CENTRAL PLAINS
WATER

Central Plains Water Limited

Annual Ground and Surface Water Monitoring Report

2020/2021

Central Plains Water Limited

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1. Purpose

The purpose of this report is to present all monitoring data collected by Central Plains Water Limited (CPWL) between 1 July 2020 and 30 June 2021, and to provide an interpretation of background conditions, and impacts arising from consented activities. This report is prepared to comply with condition 25(a) of Schedule 2: Administrative Conditions of Resource Consent CRC165680. The condition requires that:

> *The consent holder shall prepare a report describing the results of the environmental monitoring outlined in the Ground and Surface Water Plan, for the period from 1 July to the following 30 June for each year.*

CPWL are required to measure a suite of parameters for river and stream water quality; lake water quality; and groundwater quality and quantity and report the results in this Ground and Surface Water Monitoring Report for the Period 1 July to the following 30 June each year. This report is required to include all the monitoring data and an interpretation of background conditions and impacts arising from the consented activities.

CPWL have developed a Ground and Surface Water Monitoring Plan (GSWP) (as required by Condition 18 of CRC165680), which is in two parts:

- Part I: includes an outline of CPWLs monitoring programme; and
- Part II: specifies (amongst other matters) trigger levels for monitored parameters.

The results from the monitoring programme are included in this report and are compared to applicable trigger levels.

2. Executive Summary

Alpine sourced CPWL irrigation water has been supplied to the Stage 1 area for six seasons, to the Sheffield Scheme area for four seasons and to the Stage 2 area for just under three full seasons.

Due to water having been supplied to Stage 1 shareholders for six seasons this is the second report to officially consider monitoring results against trigger levels and trigger response protocols contained in the Ground and Surface Water Monitoring Plan, a plan required by water use consent CRC165680 issued by Environment Canterbury.

Irrigation water was available from 1 September 2020 through to 14 May 2021. This is the second season that all three sections of the Scheme were able to operate for the entire season.

The effects of this irrigation water on surface water and groundwater flows, levels and quality are being monitored at multiple locations within, and downstream of, the CPWL supply area.

A range of environmental trigger values are, or will be in future, used by CPWL to draw attention to changes in the state of water flows, levels and quality in the Selwyn Waihora catchment that *may* be attributed to the operation of the CPWL scheme.

There were no trigger level exceedances from the lowland groundwater level monitoring bores in 2020-21. There were two exceedances from 2019-20 and one from 2018-19. Together these results represent a large decrease from the 16 exceedances during the 2017-18 period. We will have to wait for further years of alpine water use and the associated reduction in groundwater abstraction, to be able to determine if groundwater levels are rising and flows in the lowland streams are recovering due to the influence of the Scheme.

Where stream and lake water quality triggers were exceeded, the results were found to be consistent with concentrations or trends from previous years (prior to the CPWL Scheme operating) in all instances where historic data is available.

One surface water quality site that has been consistently monitored since 1992-93 (Selwyn River at Coe's Ford, see Figure 17) showed new maximum annual median, and maximum annual 95th Percentile, Nitrate-N concentrations, however, both concentrations have been increasing since the 1990's.

Five percent more rain was recorded at Hororata during 2020-21 compared to 2019-20. This equates to 10% less than 2018-19 and 30% less than 2017-18 (which is the second highest on record). 2020-21 rainfall was 5% less than the mean since 1981-82.

Past landuse and recently intensified irrigated landuse are the likely potential contributors to the new maximum Nitrate-N concentrations measured at some of the sites. However, it is too early to be conclusive about the relative contributions of pre-existing landuse and the CPWL scheme. The time-lagged effects of past landuse, recent improvements in practice both in and outside the scheme, and climate variability all complicate assessment of the relative causes of elevated Nitrate-N and increasing trends. Time will tell whether the new elevated concentrations will be sustained.

New maximum annual mean Nitrate-N concentrations were reached in 12.5% of Stage 1, and 10% of Stage 2, bores during 2020-21. Any trends cannot yet be confirmed statistically significant at the present. Further monitoring and time will tell whether the newly elevated concentrations are sustained and will allow examination of the extent to which CPWL is contributing to this trend.

Nitrate-N levels measured in the Sheffield monitoring bores were found to be within ranges previously encountered before the Scheme commenced operating. *E. coli* was detected on a single occasion from a

Sheffield monitoring bore in 2020-21. This is the first time since March 2018 that *E. coli* has been detected in one of CPW's Sheffield bores.

E. coli was detected on five and 12 occasions during routine monitoring of Stage 1 and 2 bores respectively during 2020-21. Over two-thirds of the 2020-21 *E. coli* detections occurred in June 2021 in the weeks following a large rain event.

In general, the monitoring results obtained during the last three years of full scheme operation, and prior three years of partial scheme operation, confirm that nitrate levels in groundwater and surface water are continuing to increase as they were before the scheme commenced. However, the results are not sufficient to enable any definitive statements explaining the impact of the Scheme on water quality. This is because the CPWL monitoring results are being compared against existing elevated, or increasing contaminant level trends, caused by historic land uses and practices whose effects are time-lagged.

Additional years of water quality monitoring will be necessary, together with on-going assessment of CPWL facilitated, and other, land use change patterns in the catchment, to determine whether any significant change to existing elevated Nitrate-N concentrations or increasing trends, can be attributable to CPWL, previous land use changes and/or to improving practices through time.

Until the main cause(s) responsible for trigger exceedances and increasing trends of Nitrate-N concentrations identified in this report can be accurately attributed, CPWL will assess its operations against its Sustainability Protocol, ensure all Farm Environment Plans are audited, including compliance with nitrogen application limits, and use/application of Good Management Practice/Matrix of Good Management. A summary of compliance with all these elements of the Sustainability Protocol is provided in Appendix 6.7 of this report.

CPWL did not receive any complaints during 2020-21 concerning adverse environmental effects of the Scheme on groundwater or surface water, including more specifically, impacts on land drainage, or on-site wastewater systems.

3. Background

The CPWL Irrigation Scheme (the Scheme) is located in the Selwyn Waihora Zone, within the Selwyn District (Figure 2).

The Scheme has been developed in a staged manner. Once the full uptake of water is completed the Scheme will provide water to up to 47,600ha situated between the Rakaia and Waimakariri Rivers, the Foothills and State Highway 1.

The 22,500ha Stage 1 section of the Scheme was constructed during early 2014 – mid 2015, with first irrigation water supplied on 1 September 2015. The 4200ha Sheffield Scheme first supplied irrigation water on 25 November 2017. Water was first supplied to the 18,200ha Stage 2 section of the Scheme on 2 October 2018 (see Figures 1 and 3). The area of land supplied with CPWL water was unchanged from 2019-20 to 2020-21. At the time of writing three new parcels of land will be added to the CPWL supply area for the 2021-2022 irrigation season.

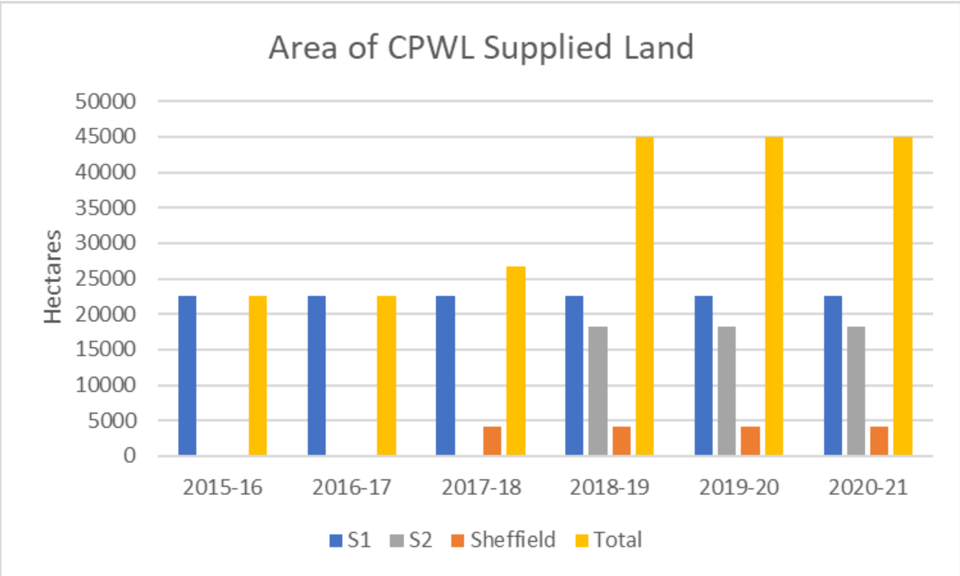

Figure 1. CPWL Scheme Area of Land Under Irrigation

The limit/target for nitrogen losses in Selwyn Waihora is 5,044.4 tonnes/year by 2037 (Table 11(i) of the Canterbury Land and Water Regional Plan (CLWRP)). A total of 358 tonnes/year (7% of the total) has been allocated to CPWL to allow for the conversion of dryland into irrigated land. This allocation is in addition to the assessed dryland nitrogen baseline of 621 tonnes (giving a total of 979 tonnes, as specified in Table 11(j) of the CLWRP).

The regulatory environment planning framework has changed since CPWL's original Take and Use Water permit was granted in 2010.

The Selwyn Waihora Zone Implementation Plan (ZIP, and ZIP Addendum) was developed by the Selwyn Waihora Zone Committee as a result of a two-year collaborative process, which commenced in December 2011. The ZIP identified a number of priority outcomes sought for the Zone, which is considered, by Canterbury Regional Council, to be over-allocated in terms of consented groundwater takes and nitrogen contamination in groundwater.

Variation 1 to the Land and Water Plan was therefore developed based on the recommendations in the Selwyn Waihora ZIP.

The original Central Plains Water Trust (CPWT) consent decision recognised the trade-off between benefits associated with increased baseflows in the lowland streams resulting from operation of the Scheme with the potential negative effects on land drainage and wastewater infrastructure in the lowland Central Plains area due to groundwater mounding.

While Variation 1 to the Land and Water Regional Plan (LWRP) has provided explicit recognition of the positive benefits associated with increased baseflows in lowland streams, it does not provide equivalent guidance in terms of thresholds for adverse effects on land drainage and wastewater infrastructure. It remained the task of CPWL to operate in accordance with the consent conditions to ensure appropriate management of environmental effects resulting from operation of the Scheme.

For a detailed summary of the background to CPWL and the Schemes' water use, and nitrogen discharge consents please refer to Appendix 6.2: Central Plains Water Limited Annual Compliance Report 2015/2016 Irrigation Season; Section 4.

