated TLI3 values were within the historical range and do not exhibit any readily discernible change that can be related to CPW activities.

4.4.3. Groundwater Quality

Trigger levels for CPW groundwater monitoring are summarised in Table 8 below. It is noted that these triggers are equivalent to the limits for groundwater quality in the Selwyn-Waihora zone established in the LWRP.

Table 8. Groundwater quality triggers for CPW monitoring

Contaminant	Measurement	Trigger
Nitrate-Nitrogen	5-year annual average concentration[(a)]	7.65 mg/L
E.coli	Median concentration[(b)]	<1 organism/100 millilitres

(a) In shallow groundwater <50 metres below ground level

(b) Measured over the length of record

Two years of groundwater monitoring data were collected by CPW prior to the commencement of irrigation in each stage of the Scheme. This data (combined with results of historical ECan monitoring) forms the baseline against which future groundwater quality within the CPW Scheme area can be assessed.

4.4.3.1. Nitrate-Nitrogen

Due to the limited period over which the CPW Scheme has been operating (Stage 1 commenced operations in 2015-16), it is only possible to compare CPW groundwater quality monitoring results against the trigger level established in the GSWMP (based on a 5-year annual average concentration) for the Stage 1 area. Figure 30 shows the spatial distribution of 5-year annual average Nitrate-N concentrations in Stage 1 monitoring bores. The figure shows Nitrate-N concentrations exceed the 7.65 mg/L trigger level in four of the eight bores sampled in the Stage 1 area[12]. Bores exceeding the trigger include BX21/0017 located south of Hororata township, and three bores (BX22/0043, BX23/0046 and BX22/0053) located at the eastern (down-gradient) end of the Scheme.

Figure 31 shows yearly mean nitrate concentrations in Stage 1 monitoring bores between 2015-16 and 2019-20. The data exhibit significant variability in nitrate concentrations in individual monitoring bores over time. A marked increase in Nitrate-N concentrations observed in several bores during the 2017-18 year coincides with a period of significant recharge during autumn and winter 2017 which followed an extended period of below normal rainfall over the preceding three seasons.

[12] Technically Nitrate-N concentrations in BX22/0043 do not exceed the trigger level because groundwater levels at this site are >50 m below ground level (the triggers listed in Table 8 apply to shallow groundwater <50 m bgl).

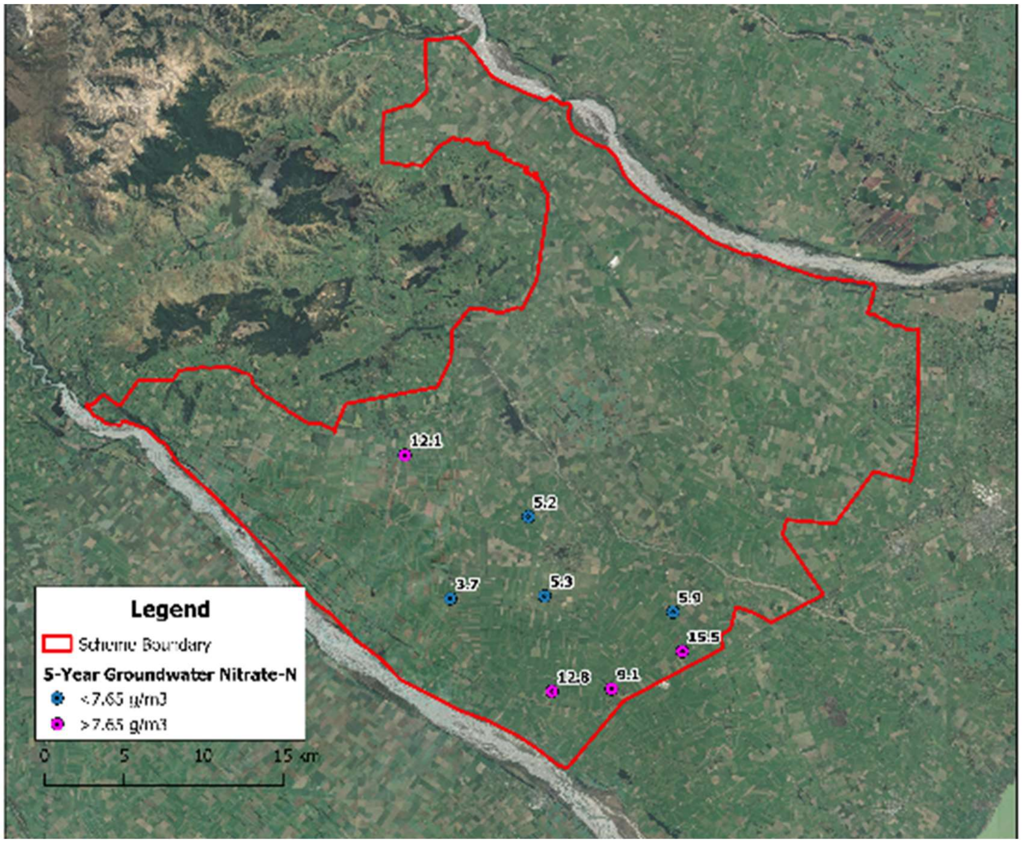

Figure 30. *5-year annual average Nitrate-N concentrations in the CPW Stage 1 area*