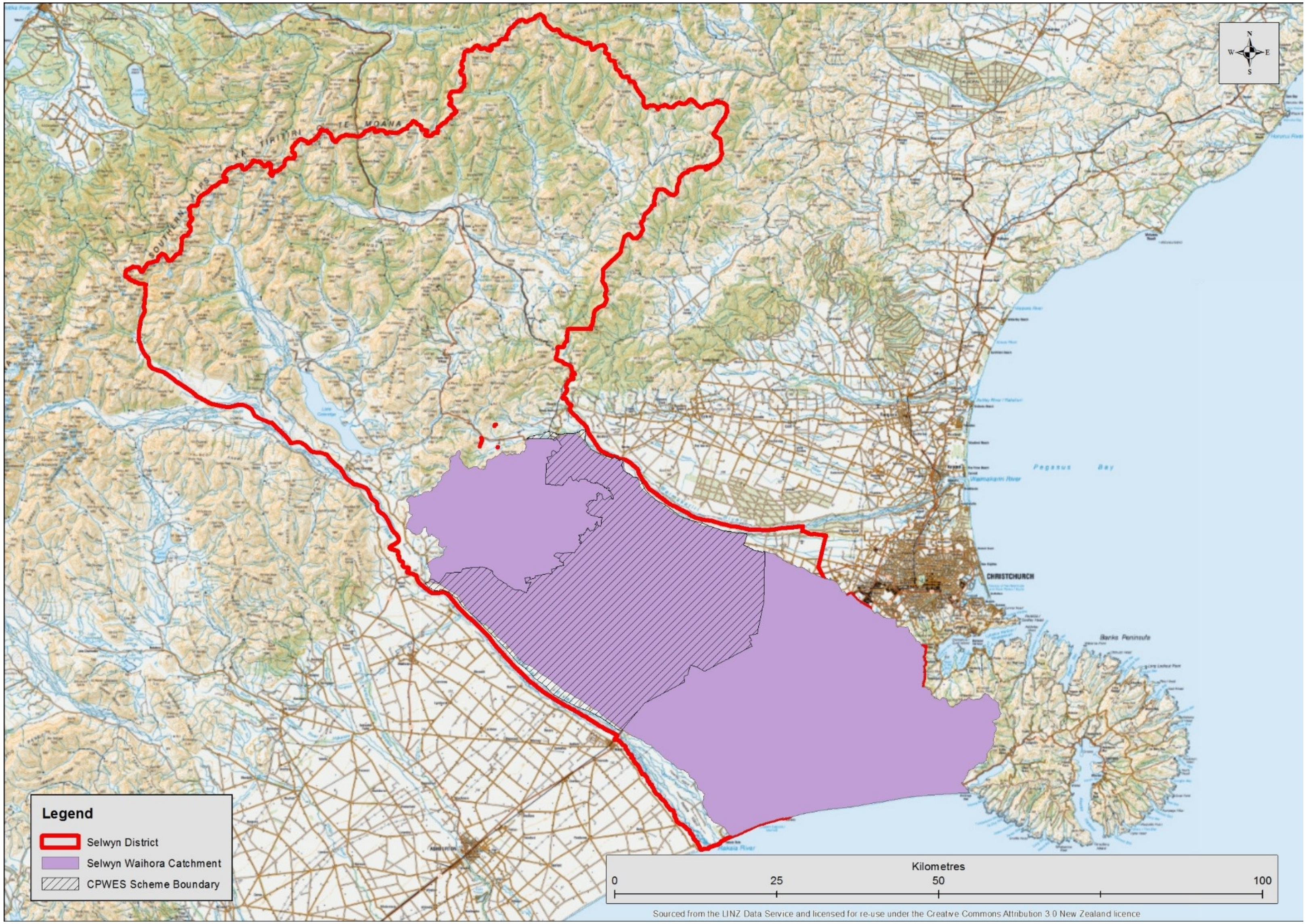

Figure 2. CPWL Scheme with the Selwyn Waihora Catchment

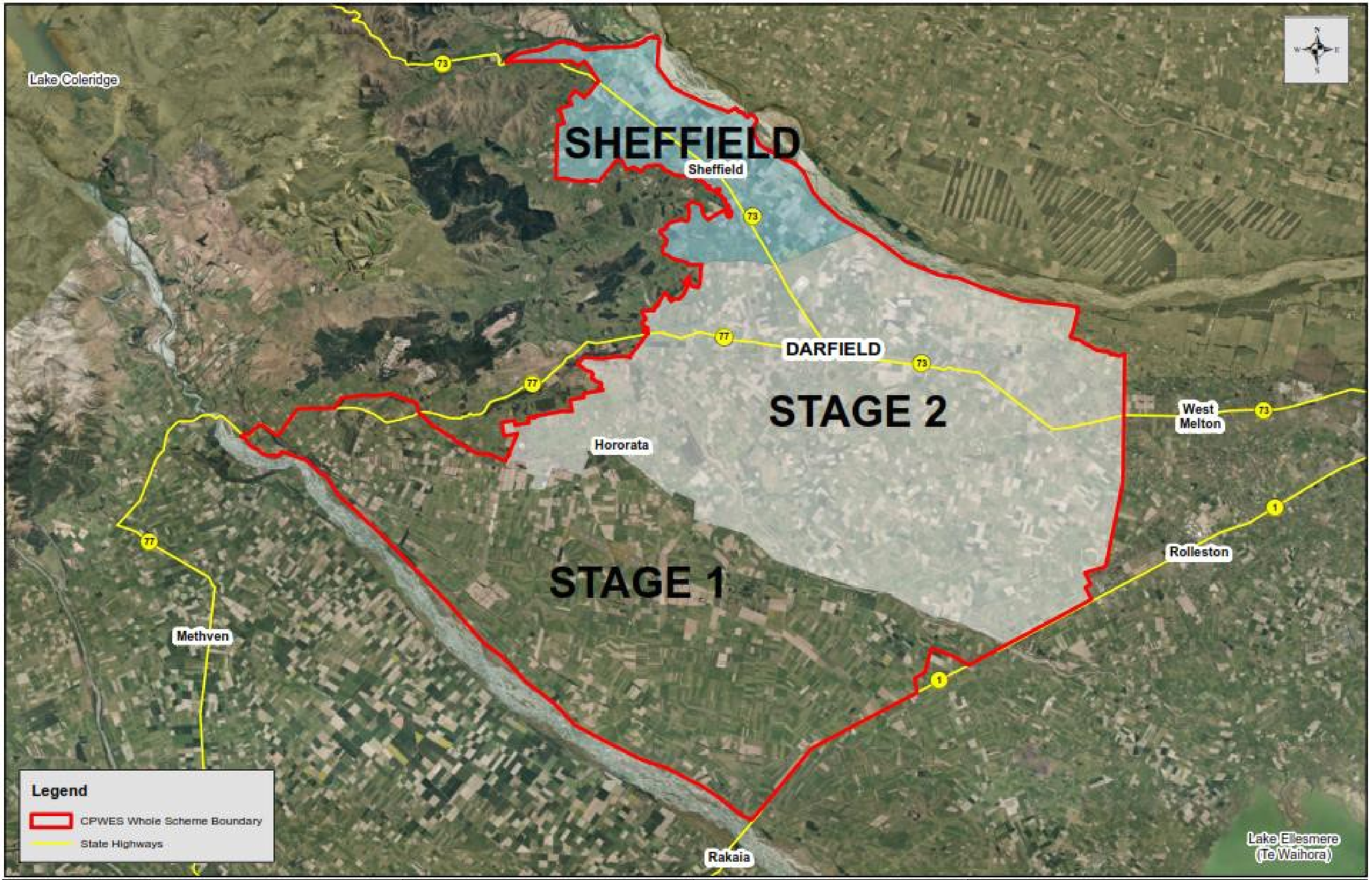

Figure 3. Scheme Overview

Water Use

During the 2020-21 irrigation season, 102,995,296m^3 of water was delivered to Stage 1, 69,626,527m^3 to Stage 2 and 10,737,829m^3 to Sheffield, farms.

This can be compared to approximately 111,000,000m^3, 58,000,000m^3 and 23,000,000m^3 of rainfall that fell on Stage 1, Stage 2 and Sheffield CPWL irrigated land respectively over the irrigation season and 183,000,000m^3, 109,000,000m^3 and 46,000,000m^3 of rainfall over the 12 months July 2020 to June 2021.

Figure 4 details seasonal water use by the various stages of the Scheme since water was first supplied by CPWL (to Stage 1) for the 2015-16 season.

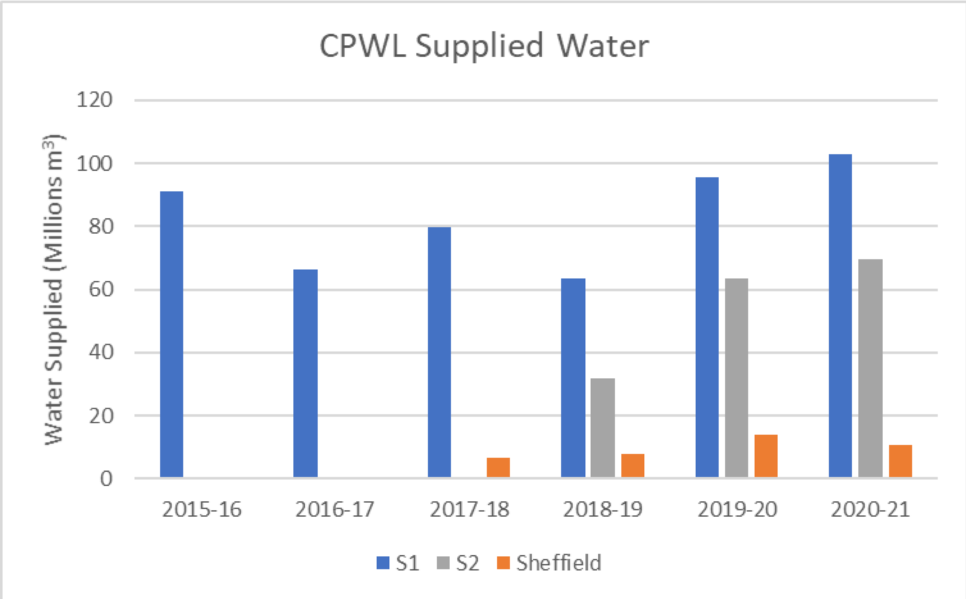

Figure 4. CPWL supplied water 2015-16 to 2020-21.

For 2020-21 groundwater abstraction by CPW shareholders was 19,268,263m^3 for Stage 1, 27,262,280m^3 for Stage 2 and 1,456,229m^3 for Sheffield. Figure 5 shows the large reduction in groundwater abstracted by; shareholders in Stage 1 from 2014-15 compared to 2015-16, and by shareholders in Stage 2 from 2017-18 compared to 2018-19, following the supply of CPWL water to the respective Stages of the Scheme.

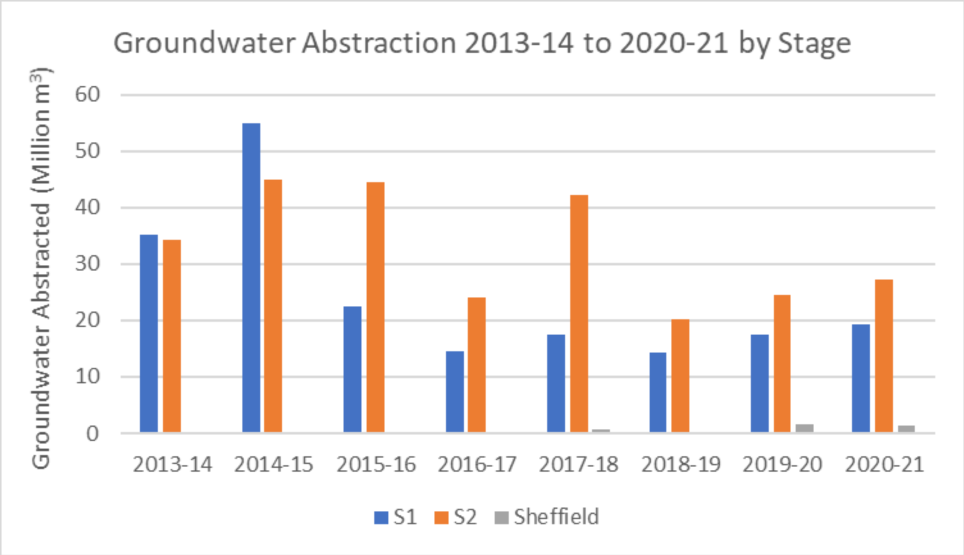

Figure 5. CPWL Shareholder Groundwater Abstraction 2013-14 to 2020-21.

Figures 6 to 8 show the sources of water to shareholder properties in the various Scheme stages during the irrigation seasons that CPWL has supplied water. To date the irrigated land areas have largely remained constant so differences in volumes of water used reflect differences in seasonal application rates.

More groundwater, and CPWL supplied water, was used by Stage 2 shareholders during the 2020-21 season compared to 2019-20, while the opposite was the case for the Sheffield Scheme. During the 2020-21 irrigation season, Stage 1 shareholders used the most CPW supplied water to date, while groundwater use in 2020-21 was at its highest level of the last five seasons.

Five percent more rain fell during the 1 July 2020 to 30 June 2021 period compared to 1 July 2019 to 30 June 2020 period (Source NIWA's Hororata Weather Station Number 4072). Fifteen percent more rain fell during the 2020-21 irrigation season compared to the 2019-20 season, albeit the 2020-21 season was 14 days (5.8%) longer.

Appendix 6.2: CPWL Annual Compliance Report 2020/2021 Irrigation Season (Section 6(b) for further details on the use of CPWL Scheme water for irrigation.

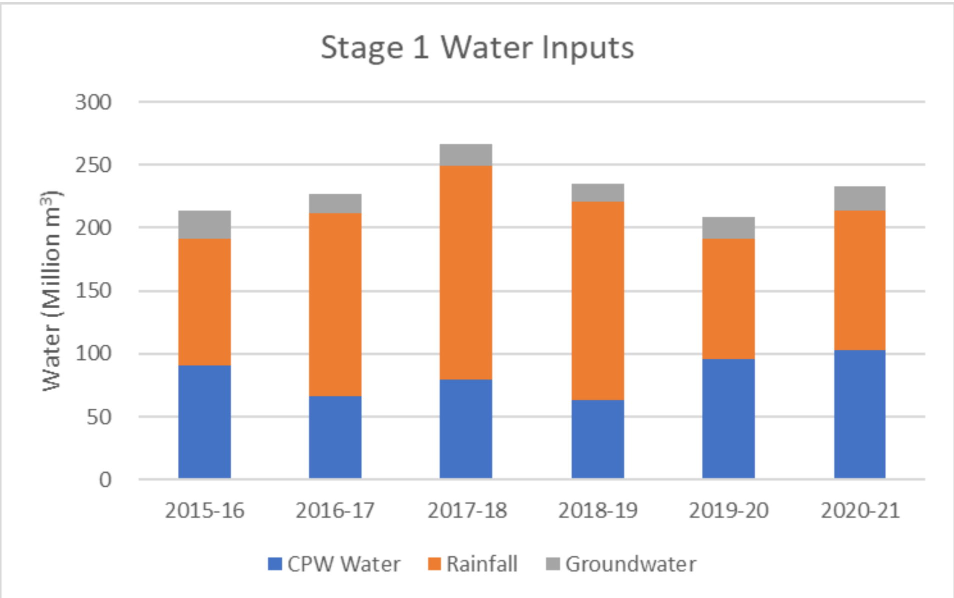

Figure 6. Stage 1 Water Inputs for the 2020-21 Irrigation Season

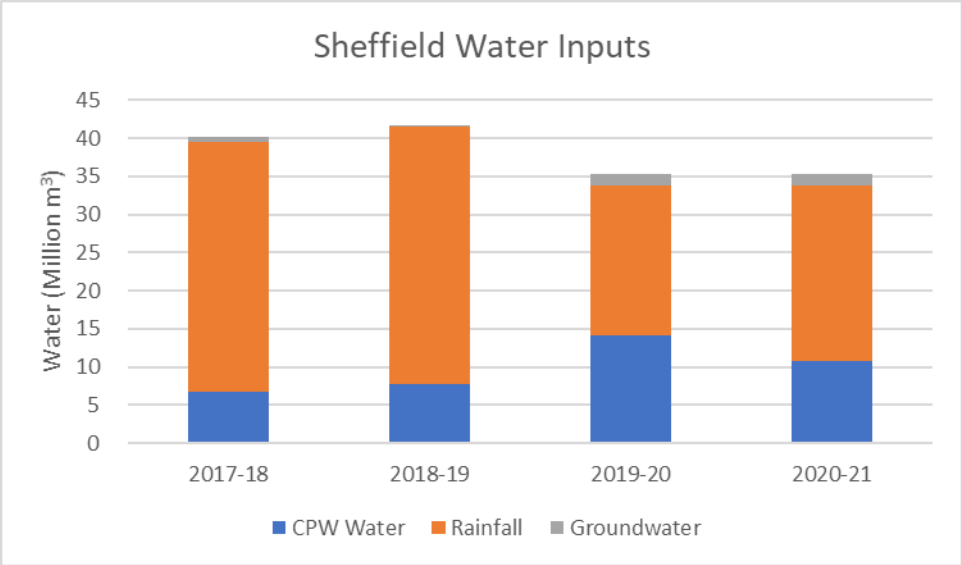

Figure 7. Sheffield Water Inputs for the 2020-21 Irrigation Season

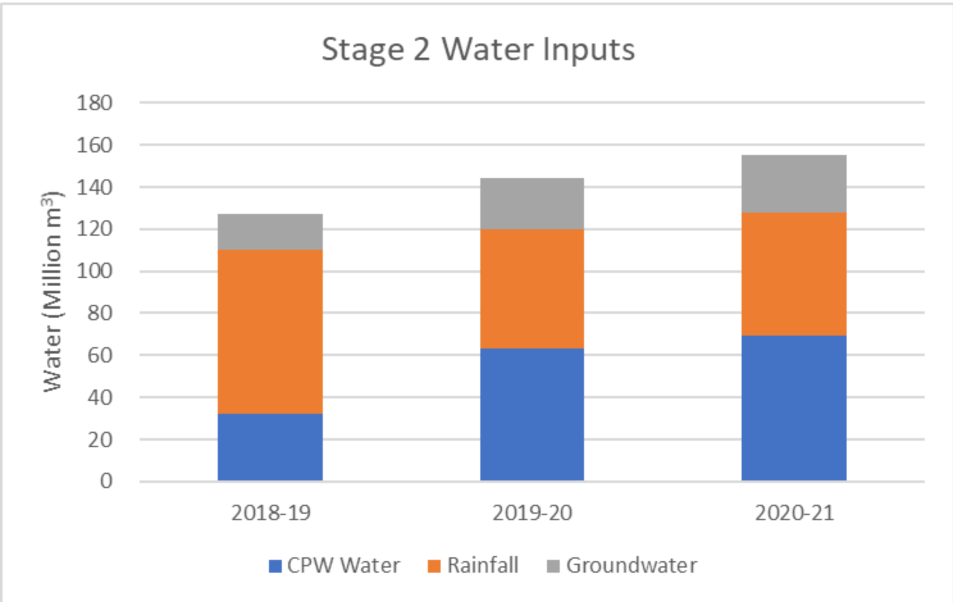

Figure 8. Stage 2 Water Inputs for the 2020-21 Irrigation Season

3.1. Scope of Water Monitoring Programme

River and Stream Water Quality

CPWL is required to monitor on a monthly basis surface water quality at 29 river and stream sites (see Figure 9). Full details of CPWL's surface water monitoring programme is contained in Part 1 of CPWL's Ground and Surface Water Monitoring Plan (available at https://www.cpwl.co.nz/companydocuments).

CRC165680 authorises CPWL to rely on data collected on Te Waihora/Lake Ellesmere, lowland streams, other rivers/streams or drains and the stockwater network by the Canterbury Regional Council or any other entity in lieu of establishing new monitoring sites. Instances where CPWL rely on data from ECan will be noted in this report.

Parameters to be analysed are: *Escherichia coli* (*E. coli)*, Turbidity, Nitrate + Nitrate-Nitrogen, Total Nitrogen, Total Ammoniacal Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus, Electrical Conductivity, Dissolved Oxygen, pH and temperature. CPWL has water quality triggers in place for Nitrate-Nitrogen (Annual Medians and Annual 95th Percentiles).

The Surface Water Monitoring programme began at the same time as the commencement of Stage 1 of the Scheme in September 2015.

Lake Water Quality

This report contains water quality data from ECan's monitoring of Te Waihora from July 2020 to June 2021. Water samples are analysed for a wide range of parameters but only those required by the Ground and Surface Water Plan (as per those listed under 'River and Stream Water Quality' above and Trophic Level Index (TLI_3) and Chlorophyll *a*) are included in this report. Figure 9 shows the five locations sampled by ECan. CPWL has water quality triggers in place for Trophic Level Index (TLI_3), Total Phosphorus, Total Nitrogen and Chlorophyll *a*.

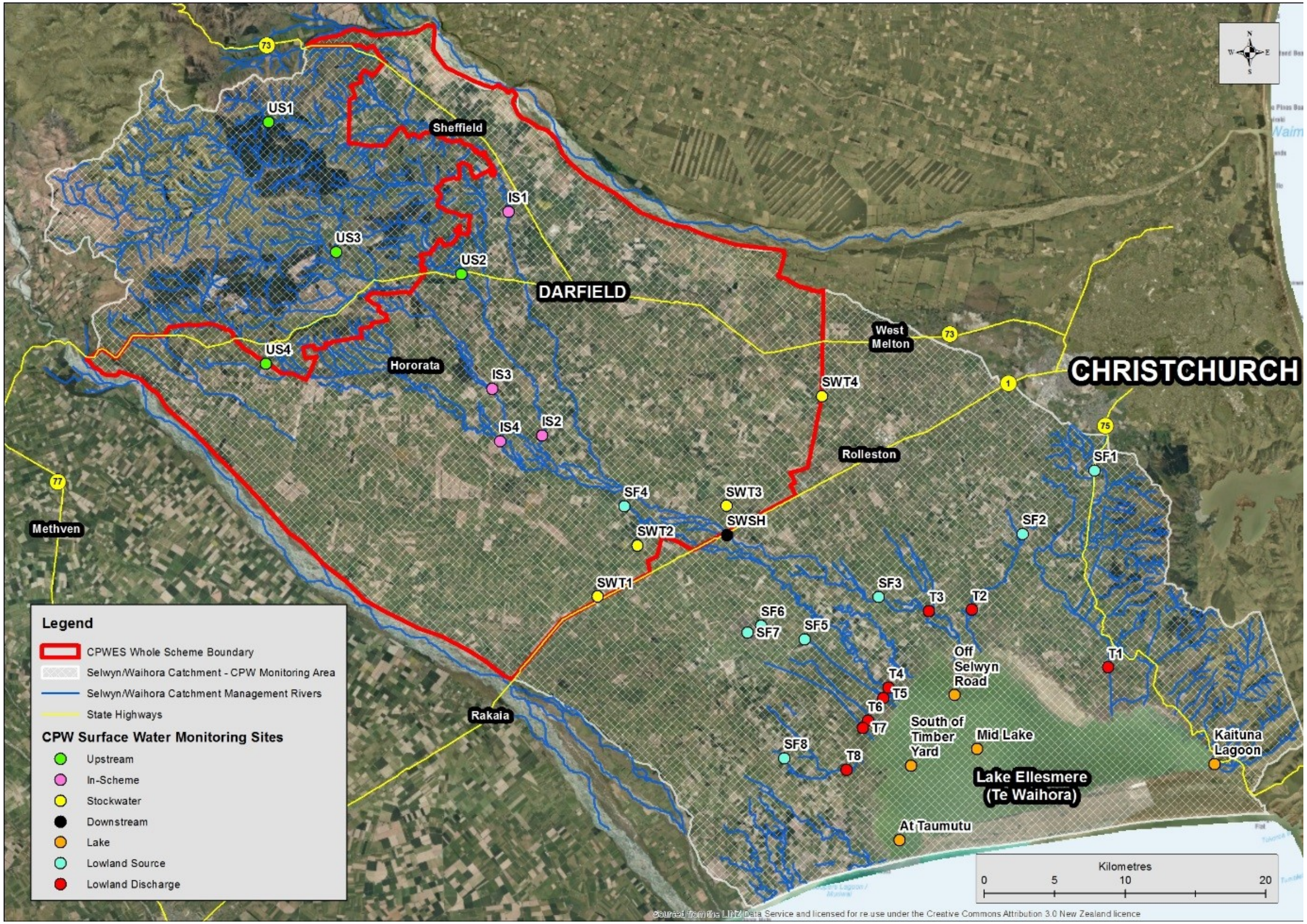

Figure 9. Surface Water Monitoring Sites

Ground Water Quality and Levels

Twenty monitoring bores have been installed by CPWL throughout the Scheme area (refer to Figure 10). Eight bores are located within Stage 1, ten in Stage 2 with two in the Sheffield area.

CRC165680 required two years of ground water monitoring data to be collected prior to the use of water. By 1 September 2015, CPWL had completed seven rounds of quarterly monitoring of our Stage 1 dedicated long-screen bores (Refer to Figure 11 for a comparison of a water supply bore to a dedicated long-screen monitoring bore). Long-screen monitoring bores are screened across the water table and this enables samples to be taken from close to the groundwater's static water level (SWL). This contrasts with typical Canterbury water supply bores that can have relatively short (~2m long) screens located close to the bottom of the bore. Water samples taken from typical Canterbury water supply bores may be abstracted from some distance below the SWL. This difference is important because some groundwater contaminants, in particular Nitrate-N, are typically most concentrated at the SWL and become decreasingly concentrated with depth, rather like cream in a bottle of milk. This means that samples taken from near to the SWL are more likely to accurately reflect Nitrate-N concentrations affected by land surface recharge in the immediate vicinity than samples collected from a bore screened 20m below the SWL. This difference is illustrated in Figure 11.

In order to have two years of monitoring data before the commencement of Stage 1 irrigation, the Stage 1 dedicated monitoring bores were located adjacent to existing water supply bores that had been monitored for at least two years prior to CPWL's first irrigation season. The water supply and long-screen bores were monitored concurrently for two years to establish a relationship between the two forms of monitoring that may be useful when comparing future results to the historic record.

The dedicated long-screen monitoring bores were installed in the Stage 2 area of the Scheme in the first half of 2015. These bores had been monitored for three and a half years prior to the commencement of Stage 2 irrigation in 2018.

Full details of the Groundwater Monitoring Programme are contained in Part 1 of CPWL's Ground and Surface Water Monitoring Plan (available at https://www.cpwl.co.nz/companydocuments).