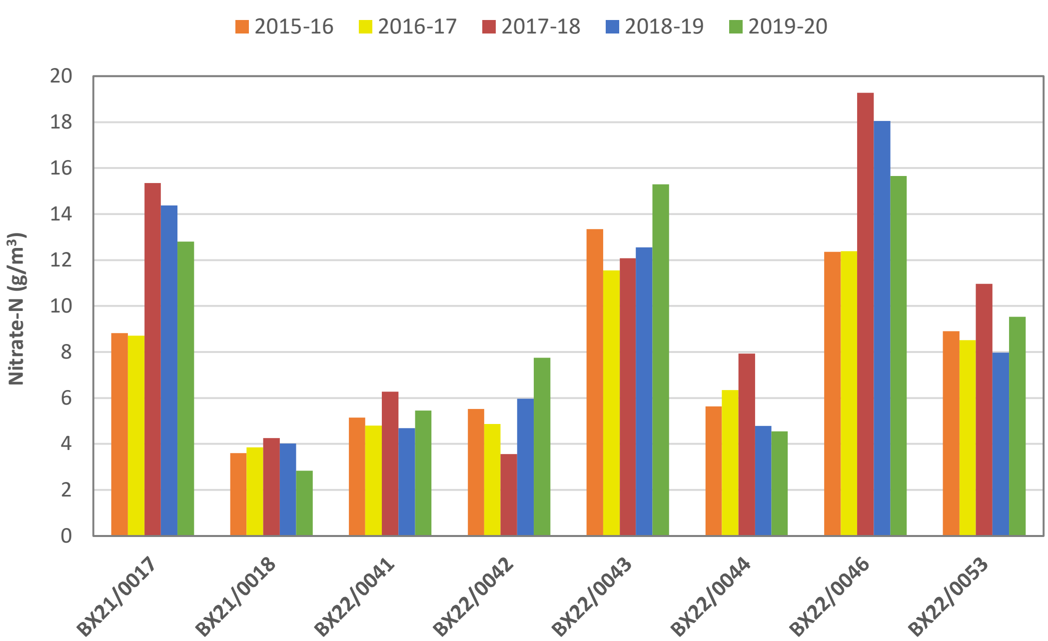

Figure 31*. Annual median groundwater nitrate concentrations in the CPW Stage 1 area, 2015-16 to 2019-20.*

For comparison, Figure 32 shows a map of 2019-20 annual average groundwater Nitrate-N concentrations across the whole Scheme area. The data indicate that 2019-20 Nitrate-N concentrations exceeded the 7.65 mg/L trigger level in:

- 4 of the 8 monitoring sites in the Stage 1 area
- 9 of the 10 sites in the Stage 2 area
- 1 of 2 sites in the Sheffield Scheme area.

Overall, the data indicate the 2019-20 annual average Nitrate-N concentration exceeded the medium-term trigger in 14 of the 20 CPW monitoring bores (70 percent).