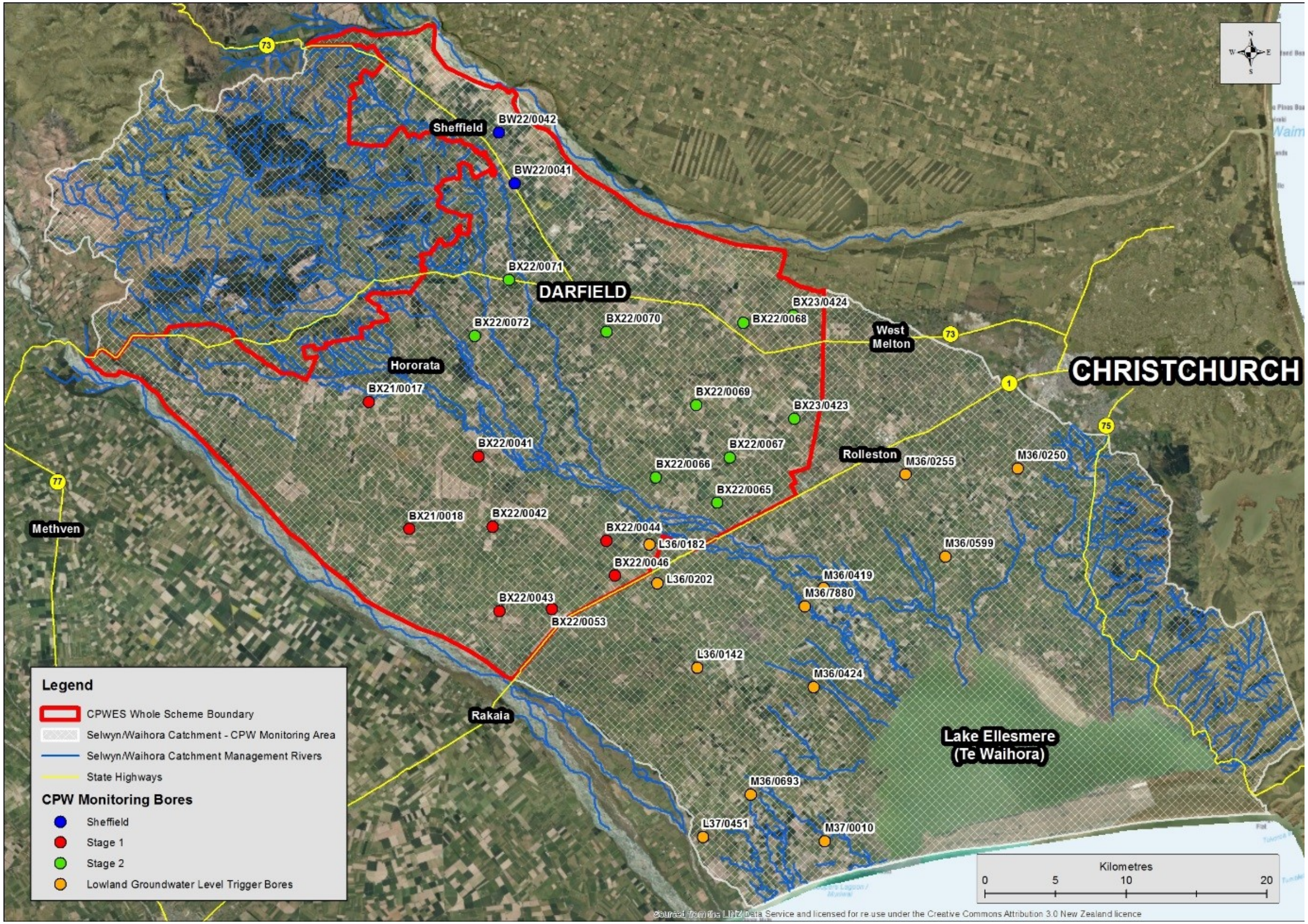

Figure 10. CPWL Groundwater Quality and Lowland Water Level Monitoring Sites

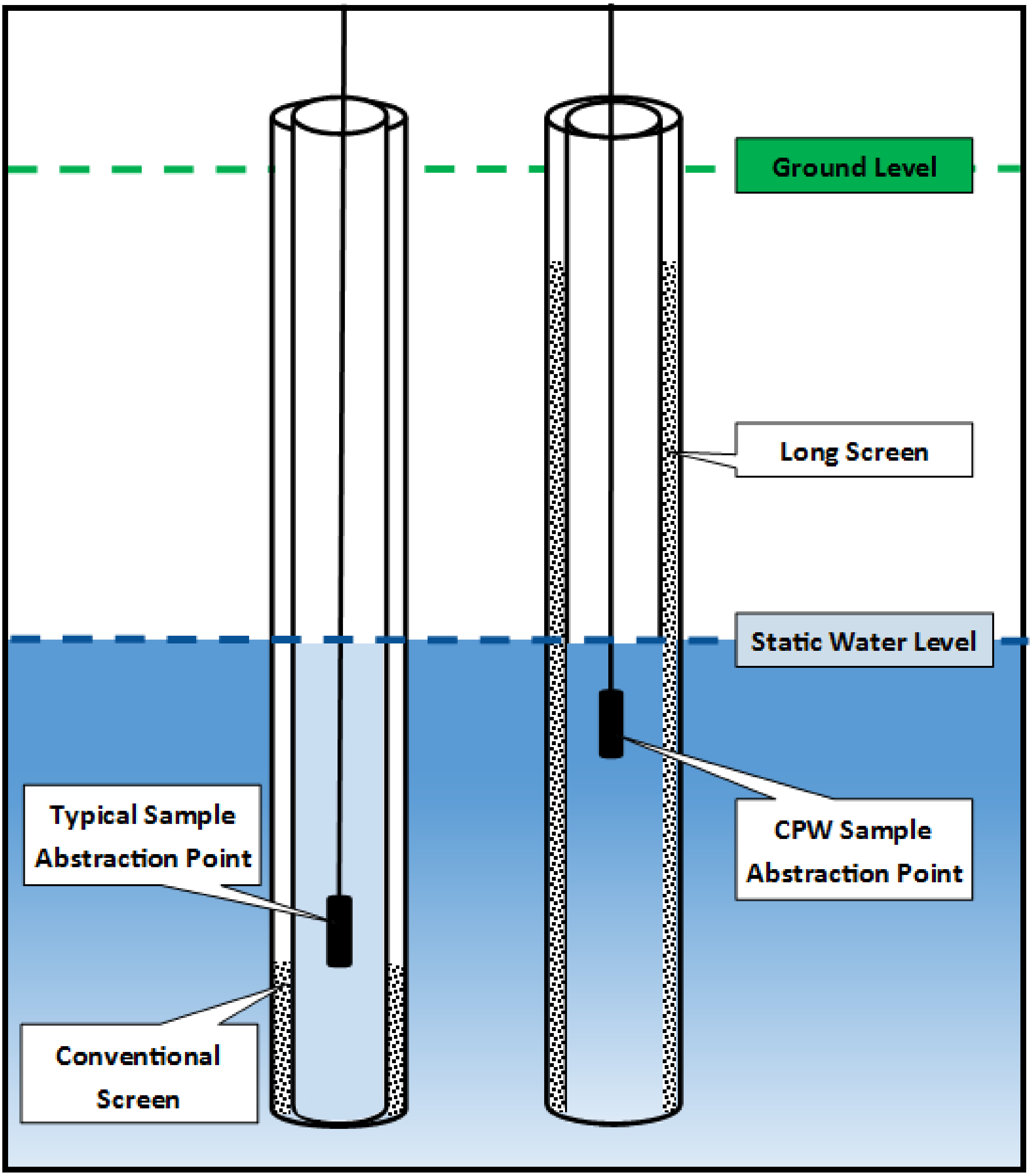

Figure 11. Comparison of a typical Canterbury Water Supply Bore to a dedicated CPWL long-screen Monitoring Bore

Groundwater Level Trigger Levels

CPWL does not carry out any specific groundwater monitoring in the Lowland Central Plains area but instead utilises data collected by Environment Canterbury (ECan). ECan operate an extensive groundwater level monitoring network in the Lowland Central Plains. GSWERP has established groundwater level trigger limits for a series of 12 bores within the ECan network (orange circles in Figure 10). The trigger limits will be used to provide advance warning of potential groundwater mounding. In order to provide sufficient warning of possible groundwater mounding the trigger limits are relatively conservative in that they have been set at a level which has been reached in the past. This may result in occasions where the triggers are reached following for example, high intensity rainfall events that lead to elevated groundwater levels, or for other reasons that are outside of CPWL's control. For example, the large, complex low-pressure system that brought heavy rain and gales to Canterbury during 20-22 July 2017 led to trigger levels being exceeded from 5 out of 12 monitoring bores. No trigger levels were exceeded during the 2015-16 and 2016-17 monitoring periods.

Groundwater Quality Trigger Levels

With the exception of Nitrate-N and *E. coli* in groundwater, CPWL's trigger levels are assessed against monthly or annual data.

Trigger levels for Nitrate-N in groundwater are based on five-year annual averages. This means a comparison of monitoring results to the groundwater Nitrate-N trigger from five years' of CPWL activities could not be made until September 2020 for Stage 1, and cannot be made until 2022 for Sheffield and 2023 for Stage 2. It will still be useful however, to evaluate the results obtained prior to the formal assessment against the five-year trigger level being made, to see if any developing trends can be identified.

Until a sufficient amount of data has been collected to report against five-year annual averages, CPWL will highlight in the results section instances where new maximum Nitrate-N concentrations are detected and where annual average Nitrate-N values exceed 7.65mg/L[1] for the Stage 1 and Sheffield areas.

It is worth noting that there is a recognised lag effect in the transport of nitrogen in the groundwater system. Therefore elevated and/or increasing Nitrate-N readings may continue to be measured in deep groundwater, lowland streams and Te Waihora for a period of time, from pre-scheme land use, irrespective of improving farm practices that would be expected to result in lower discharges of nutrients into the environment. Consequently, in deep groundwater, lowland streams and Te Waihora it may take many years to detect changes in Nitrate-N concentrations resulting from changed land use under CPWL, if this occurs.

Prior to the commencement of CPWL irrigation, 42% of the water samples taken from Stage 1 long-screen bores had Nitrate-N concentrations greater than 7.65mg/L, for Sheffield bores the figure was 30%, and for Stage 2 the figure was at 61%.

The *E. coli* trigger level is a median (over the length of record, post commencement of CPWL irrigation) of a detectable concentration of the bacteria.

Groundwater samples are analysed for pH, Electrical Conductivity, Dissolved Oxygen, Temperature, Alkalinity, Bromide, Chloride, Dissolved Reactive Phosphorus, Nitrate-Nitrogen, Total Nitrogen, Sulphate and *E. coli.* The static groundwater level is also measured at the time of sampling. CPWL has water quality triggers in place for Nitrate Nitrogen and *E. coli*. Appendix 6.1 contains all trigger limits and trigger response processes from Part II of the Ground and Surface Water Plan.

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[1] 7.65mg/L is the trigger level for Nitrate-N based on a five-year annual average concentration.

3.2. 2020/2021 Seasonal Climatic Influence

Rainfall

162.5mm of rain was recorded at the Ridgens Road Rain station between 28 May and 2 June 2021. This included 150mm falling over three days, 115mm over two days and 77.5mm on a single day.

By contrast during the significant rain event in July 2017, 98.5mm of rain was recorded over two days with 82.5mm being recorded on a single day.

During the period 1 July 2020 to 30 June 2021, 802mm of rainfall was recorded at NIWA's weather station 4702 located approximately 4km west of Hororata. This was the 16th lowest 12-month total (1 July to 30 June) since records began in the 1981-82 period (n=40) (refer to Figure 12), this is 5% less than the long-term mean of 845mm.

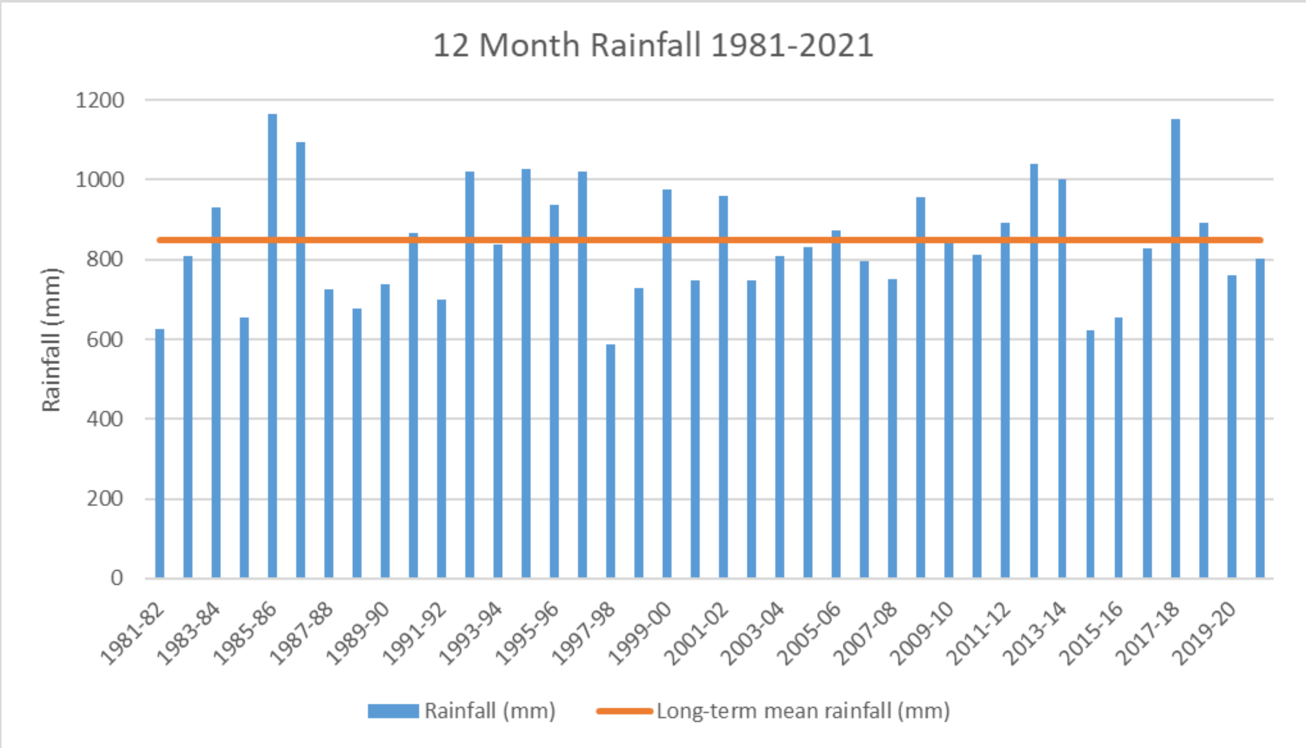


Figure 12. Rainfall record at NIWA's Weather Station 4702, Hororata
Source NIWA Clifo Database.

Rainfall and Soil Moisture Deficit data generated from NIWA's weather station (4702) for the July 2017 to June 2021 period is shown in Figure 13 below. The soil at the weather station 4702 site could be classified as being severely dry for 113 days, with zero days rated as extremely dry, during the 1 July 2020 to 30 June 2021 period. Table 1 illustrates the soil moisture classification data from 2015-16 to 2020-21.

Table 1 Soil Moisture Classification at weather station 4072 from 2015-16 to 2020-21

Year	NIWA Soil Moisture Classification	
	Severely Dry (Days)	Extremely Dry (Days)
2015-16	76	8
2016-17	25	17
2017-18	28	0
2018-19	16	0
2019-20	57	42
2020-21	113	0

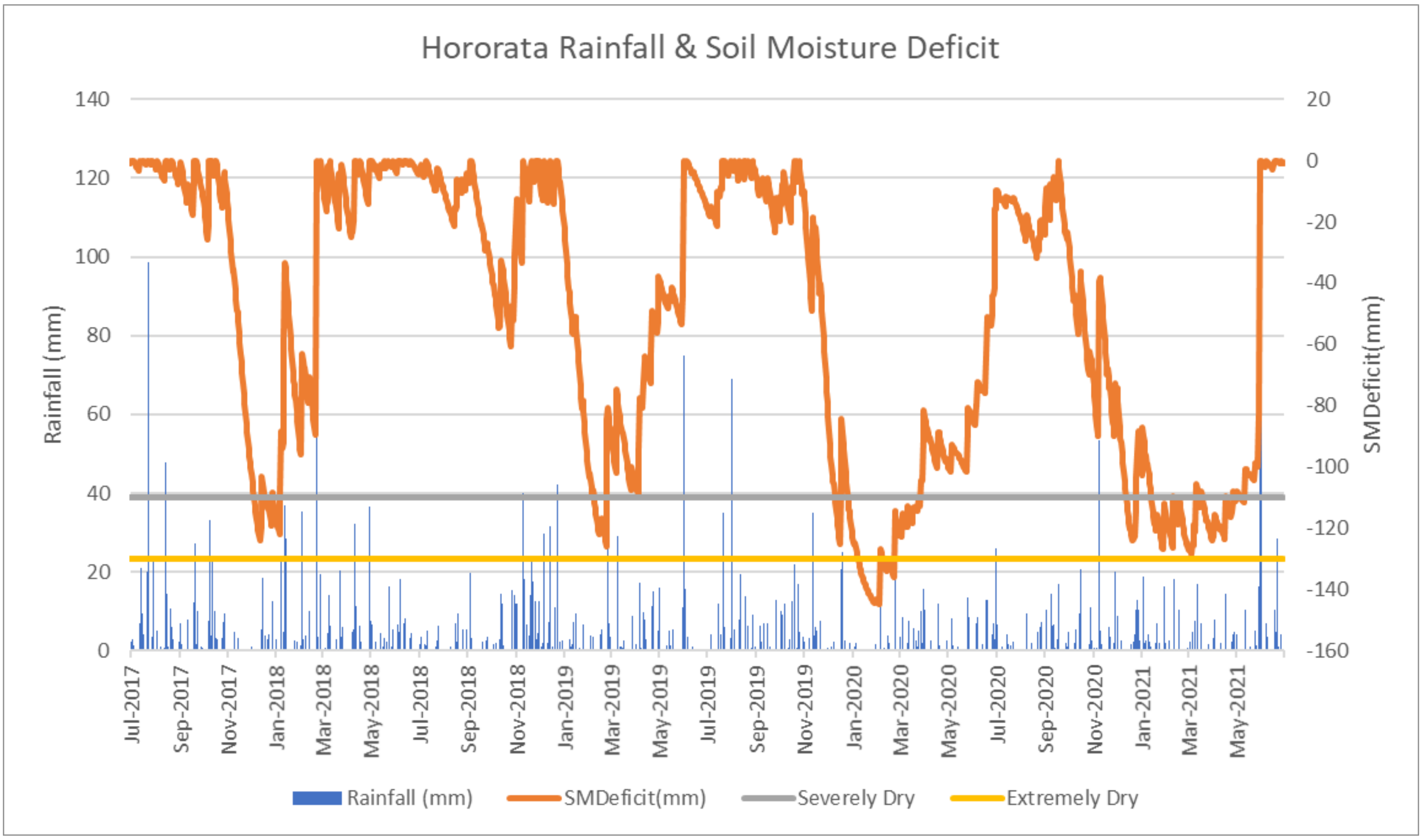


Figure 13. Rainfall and Soil Moisture Deficit Measured at NIWA's Monitoring Station in Hororata (unirrigated pasture).
Source NIWA Clifo Database.

4. Results & Interpretation

All monitoring data is listed, as required by CRC165680, appears in Appendices 6.3-6.6.

4.1. River and Stream Water Quality

CPWL has annual median, and annual 95th percentile, trigger limits for Nitrate-N. CPWL has surface water samples analysed for Nitrate + Nitrite-N. Like ECan and the majority of Regional Councils in New Zealand, CPWL monitors oxidised nitrogen as Nitrite-Nitrate-Nitrogen. Nitrite is not directly measured because of its transient nature and the very low concentrations that are present in Canterbury Rivers. When discussing surface (including lake) water quality monitoring results in this report, Nitrate-Nitrogen + Nitrite-Nitrogen will be referred to as Nitrate-N

CPWL River and Stream quality trigger levels are shown in Table 2 and the monitoring results are shown in Table 3 (NB: values depicted in red indicate trigger level exceedances). The number of samples collected, as reported in Table 2, is a reflection of flows in those waterways; samples can only be collected if the waterway is flowing. For example, the Irwell River source was found to be flowing on only six out of 12 occasions throughout monitoring period.

A maximum of 308 samples were able to be collected by CPWL and ECan during the 2019-20 monitoring period from the 25 sites displayed in Table 2 if all rivers and streams are flowing. During 2020-21 the total number of samples collected was 233. This compares to 251 out of 308 for 2019-20 and 279 out of a maximum 308 for 2018-19.

Table 2. Surface Water Quality Triggers for Nitrate-N in mg/L

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

Table 3. Surface Water Quality Nitrate-N Annual Medians and 95th Percentiles. Results in red indicate trigger exceedances.

Site	Site ID	2015-2016			2016-17			2017-2018			2018-2019			2019-2020			2020-2021			2020-21 Month of Peak Nitrate-N Conc-entration
		Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	Nitrate Annual Median (mg/L)	Nitrate Annual 95th percentile (mg/L)	No. of samples	
Hill-Fed Lower Sites																				
Hawkins River In-scheme	IS1	**1.9**	2.1	2	1.8	2.4	9	**2.69**	**3.11**	12	**2.30**	**2.83**	12	**2.44**	**2.66**	8	1.26	**2.95**	10	Jun-21
Waianiwaniwa River In-scheme	IS2	n/a	n/a	0	**4.4**	**4.4**	1	1.80	**3.05**	6	0.75	0.91	2	**2.26**	2.29	2	**2.96**	**2.96**	1	Jun-21
Selwyn River In-scheme	IS3	0.5	0.5	1	0.7	0.7	3	0.66	0.85	9	0.75	1.09	4	1.02	1.40	5	0.56	0.81	4	Jun-21
Hororata River In-scheme	IS4	1.1	1.4	6	1	1.5	12	**2.05**	**3.21**	12	1.79	2.15	12	**1.81**	**2.66**	12	1.42	2.07	12	Jun-21
Selwyn River @ SH1	SWSH	**2.8**	**2.8**	1	1.1	1.1	1	1.53	2.16	9	1.13	2.10	6	**2.10**	2.47	6	**1.96**	1.96	1	Jun-21
Hawkins River Upstream	US1	0.1	0.3	10	0.5	1.1	12	0.54	1.22	12	0.46	0.61	12	0.44	1.21	12	0.58	1.09	12	Jun-21
Waianiwaniwa River Upstream	US2	0.5	1	3	0.5	1.3	9	**1.87**	**2.78**	9	0.74	1.20	8	1.14	**2.83**	6	0.35	1.74	7	Jun-21
Selwyn River Upstream	US3	0.2	0.4	14	0.2	0.3	12	0.41	0.65	12	0.48	0.63	12	0.44	0.66	11	0.31	0.52	12	Jun-21
Hororata River Upstream	US4	0.2	0.7	10	0.7	1.4	12	1.09	1.34	12	0.79	1.18	12	0.64	1.07	12	0.21	0.90	12	Jun-21
Spring-Fed Plains Sites																				
Halswell River Source	SF1	3.7	4.4	10	3.3	3.8	12	3.14	3.48	12	3.55	3.77	12	3.29	3.64	12	2.96	3.42	12	Sep-20
LII Stream Source	SF2	4.9	5.2	10	4.2	4.6	12	4.09	4.18	12	4.13	4.45	12	4.39	4.72	12	4.06	4.26	12	Nov-20
Selwyn River Spring Source	SF3	**7.8**	**8.4**	10	**7.5**	**8.5**	11	4.94	6.30	12	**5.73**	**7.45**	12	**7.52**	**8.50**	12	**8.86**	**9.40**	12	Apr-21
Irwell River Source	SF4	2.2	2.8	2	1.8	3.4	4	1.95	3.31	12	1.72	2.42	10	2.14	3.01	7	1.46	4.93	6	Jun-21
Hanmer Road Drain Source	SF5	3.8	3.9	2	**7.8**	**7.8**	1	4.23	**7.96**	12	3.08	4.44	12	3.90	4.80	8	2.93	3.45	8	Sep-20
Boggy Creek Source	SF6	**6.4**	**8.5**	10	**8.3**	**12.2**	5	**8.10**	**12.89**	12	5.04	7.17	12	5.16	6.59	12	5.07	5.55	12	Jun-21
Doyleston Drain Source	SF7	n/a	n/a	0	n/a	n/a	0	**8.10**	**14.49**	12	**5.25**	**8.79**	12	**8.30**	**9.38**	6	**9.86**	**10.53**	2	Jun-21
Harts Creek Source	SF8	**9.2**	**9.3**	2	**8.7**	**8.8**	6	**8.40**	**9.41**	12	**9.19**	**10.25**	12	**9.69**	**10.51**	10	**10.20**	**10.37**	4	Aug-20
Halswell River Downstream	T1	2.9	3.2	10	2.5	3	12	2.34	2.66	12	2.51	2.82	12	2.43	2.64	12	2.06	2.49	12	Aug-20
LII Stream Downstream	T2	3.4	3.9	10	2.9	3.3	12	3.10	3.55	12	3.80	4.00	12	3.35	3.60	12	3.30	4.09	12	Nov-20
Selwyn River Downstream	T3	**6.5**	6.8	14	**6.1**	**7.5**	12	5.05	6.65	12	**6.15**	**7.50**	12	**7.25**	**7.69**	12	**7.45**	**8.55**	12	Aug-20
Irwell River Downstream	T4	0.03	2	4	<0.01	4.8	4	1.93	4.87	12	0.93	1.92	12	1.62	2.53	9	0.02	3.20	6	Aug-20
Hanmer Road Drain Downstream	T5	1.1	2.1	4	<0.01	3.6	9	3.40	6.85	12	2.04	3.67	12	3.02	4.05	9	1.08	2.29	8	Jul-20
Boggy Creek Downstream	T6	4.5	6.4	14[A]	3.8	**8.5**	16[A]	**8.18**	**10.74**	15[A]	4.50	5.81	16[A]	4.90	5.61	16[A]	4.80	5.14	16[A]	Apr-21
Doyleston Drain Downstream	T7	0.2	1.3	14[A]	0.4	3.2	16[A]	**5.72**	**10.55**	15[A]	4.63	6.67	16[A]	0.74	5.94	16[A]	0.23	4.93	16[A]	Jun-21
Harts Creek Downstream	T8	**6.7**	7.3	14	**7**	7.3	12	**7.55**	**7.89**	12	**8.05**	**8.35**	12	**7.80**	**8.25**	12	**7.55**	**8.15**	12	Aug-20

[A] Includes ECan monitoring data. NB: Nitrate-N results supplied to 1 decimal place in 2014-15 and 2015-16 and 2 decimal places from 2017-18.

Both the annual median, and annual 95th percentile, trigger limits were exceeded at six monitoring sites, one site exceeded only the 95th percentile trigger and one site exceeded only the annual median trigger level. Table 4 summaries the annual trigger exceedances since CPWLs monitoring programme commenced. Figure 14 spatially depicts which sites experienced trigger level exceedances during 2020-21.

Table 4. Surface Water Quality Nitrate-N Annual Medians and 95th Percentiles Trigger Exceedances to June 2021

Period	Exceeded both triggers	Exceeded 95th % trigger	Exceeded Annual median trigger	Total site with at least one trigger exceeded
2020-21	6	1	1	8
2019-20	7	1	2	10
2018-19	6	0	0	6
2017-18	9	2	0	11
2016-17	6	1	1	8
2015-16*	4	0	3	7

* 10-month period Sept 2015 to June 2016.

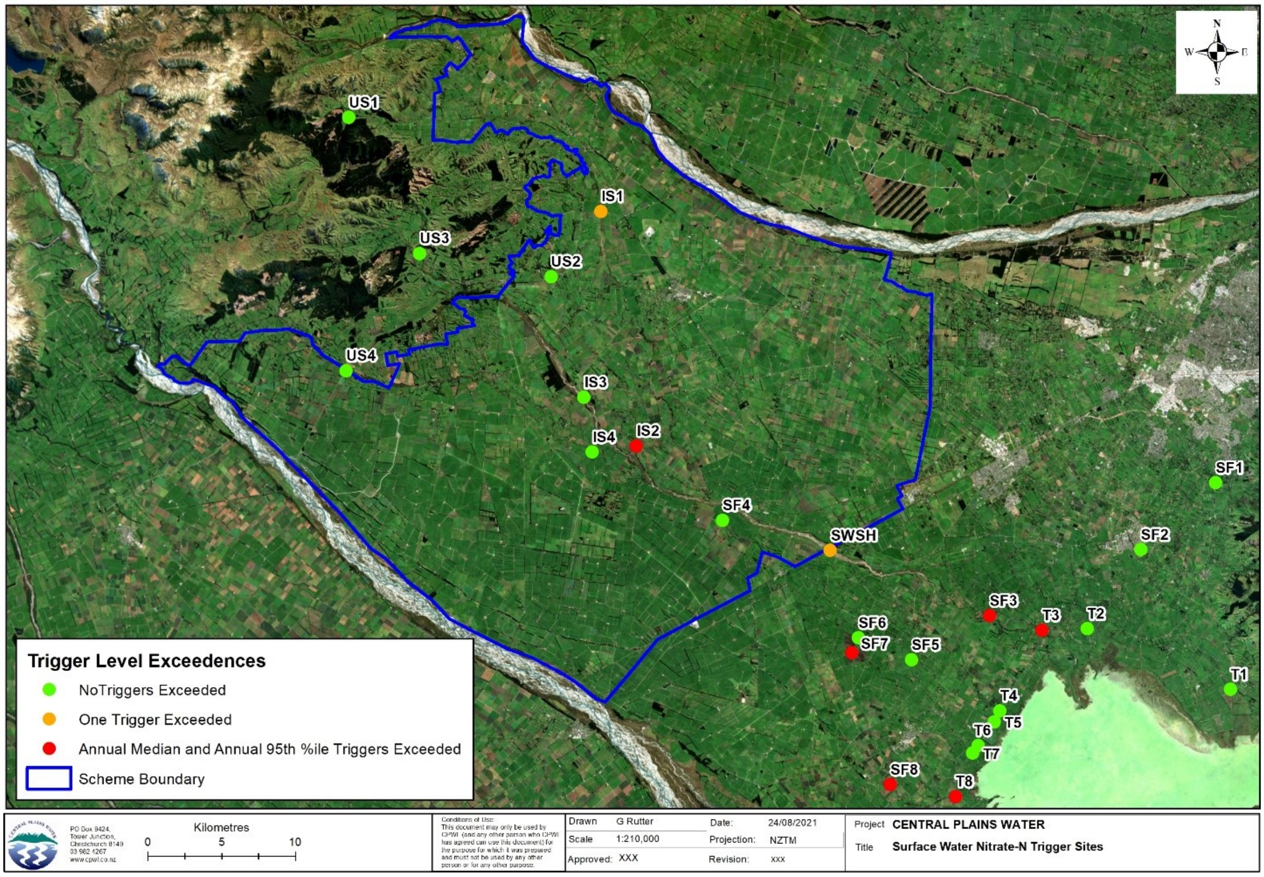


Figure 14. Surface Water Nitrate-N Trigger Level Exceedances

The trigger exceedances were from five waterways, Hawkins River, Waianiwaniwa River, Selwyn River, Doyleston Drain and Harts Creek. These five waterways have all had trigger exceedances during at least one of the previous monitoring periods.