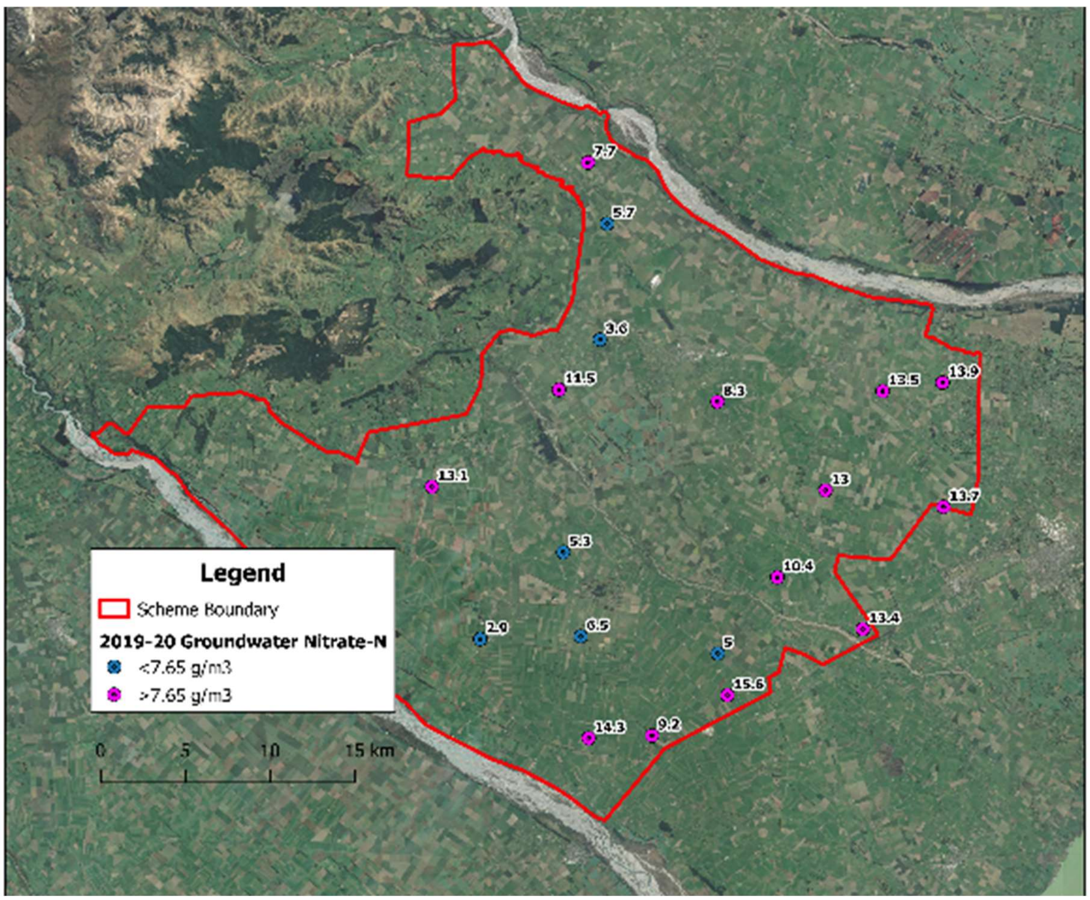

***Figure 32**. 2019-20 average Nitrate-N concentrations for the whole CPW Scheme area*

Figure 33 shows a plot of quarterly groundwater nitrate concentrations in selected CPW monitoring bores between 2014-15 (i.e., prior to commencement of Stage 1 operations) and 2019-20. While the data indicate Nitrate-N concentrations have remained relatively low and stable at some sites (e.g., BX22/0071), many others exhibit appreciable temporal variability, particularly following the wet autumn and winter in 2017. The significant increase in nitrate concentrations during 2017 (observed in all three Scheme stages) is attributed to the large volume of recharge mobilising excess nitrogen from the soil and underlying unsaturated zone following 3 years of generally below normal winter recharge. While this effect was observed across all three Stages, only Stage 1 of the CPW Scheme was operating at this time. With few exceptions, Nitrate-N concentrations during 2019-20 remained below peak values recorded during the 2017-18 season[13].

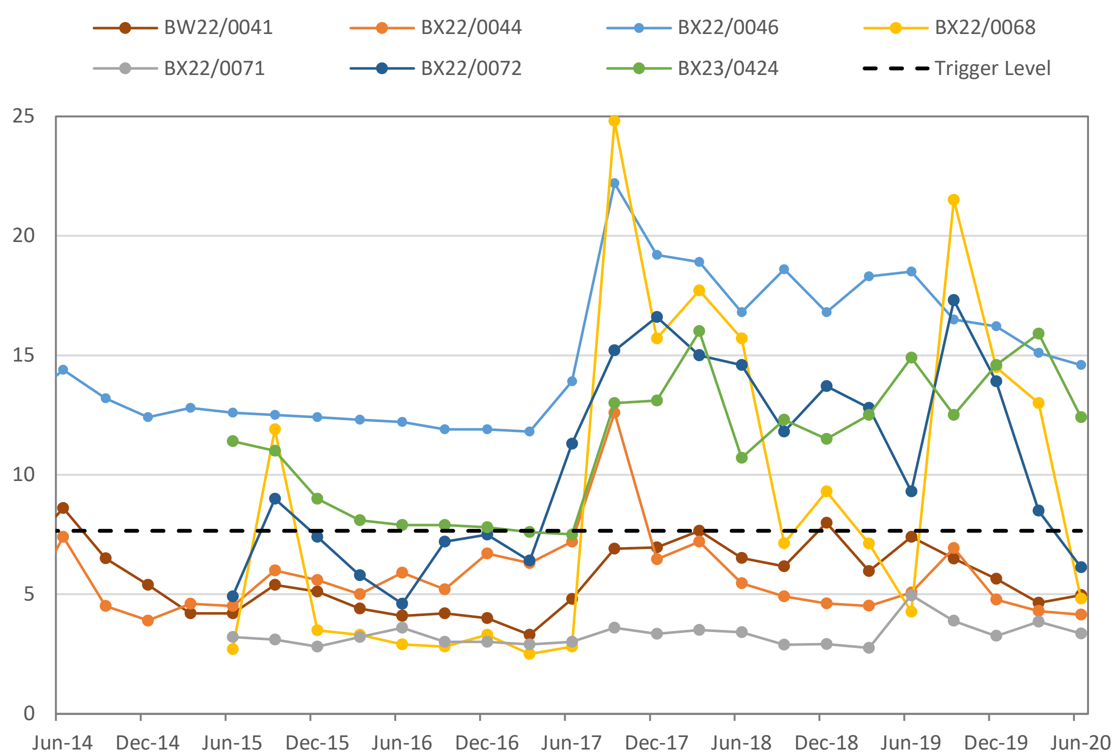

Figure 33. *Mean annual groundwater nitrate concentrations in the Stage 1 area, 2014-15 to 2019-20 (black line indicates CPW 5-year annual average trigger)*

As shown on Figure 34, monitoring data collected by ECan elsewhere in the Central Plains (outside of the CPW scheme area) exhibit a similar relationship with large increases in groundwater levels (associated with significant recharge events) corresponding to significant increases in groundwater nitrate concentrations. The data show a similar increase in Nitrate-N concentrations during the 2017-18 year to that observed in data from the CPW Scheme area.

[13] Although some sites (e.g., BX22/0068 and BX22/0072) exhibited an increase in Nitrate-N concentrations during the 2019 winter of a similar magnitude to those observed during 2017.

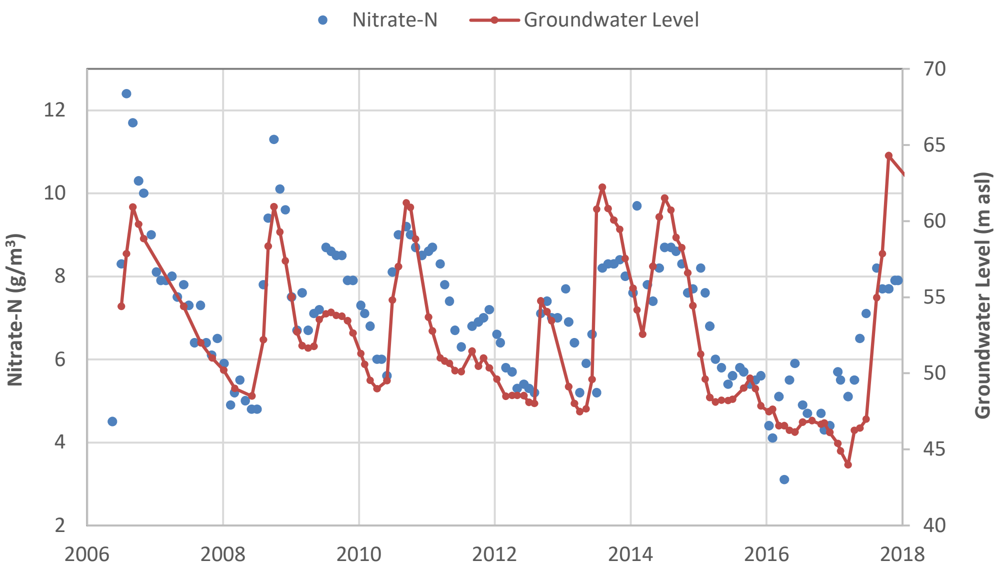

Figure 34. *Temporal variation in groundwater level and nitrate concentrations in M36/4126 near Rolleston (monitored by ECan), 2006 to 2018*

It is also noted that a significant proportion of monitoring sites in both the Stage 1 and Stage 2 areas exhibited nitrate concentrations in excess of the GSWERP nitrate triggers in baseline data collected prior to commencement of Scheme operations.

Overall, while monitoring data from the 2019-20 year show elevated groundwater nitrate concentrations (in excess of GSWERP triggers) in approximately 70% of CPW monitoring bores, the following points are noted:

- Due to the construction of the CPW monitoring bores and the sampling methodology utilised, nitrate concentration from CPW monitoring likely reflect 'worst case' nitrate concentrations recorded at the top of the water table
- Nitrate concentrations in excess of GWERP triggers were recorded in baseline data from approximately 30% of monitoring bores located in the Stage 1 and Stage 2 areas prior to CPW operations commencing[14]. Several bores in these areas (particularly Stage 2) exhibited an increasing trend in Nitrate-N concentrations prior to CPW operations commencing.
- Significant temporal variability in nitrate concentrations is observed between individual monitoring bores. A significant number of sites exhibit a marked increase in nitrate concentrations (above trigger levels) during 2017. This increase is attributed to a period of above average rainfall during autumn/winter 2017 which mobilised excess nitrogen from the soil and underlying unsaturated zone following 3 years of generally below normal winter recharge.
- With few exceptions, groundwater Nitrate-N concentrations observed during the 2019-20 year were lower than peak values recorded during the 2017-18 year.

[14] These bores are typically screened some distance below the water table.

These observations are consistent with data presented in the GWSERP Baseline Water Quality Report which showed a significant number of bores (>30%) in the Central Plains area sampled between 2010 and 2013 exhibited nitrate concentrations in excess of the nominated trigger value, with approximately 40 percent of wells also exhibiting statistically significant increasing trends in nitrate concentrations.

4.4.3.2. Microbial Quality

As shown on Figure 35 below, the intermittent presence of low levels of indicator bacteria (*E.coli*) was observed in a number of CPW monitoring wells during the 2019-20 year.

Within the operational Stage 1 area low levels of *E.coli* (<3 MPN) were detected on a single sampling occasion in three bores (BX23/0043) during the 2019-20 year. These detections did not result in the GSWERP trigger (based on median concentration for entire monitoring record) being exceeded. Positive *E.coli* detections in the Stage 1 area were recorded in 3 out of 32 samples (9.4%) collected from the Stage 1 area during 2019-20, the same rate as during the previous season.

Positive detections of E.*coli* bacteria were recorded in 6 out of 10 monitoring bores in the Stage 2 area during 2019-20 (slightly lower than 8 out of 10 bores during the 2018-19 season), with a total of 9 samples (9%) returning positive results. Six samples from 4 separate bores (BX22/0065, BX22/0067, BX22/0070 and BX22/0424) recorded elevated E.coli concentrations >10 MPN. It is noted that intermittent detections of *E.coli* were recorded in 26% of samples collected in the Stage 2 area during the baseline monitoring period (i.e., prior to commencement of Stage 2 operations), with indicator bacteria recorded at times in 9 of the 10 monitoring bores (BX22/0069 the only exception).

No positive detections for E.coli were recorded in the Sheffield Scheme monitoring bores during 2019-20.

A majority of positive E.coli detections during 2019-20 were recorded in bores locates near the eastern (down-gradient) extent of the CPW Scheme where the water table is shallowest. Where a positive *E.coli* detection was recorded in the CPW monitoring, a follow-up assessment was undertaken to identify potential causes. This assessment considered factors such as climate (rainfall) preceding sample collection, land use (stocking) in the vicinity of the bore, irrigation activities, as well as the general condition of land surrounding the bore at the time of sampling. The assessment also considered potential water quality risks for nearby bores used for potable or farm supply. While some positive *E.coli* detections correlated with rainfall events and/or land use activities, no obvious cause was identified for a majority of the positive detections recorded.