No monitoring sites have shown a trigger level exceedance for the first time for the 2020-21 monitoring period.

Results presented in Part II of CPWL Ground and Surface Water Monitoring Plan also highlighted elevated nitrate readings, prior to commencement of CPWL irrigation, from sites in the Hawkins River, Selwyn River, Doyleston Drain and Harts Creek that would have exceeded CPWL's trigger limits when based on 2014 and/or 2010-15 data.

HILL-FED LOWER SITES - Annual Median Nitrate-N Trigger = 1.8mg/L, 95th%ile Trigger = 2.6mg/L

Three Hill-Fed Lower sites exceeded a trigger level for 2020-21 compared to five in 2019-20.

The Hawkins River at the Deans Road location, monitored by ECan (within the CPWL Scheme but upstream of CPW monitoring site IS1) had a higher annual median (1.60mg/L vs 1.26mg/L) and an identical annual 95th percentile (2.95mg/L) Nitrate-N concentration compared to CPWL's Hawkins River instream site (IS1) (located 3.5km downstream) during 2020-21 (refer to Figure 15).

Annual 95th Percentile Nitrate concentrations measured at the ECan, and CPWL In-scheme, locations in the Hawkins River were similar in the 2020-21, 2019-20 and 2018-19 periods. The Annual Median concentrations were either the lowest (CPW) or the second lowest (ECan's result in 2005-06 was 1.45mg/L) since records began.

A review of historic ECan data for the Deans Road site shows that although the Annual 95th Percentile, for 2020-21, exceeded the trigger level, the results fit within those recorded prior to operation of the Sheffield Scheme.

For both the ECan and CPW monitoring programmes, it was the respective June 2021 results that raised the Annual 95th Percentile above the trigger level as all other discrete monthly results were less than 2.6mg/L.

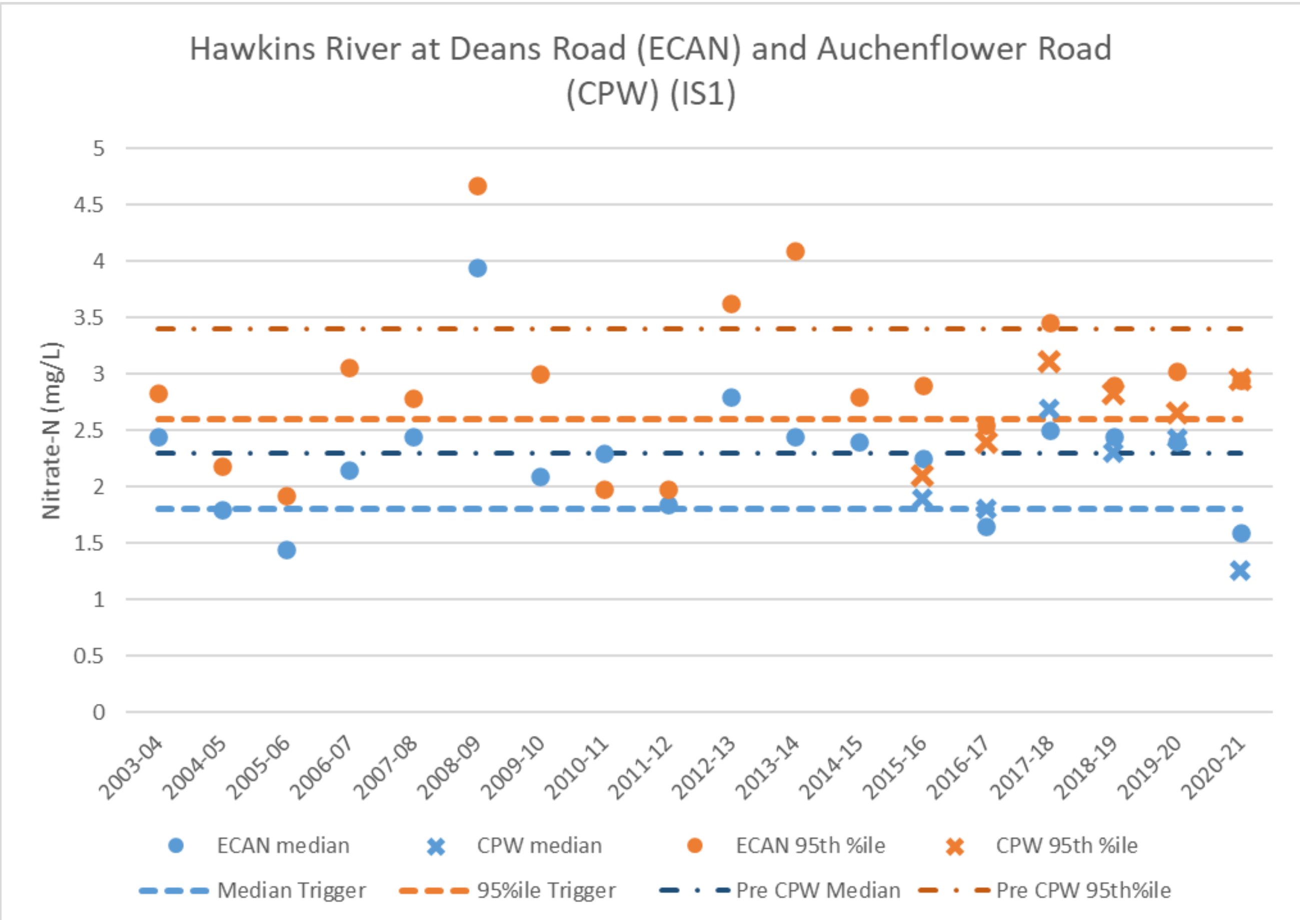


Figure 15. Hawkins River at Deans and Auchenflower (IS1) roads – Nitrate-N concentrations 2003-04 to 2020-21

During 2020-21, the Waianiwaniwa River at Coaltrack Road (IS2) and the Selwyn River at State Highway One (SWSH) were found to be flowing during the June 2021 monitoring round only. The Nitrate-N concentrations recorded were greater than the Annual Median and Annual 95th Percentile trigger level concentrations for IS2, and greater than the Annual Median trigger level concentration for SWSH. Higher Nitrate-N concentrations have previously been recorded at both sites, however there is no pre-CPWL monitoring data for which to make further comparisons against.

A possibly emerging upward trend in the Nitrate-N concentration for the Selwyn River In-Scheme site (IS3) identified in the 2019-20 report has weakened following inclusion of 2020-21 results (Refer to Figure 16).

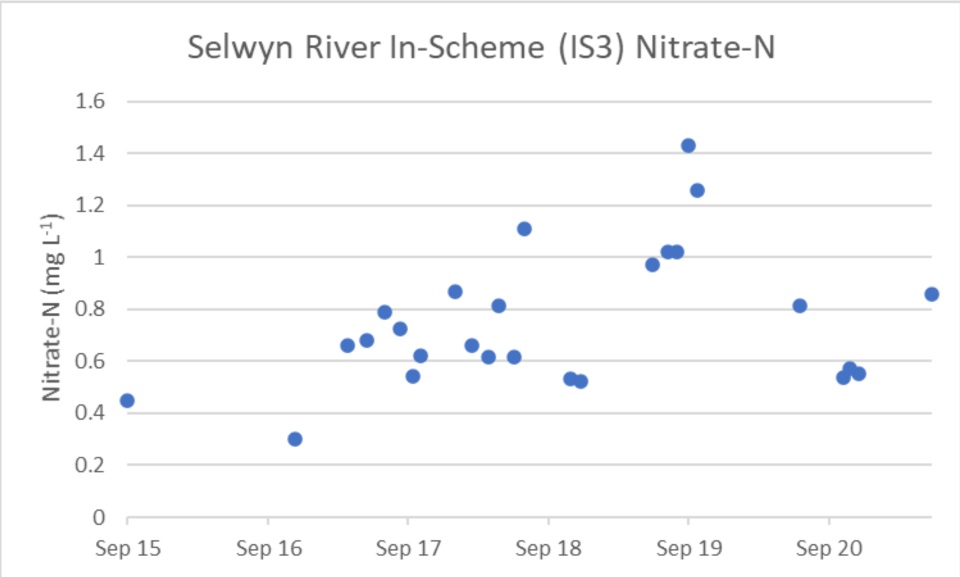


Figure 16. Selwyn River In-scheme (IS3) Nitrate-N concentrations 2015-16 to 2020-21

SPRING-FED PLAINS SITES - Annual Median Trigger = 5.2mg/L, 95th%ile Trigger = 7.4mg/L

Both annual median and annual 95th percentile Nitrate-N triggers were exceeded for the Selwyn River sites SF3 ('Spring Source' at Chamberlains Ford) and T3 ('Discharge' site at Coes Ford), Harts Creek at SF8 ('Spring Source' and T8 ('Discharge') and at the Doyleston Drain SF7 ('Spring Source '). The same triggers at the same monitoring sites were also exceeded for the 2019-20 and 2018-19 monitoring periods.

Annual Median and Annual 95th percentile Nitrate-N concentrations for site SF3 in 2020-21 were the highest measured to date (Refer to Figure 17).

The Annual Median and Annual 95th Percentile Nitrate-N concentrations at SF3 had been rising following the higher rainfall, 2017-18 period where concentrations showed a noticeable decrease on the previous two years. The Nitrate-N concentration of 3.05mg L^{-1} recorded for June 2021 was the lowest concentration measured in two and a half years.

It will be interesting the see whether the Nitrate-N concentration at SF3, following the significant rain event at the end of May/beginning of June 2021, follows a similar pattern to that observed following the significant rain event of July 2017.

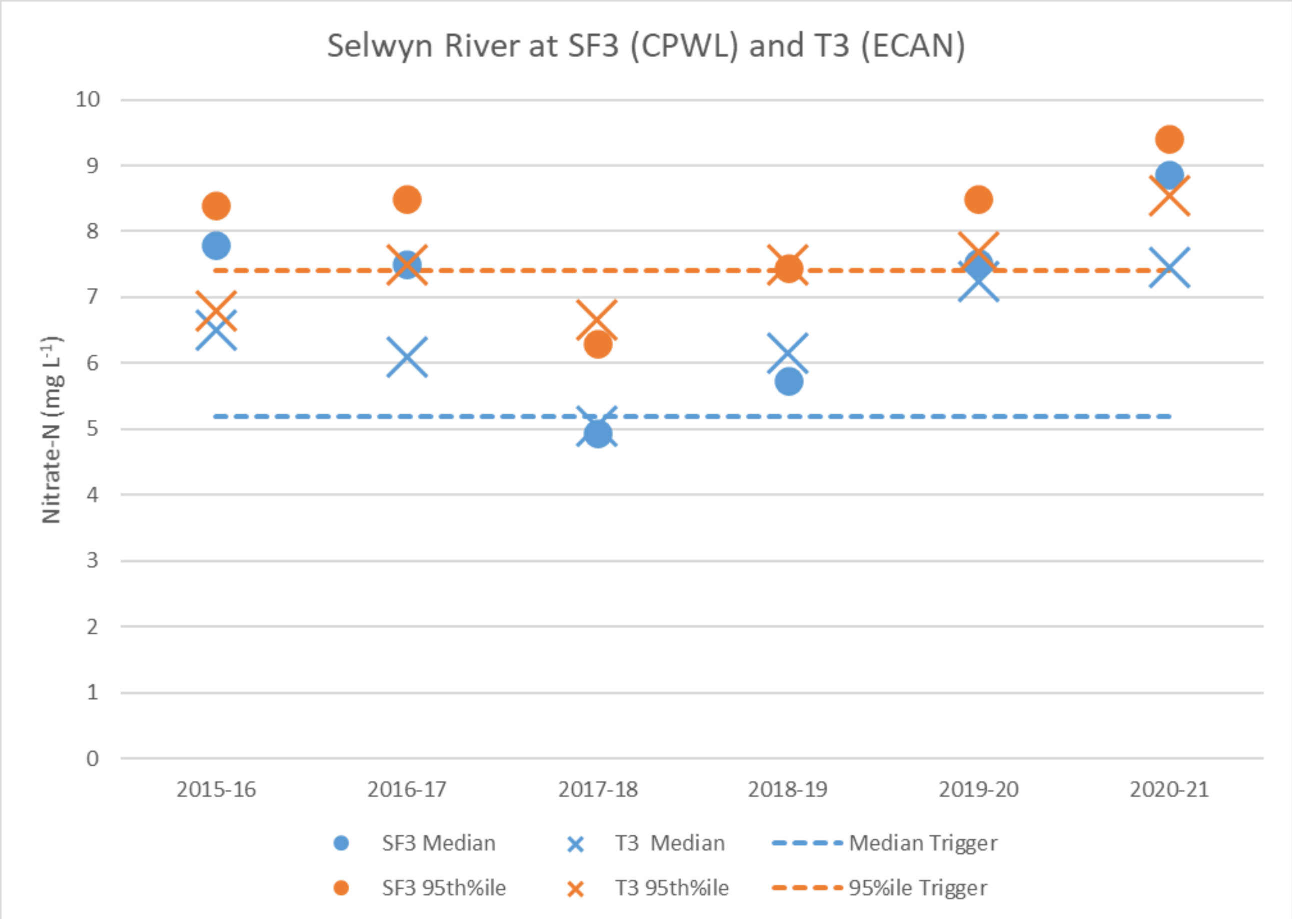


Figure 17. Selwyn River Spring Source (SF3) and Downstream (T3) location – Annual Nitrate-N concentrations 2015-16 to 2020-21

At 7.45 mg L^{-1} and 8.55mg L^{-1} the Annual Median and Annual 95th Percentile Nitrate-N concentrations at T3 were the highest recorded to date. Figure 18 shows both the Annual Median and 95th Percentile concentrations have been generally steadily increasing since 1992-93. Therefore, the trigger level exceedance may be due to the (deteriorating) baseline water quality i.e. the lag effect from historic farming practices, and it is not yet possible to conclude what contribution the CPWL related activities make. Further monitoring will allow closer examination of this trend in future.