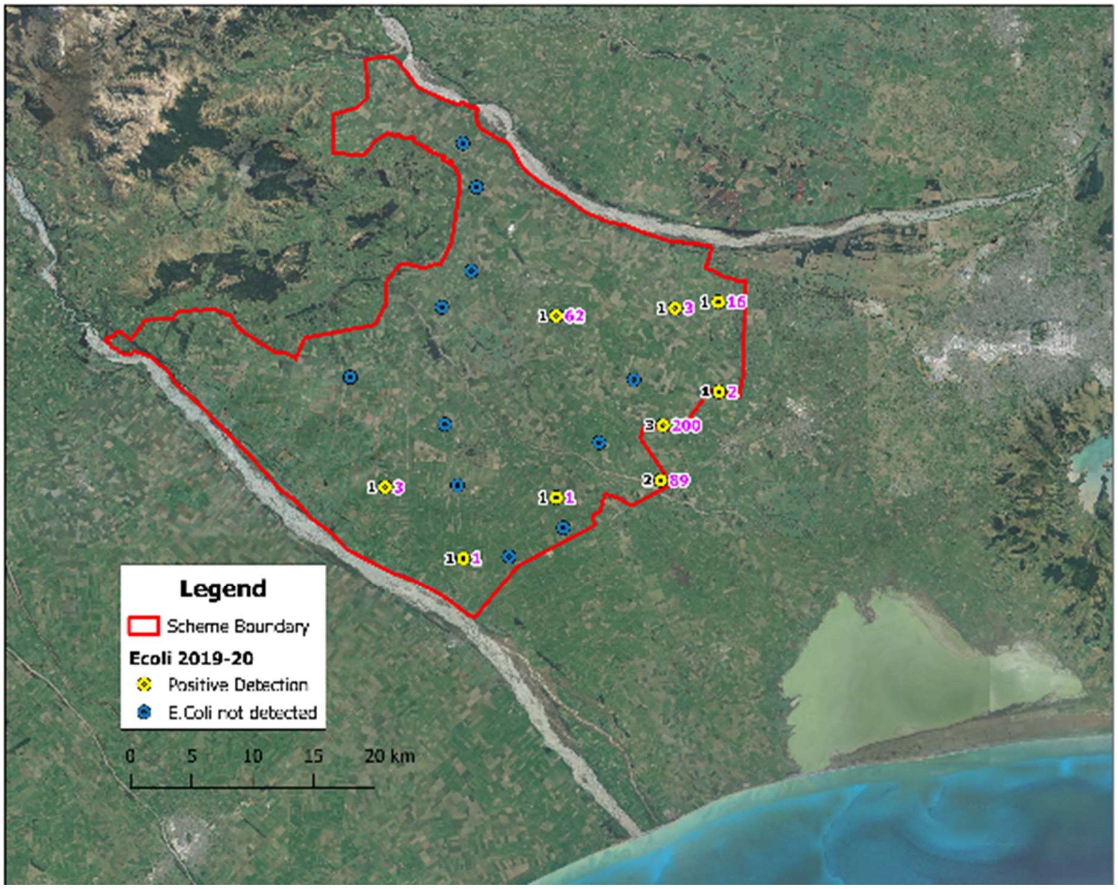

Figure 35. *Positive E.coli detections in CPW monitoring bores, 2019-20 (black numbers indicate number of positive detections (n=9), magenta numbers indicate maximum concentration).*

It is noted that the rate of positive E.coli detections across the CPW groundwater monitoring network in 2019-20 (17.5% of samples) is similar to that observed during previous years (17.5% 2018-19 and 20% 2017-18). Overall detection rates for indicator bacterial across the CPW monitoring network are similar to those reported for ECan's annual regional groundwater surveys from 2009 to 2018 (3.7% to 14% of bores sampled), particularly given the construction of the monitoring bores and sampling methodology utilised (i.e., long-screen bores with samples collected from immediately below the water table).

No clear relationships were observed between surrounding land use or rainfall events and positive detections of indicator bacteria in CPW monitoring bores, although the relatively high frequency of detection may in part relate to the sampling methodology used, particularly in shallower monitoring bores along the eastern (down-gradient) boundary of the Scheme.

4.4.4. Groundwater Levels

Increased irrigation of alpine-sourced water and decreased abstraction of groundwater has the potential to result in elevated groundwater levels in areas down-gradient of the CPW Scheme. While providing positive benefits in terms of discharge in spring-fed streams, elevated groundwater levels also have the potential to result in adverse effects on land drainage, particularly around the margins of Lake Ellesmere/Te Waihora.

CPW has supplied between 80 to 115 million m^3 of water per year to the Stage 1 area over the past 5 irrigation seasons, with a corresponding decrease in the overall volume of groundwater abstraction (as outlined in Section 3.4.1 above). In addition, as shown on Figure 36, while periods of above average rainfall (and associated groundwater recharge) were recorded during winter 2017 and autumn and spring 2018, rainfall has generally remained close to or below average levels from early 2019 (June 2019 being an exception). Groundwater levels in, and down-gradient of the CPW Stage 1 area are likely to have reflected a combination of these factors during the 2019-20 year.