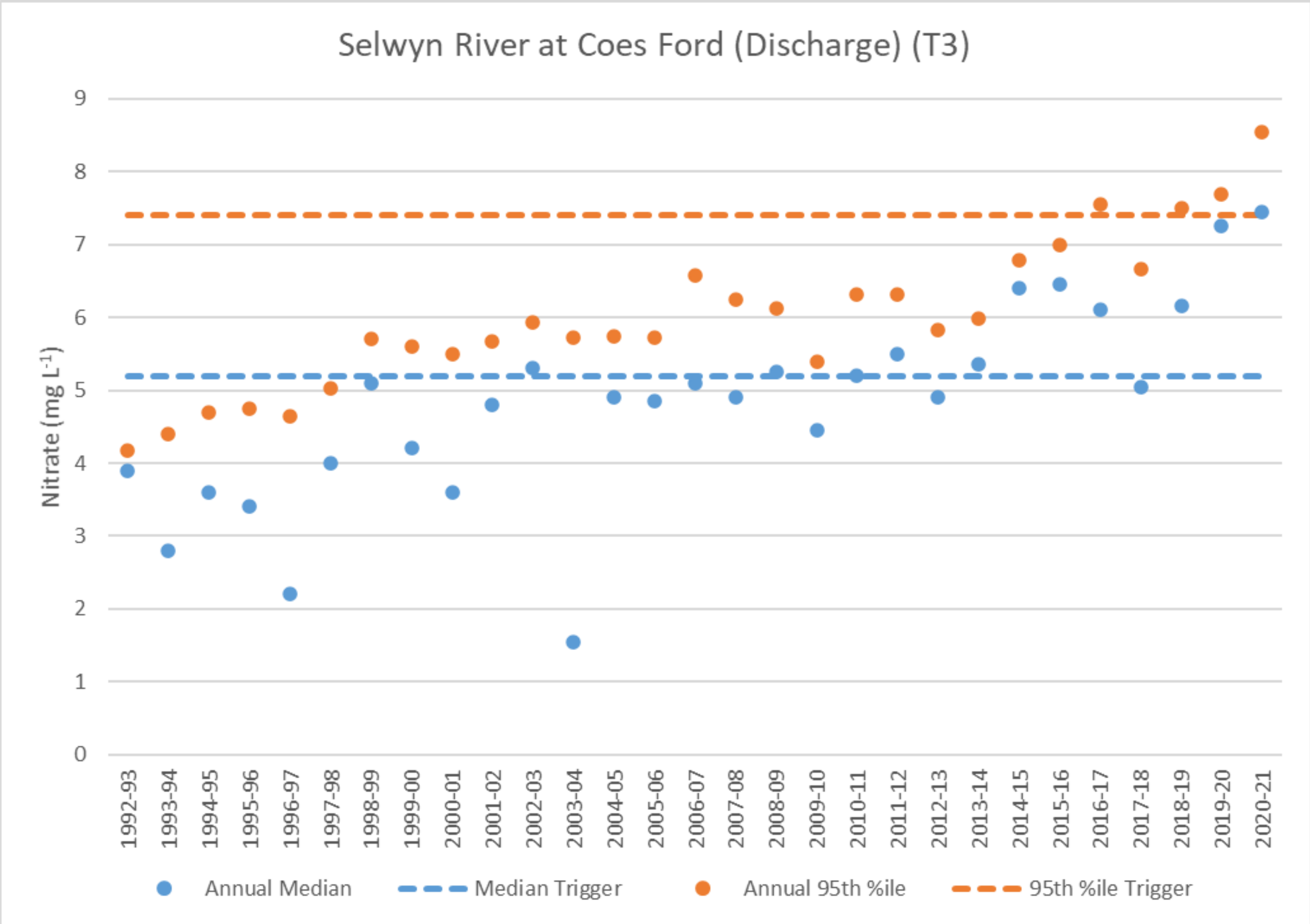


Figure 18. Selwyn River Downstream (T3) location – Annual Nitrate-N concentrations 1992-93 to 2020-21

The Doyleston Drain Spring Source site (SF7) was found to be flowing during two monitoring rounds in the 2020-21 period. Therefore, its Annual Median and Annual 95th Percentile Nitrate-N concentrations cannot be considered robust.

From the commencement of the surface water monitoring programme in September 2015, through to the 27 June 2017 monitoring round, SF7 was never observed to be flowing. Following a significant heavy rain event during 20-22 July 2017, SF7 was found to be flowing on 25 July 2017. It continued to be flowing at each monitoring round up until the December 2019 round. Post the December 2019 round, SF7 has only been found flowing during July 2020 and June 2021.

Figure 19 shows the discrete monthly Nitrate-N concentrations and corresponding flows recorded at SF7 to date. There are only four 12-month periods containing monitoring data for site SF7, so more information is needed to confirm whether any trend in Nitrate-N concentration is developing. Prior to the results from 2020-21, the Nitrate-N concentration appeared to be related to flow rate.

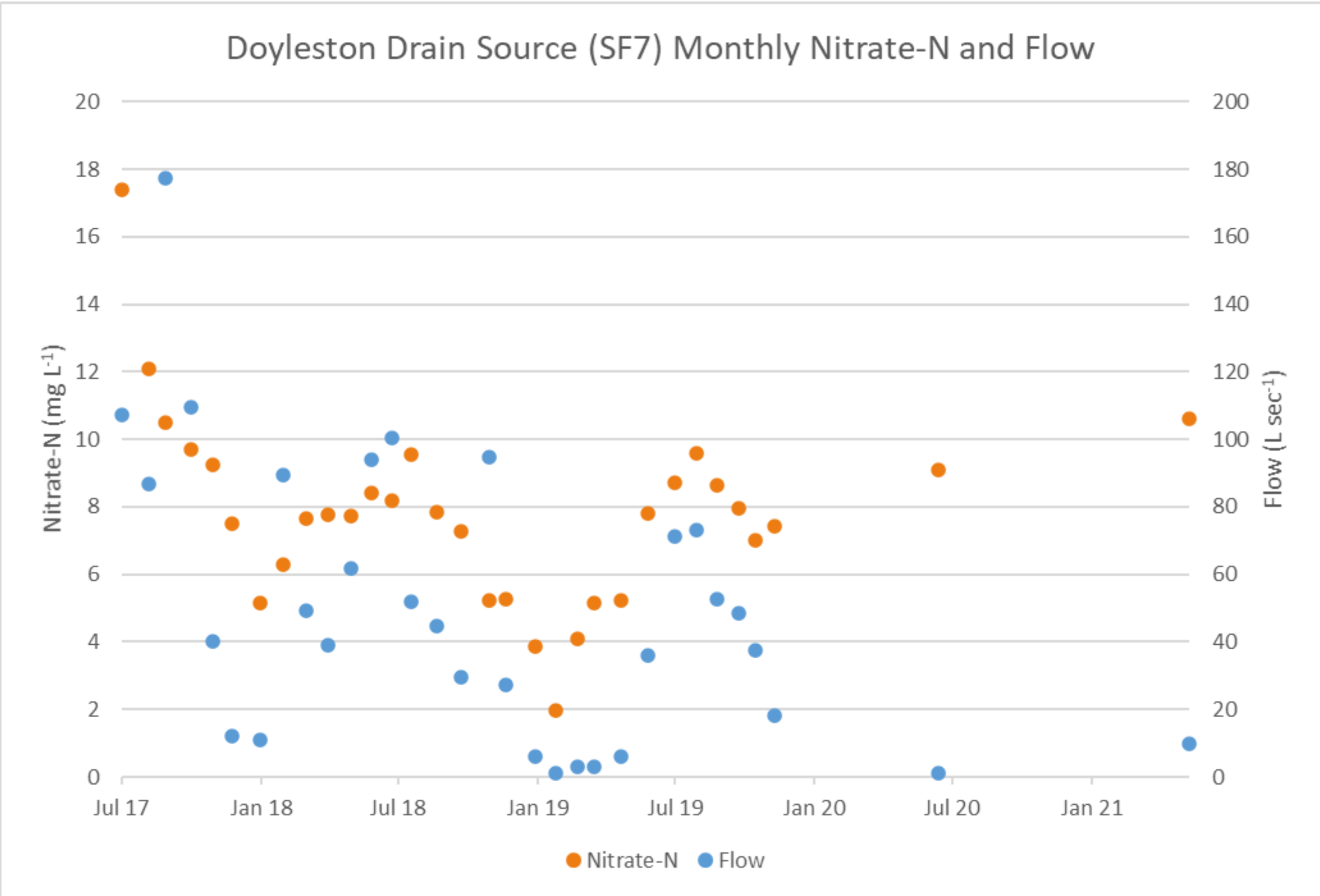


Figure 19. Doyleston Source location –Spot Nitrate-N concentrations and flow July 2017 to June 2021

For the two applicable rounds during 2020-21, Nitrate-N concentrations continued to be found at higher concentrations at site SF7 compared to the downstream site T7 (refer to Figure 20). This is potentially due to the uptake of nutrients by periphyton and aquatic plants and/or the dilution of groundwater inflows that have been denitrified as they seep upwards through low permeability confining sediments.

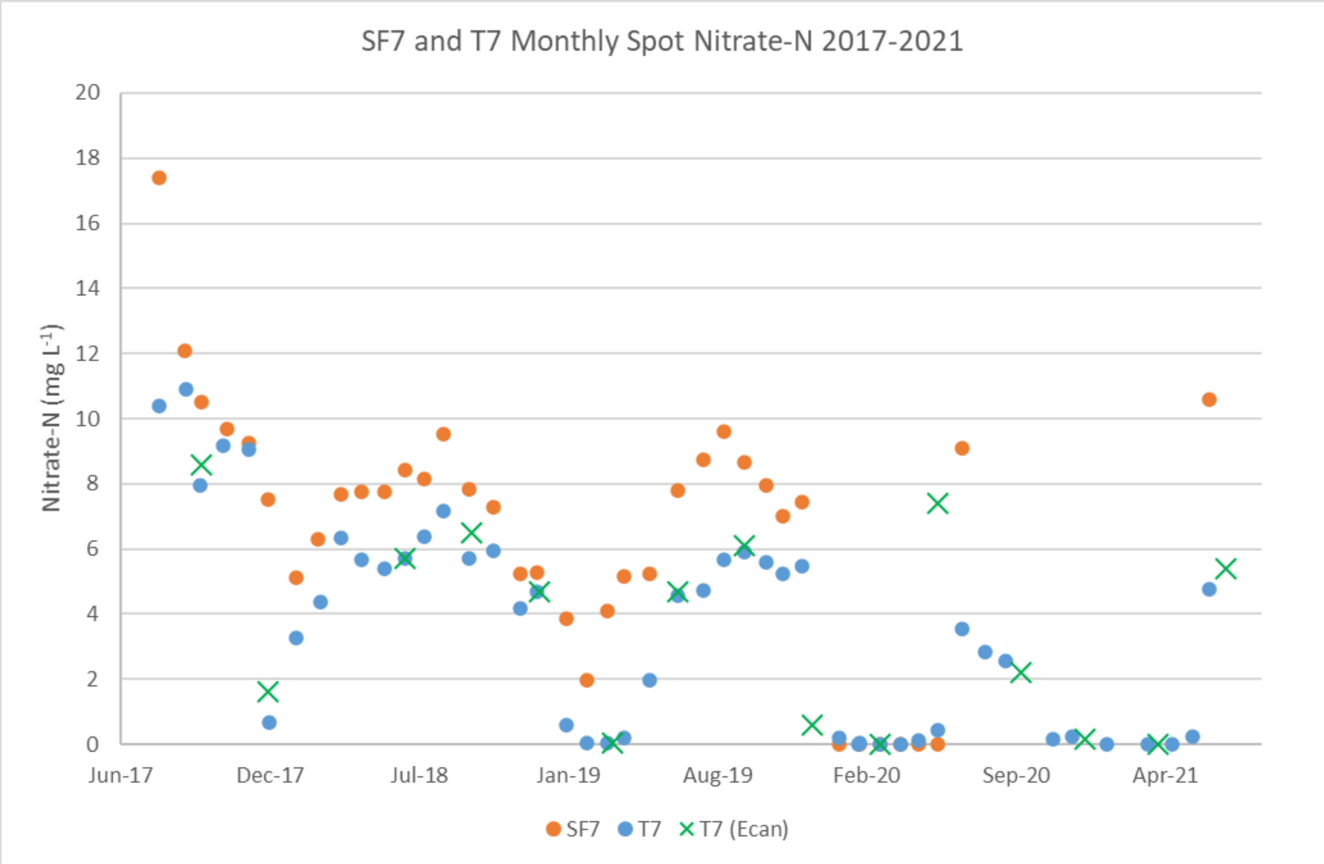


Figure 20. Doyleston Drain Source and Discharge locations – Discrete Monthly Nitrate-N concentrations 2017-21.