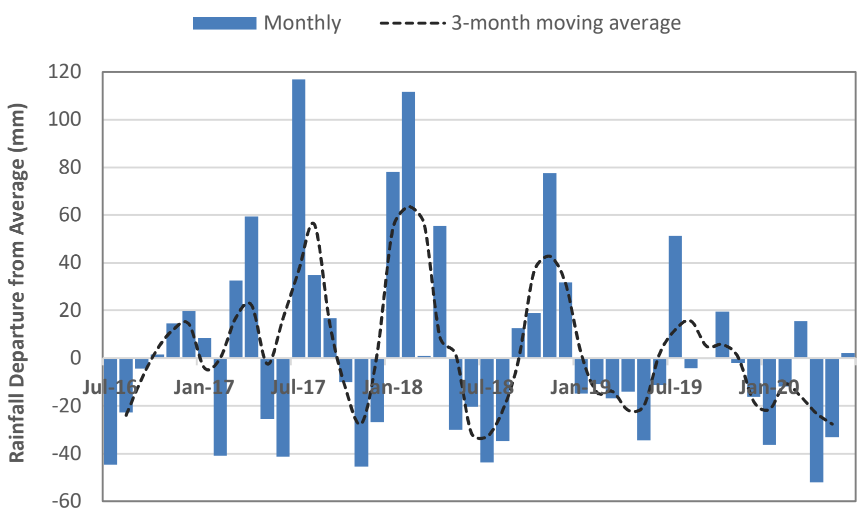

Figure 36. *Monthly and 3-monthly moving average rainfall departure from average at Ridgens Road, 2016 to 2020 (Source: Environment Canterbury).*

4.4.4.1. In-Scheme Groundwater Levels

Figure 37 shows a plot of groundwater level data recorded in three bores monitored by ECan within the CPW Stage 1 area since the mid to late-1970s (i.e. >40 years of ~monthly water level data). The figure shows groundwater levels recorded over the las two irrigation seasons have generally remained well above the long-term average despite generally average to below average rainfall over this period. While it is not possible to attribute the high groundwater levels solely to effects associated with CPW Scheme operation given climate variability over the preceding period), the data are consistent with the recovery in groundwater levels anticipated to occur as a result of Scheme operation[15].

[15] Particularly given lowland groundwater levels during 2019-20 were lower than in previous seasons

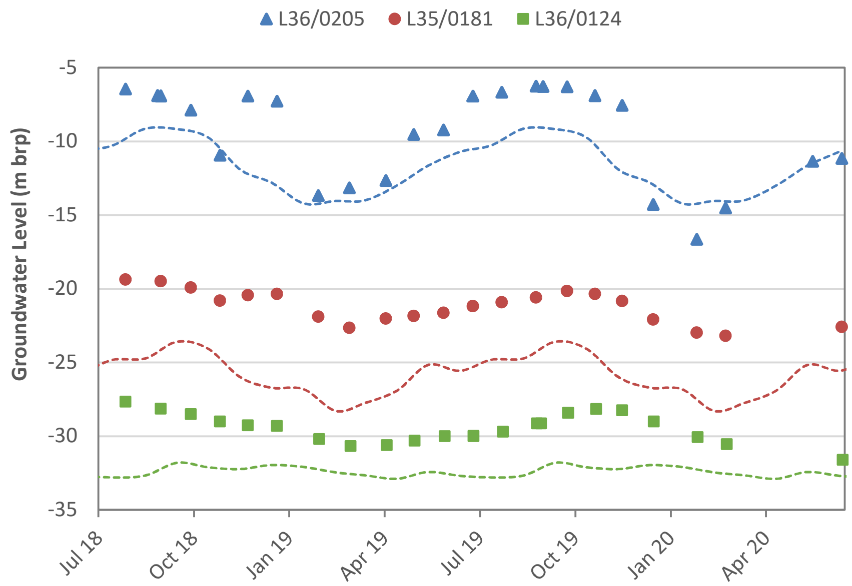

***Figure 37**. 2018-20 groundwater levels in the Stage 1 area compared to monthly median values from long-term ECan monitoring sites in the Stage 1 area.*

4.4.4.2. Lowland Groundwater Levels

The GSWERP established triggers for (high) groundwater levels in 12 bores located down-gradient of the Scheme which are currently monitored either automatically, or on a regular (monthly) basis, by ECan. These monitoring sites, shown in Figure 36 below, were selected on the basis of having a long historical record (>40 years) to account temporal changes in groundwater levels associated with natural climate variability. Triggers for high groundwater levels were established at the 95th percentile of the historical record for individual monitoring sites.

Although groundwater levels remained above the long-term median, only two minor exceedances (by less than 30 mm) of lowland groundwater level triggers were recorded in July 2019 during the 2019-20 year. Figure 37 shows groundwater level variations at two representative monitoring sites (M36/0250 and M36/7880) between 2000 and 2020 illustrating that while lowland groundwater levels were elevated in July 2019, they declined to within the 'normal' range through the remainder of the 2019-20 year.

CPWL did not receive any complaints concerning elevated groundwater levels or adverse impacts on land drainage or on-site wastewater systems in the Lowland Plains area during the 201-20 year.

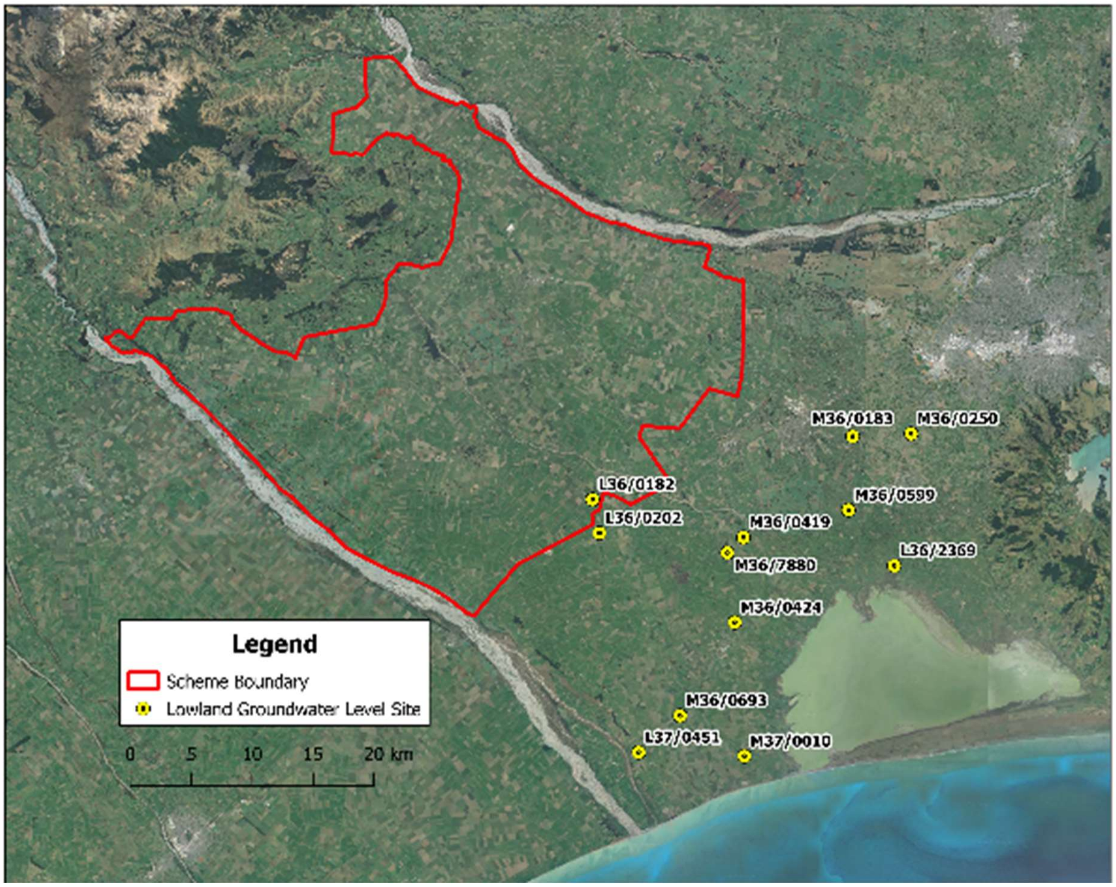

Figure 38. *CPW lowland groundwater level monitoring sites*

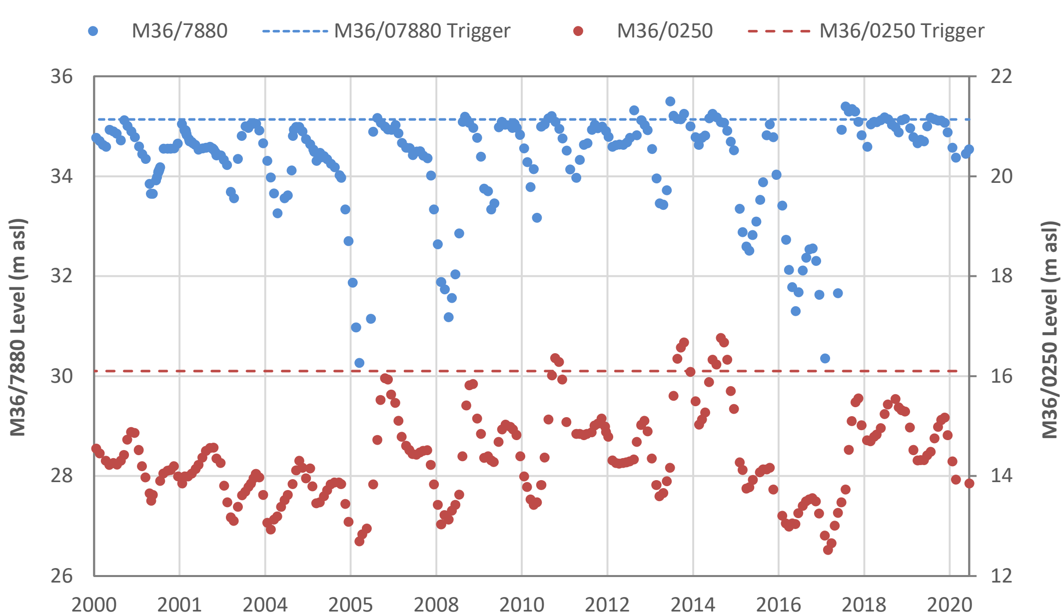

Figure 39. *Groundwater levels (and respective triggers) recorded in M36/0250 and M36/7880, 2000 to 2020.*

4.4.5. Summary

Water quality monitoring results recorded in the CPW monitoring network during the 2019-20 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established in Part II of the CPW GSWMP[16] at a number of monitoring sites located both in Stage 1, Stage 2 and Sheffield Scheme areas. Although trigger level exceedances were recorded, monitoring results show groundwater, surface water and lake water quality during 2019-20 was either within the historical (i.e., pre-CPW) range or consistent with long-term trends in baseline water quality.

The *Annual Ground and Surface Water Monitoring Report 2019/20* produced by CPW was approved by the GSWERP in November 2020 as providing a valid interpretation of monitoring results for the 2019-20 year. The report also notes that there were no complaints related to surface water quality, groundwater quality, land drainage or effects on on-site wastewater discharges received by CPW during the 2019-20 year.

4.5. Environmental Mitigation and Enhancement

4.5.1. Environmental Management Funds

In addition to an extensive environmental monitoring programme, part of the mitigation package offered by CPW during the resource consent process involved the establishment of funding for three environmental initiatives:

- The CPWL Environmental Management Fund (EMF)
- Te Waihora Environmental Management Fund (TWEMF); and
- Te Waihora Lake Opening.

The EMF and TWEMF were established during the 2015-16 irrigation season. Contributions to these funds are provided by Scheme shareholders. Due to the staged nature of Scheme development, annual contributions to these funds increased as the area under irrigation increased, with full contribution to the fund (from all three stages) commencing during the 2018-19 year. The fully operational Scheme generates approximately $115,000 annually for the EMF to allocate.

An independent Environmental Management Fund Committee (EMFC) is responsible for managing and allocating distributions from the EMF to environmental initiatives within the Selwyn Waihora catchment. In contrast, the TWEMF fund is provided directly to Ngai Tahu who manage allocation and annual reporting of fund expenditure. To date funding for the TWEMF is held in trust while details and priorities for initiatives associated with the restoration of health/mauri of the environment in the vicinity of Lake Ellesmere/Te Waihora are being determined by iwi.

The primary focus of the EMF is the enhancement of biodiversity across the Selwyn/Waihora catchment. To date funding has been provided for the planting of native species, development of wetlands and research. Since its formation, the EMF has allocated approximately $400,000 of funding to groups and individuals within the Selwyn Te Waihora catchment for environmental enhancement projects. One of the regular recipients of the Fund, Te Ara Kakariki Greenway Canterbury Trust (TAK), have used CPW-sourced funding for their annual Spring plant out days, funding landowner initiatives,

[16] These trigger levels are consistent with equivalent environmental limits established in the LWRP

school education and maintenance of established sites enrolled in their successful Greendot Programme. The EMFC have elected to continue their ongoing support for TAK as the organisation is now seen as one of the key promoters for biodiversity and narrowing the divide between urban and rural communities, along with the huge success of their work to date.

4.5.2. Targeted Stream Augmentation

A targeted stream augmentation project has been developed by CPW in conjunction with ECan to utilise ‘spare’ CPW water to augment natural flows in the Selwyn River in a manner that provides significant environmental benefits to the river system, while respecting cultural values associated with the mixing of waters.

The Selwyn Near River Recharge project includes the construction of an off-take on the Central Plains Water scheme that supplies up to 3.5m^3/s of Rakaia River Water into an infiltration basin beside the upper Selwyn River during dry periods. Water discharged into the infiltration basin percolates through the groundwater system beneath recharging the aquifer and ultimately increasing baseflow discharge in spring-fed stream across the down-gradient area, including tributaries of the Hororata, Irwell and lower Selwyn rivers. Operation of the scheme is not expected to increase the length of time the Selwyn River flows under the SH1 bridge.

Construction of the Near River Recharge project was completed during the 2019-20 year and will commence operations in future seasons as and when Scheme capacity allows, provided consent conditions relating to groundwater levels (i.e., to avoid flooding of nearby farm land) are met.

5. Summary

During the 2019-20 year the CPW Scheme delivered 172.7 million m^3 of water to a total of 255 properties. This total comprised 114.9 million m^3 of water taken directly from the Rakaia and Waimakariri Rivers, with the balance (57.8 million m^3) derived from water storage. Properties in the CPW Scheme also utilised 45.6 million m^3 of groundwater (equivalent to 24% of the total volume authorised by existing resource consents). The average seasonal irrigation application rate (CPW Scheme water and groundwater) across the Scheme area (including Farm Enterprise Properties) was 3,150 m^3/ha (equivalent to a seasonal application depth of 315 mm), comprising 658 m^3/ha of groundwater and 2,492 m^3/ha of CPW water.

Rainfall across the Central Plains area was significantly above average in July 2019, around average from August to November 2019, then below average through until June 2020. Soil moisture across the Central Plains was generally above average through to early December 2019 when it declined rapidly and remained well below average for a remainder of the 2019-20 season. Above average soil moisture during spring 2019 reduced irrigation requirements during the early part of the season, however the onset of dry conditions from November/December 2019 saw irrigation demand increase rapidly and remain high until tapering off during autumn 2020. 2019-20 water use in CPW Stage 1 was the highest since operations commenced in 2015-16.

Water quality monitoring results recorded for the CPW monitoring programme during the 2019-20 year indicate surface water quality, groundwater quality and lake water quality exceeded trigger levels established for the Scheme at a number of monitoring sites located both in Stage 1 and Stage 2 areas, as well as down-gradient of the Scheme. The recorded trigger level exceedances are consistent with the historical range and/or background trends observed prior to commencement of CPW operations. No obvious effects on water quality, groundwater levels or surface water flows attributable to operation of the Scheme were observed during the 2019-20 year