NB: Samples for paired SF7 and T7 sites were taken on the same day for all monitoring rounds from 26-03-2018. Nitrate-N concentrations of <0.005 and <0.002mgL^{-1} are plotted in Figure 20 as 0.005 and 0.002mgL^{-1}.

Annual Median and 95th Percentile Nitrate-N concentrations both exceeded trigger levels at the Harts Creek Source (SF8) and Discharge (T8) sites during 2020-2021 (refer to Figure 21) with the 2020-21 Annual median Nitrate-N concentration at SF8 being the highest measured so far.

Spot Nitrate-N concentrations at the downstream Harts Creek Discharge (T8) site have been found to be consistently lower than those from the Source site, SF8 (Refer to Figure 22). On one occasion where the Nitrate-N concentration at T8 was found to be greater than at SF8 (April 2020), the flow at SF8 was the lowest that water quality sampling has been carried out at to date (0.1L sec^{-1}). NB: SF8 Nitrate-N concentrations were however, found to be greater than the corresponding T8 concentration, on ten occasions when the flow at SF8 was between 1 and 7 L sec^{-1}.

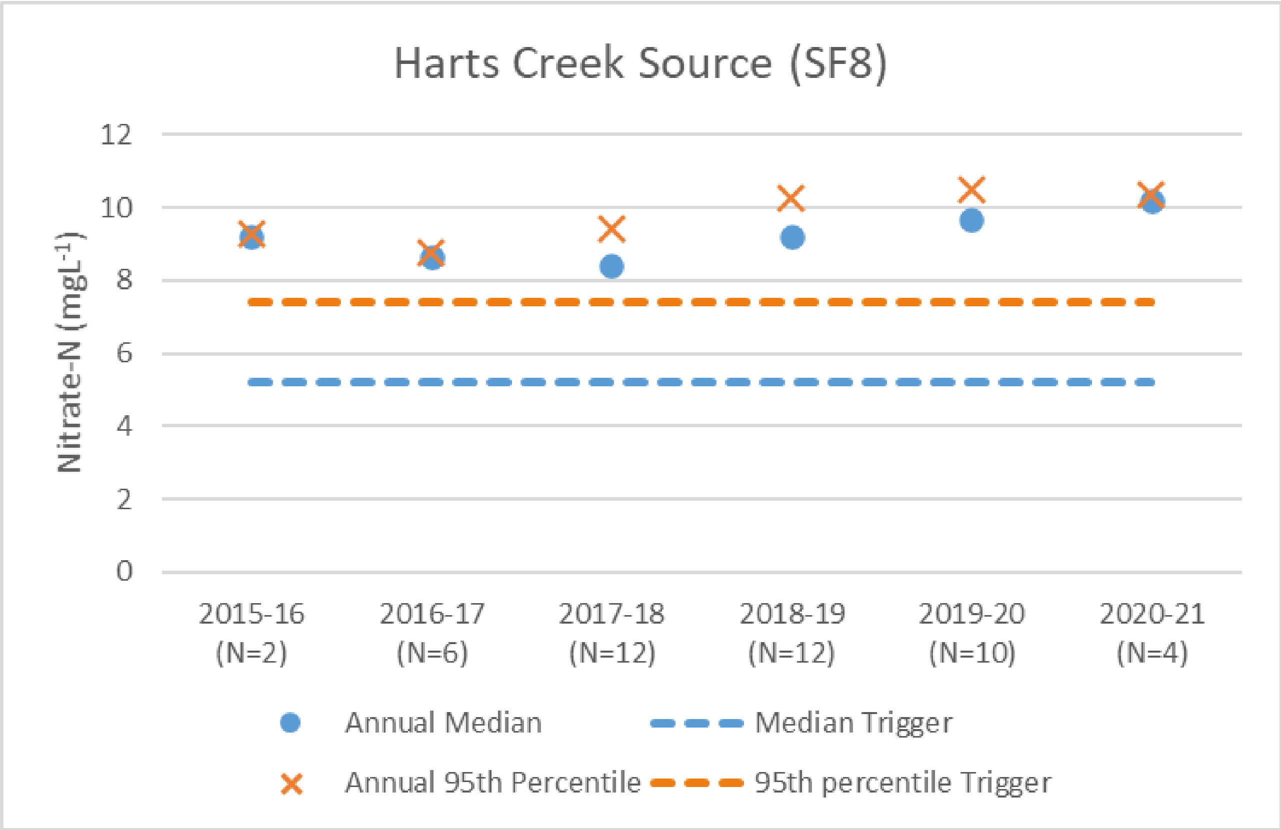


Figure 21. Harts Creek Source location – Nitrate-N concentrations 2015-16 to 2020-21

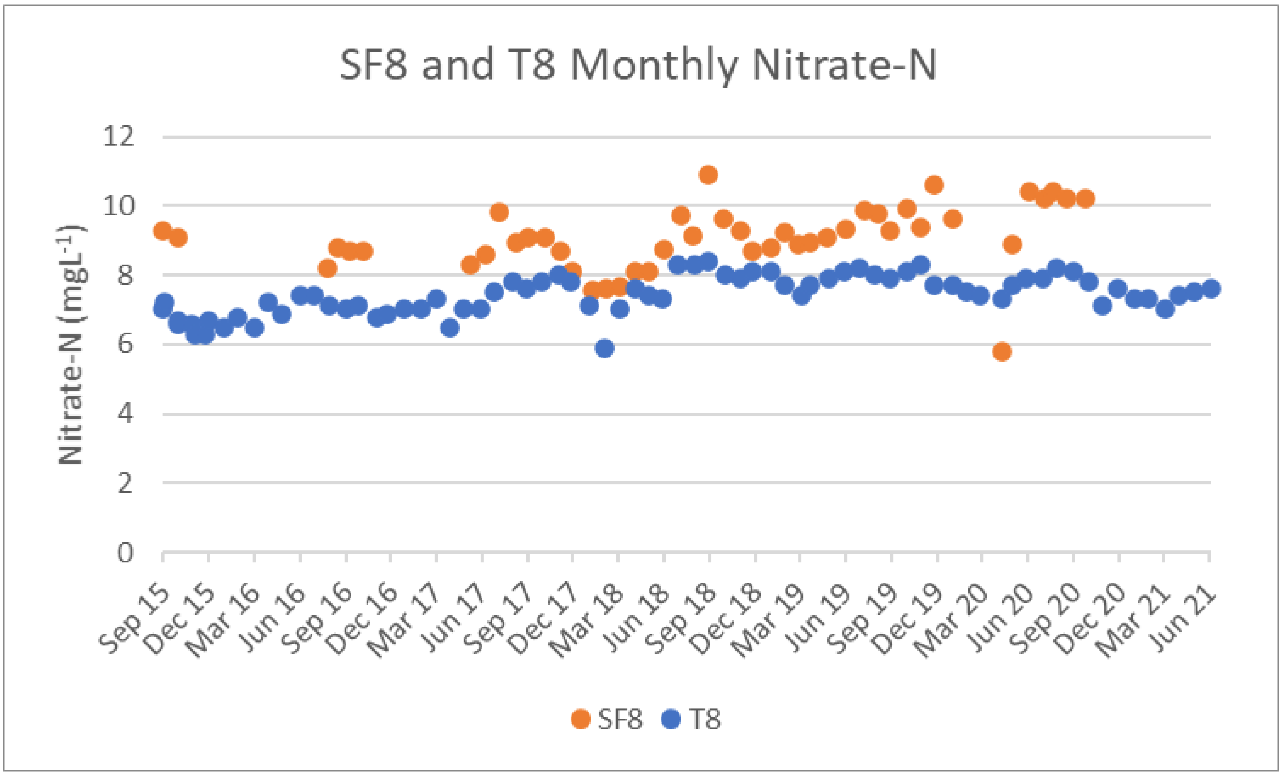


Figure 22. Harts Creek Source and Discharge locations – Discrete Monthly Nitrate-N concentrations from September 2015.

NB: Data gaps for site SF8 represent times when the Creek was dry.

A review of Annual Median and Annual 95th Percentile Nitrate-N data from site T8 as far back as the 1994-95 period (refer to Figure 23) shows that the 2020-21 Annual Median Nitrate-N concentration [7.55mg L^{-1}] was the third equal highest measured to date, with the four highest results all coming in the last four 12-mouth monitoring periods. At 8.15 mg L^{-1}, the 2020-21 Annual 95th Percentile Nitrate-N concentration was the fourth highest recorded to date. Only the 2013-14 [8.4 mg L^{-1}], 2018-19 [8.35mg L^{-1}] and 2019-20 [8.25 mg L^{-1}] values were greater.

Both annual median and annual 95th percentile Nitrate-N concentrations at T8 have been increasing since the mid 2000's (refer to Figure 23) and the Mann Kendall trend test confirms the trends are statistically significant (P = .00000003 and P = 0.000001), albeit the magnitude of the seasonal slopes decreased by a small degree following the addition of 2020-21 data.

The trigger level exceedances at T8 may be due to the (deteriorating) baseline water quality and it is not yet possible to conclude what contribution the CPWL related activities make. Further monitoring will allow closer examination of this trend in future. Results from 2020-21 marks the first period since 2015-16 whereby Nitrate-N concentrations have not increased from those of the year before.

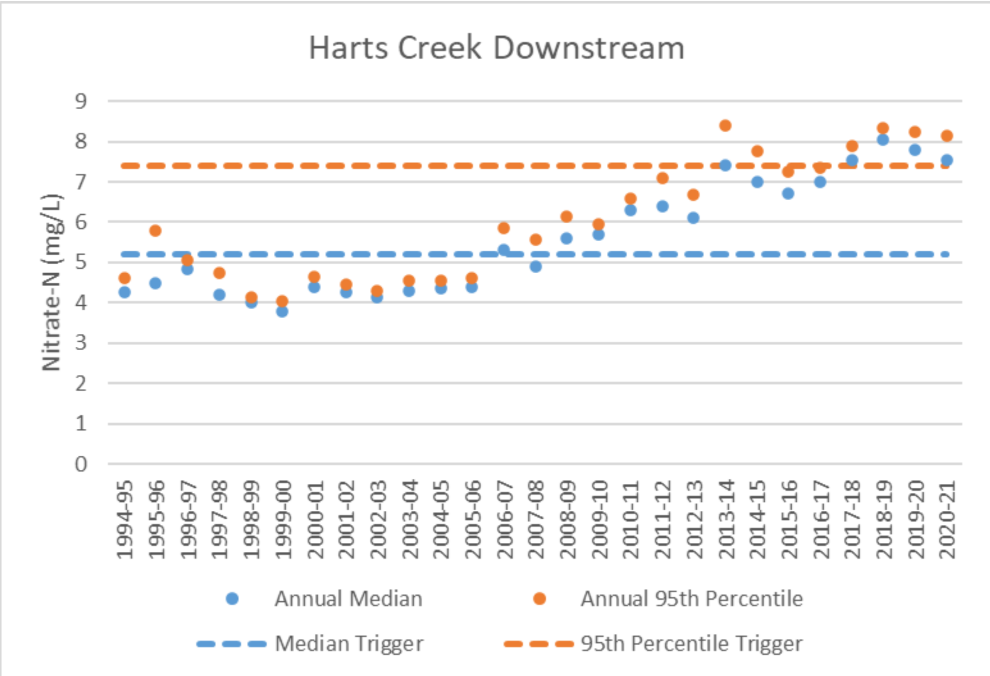


Figure 23. Harts Creek Discharge (T8) location – Nitrate-N concentrations 1994-95 to 2020-21

4.2. Lake Water Quality

The trigger levels for Lake Water Quality are listed in Table 5. The trigger levels have been taken from the water quality limits contained in Table (l) of the Land and Water Regional Plan.

Table 5. Lake Water Quality Triggers

Monitoring Location	**Chlorophyll *a* (µg/L)[b]**	**Total Phosphorus (mg/L)[b]**	**Total Nitrogen (mg/L)[b]**	**TLI[a]**
Mid-Lake	74	0.1	3.4	6.6
Lake Margins	no trigger	no trigger	no trigger	6

(a) TLI (Trophic Level Index) assumed to be calculated as TLI3 (using TP, TN and chl a)

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

During the 1 July 2020 to 30 June 2021 period, 11 rounds of data were collected by Environment Canterbury.

The total phosphorus trigger limit is an annual average of no more than $0.1mgL^{-1}$. The 12-month average for total phosphorus at the Mid Lake monitoring site was $0.21mgL^{-1}$.

The Chlorophyll *a* trigger limit is an annual average of no more than 74µg/L. The 12-month average for Chlorophyll *a* at the Mid Lake monitoring site was $122\mu gL^{-1}$. (see Table 6, NB: data in red indicates an exceedance of the applicable trigger limit).

Table 6. Lake Water Quality Monitoring Results 2020-2021

Te Waihora Site	Chlorophyll a (µg/L)	Total Phosphorus (A) (mg L^{-1})	Total Nitrogen (A) (mg L^{-1})	TLI_3
Mid Lake	**122**	**0.21**	2.69	**7.09**
Lake Margin Sites				
• Kaituna Lagoon (B)	90	0.23	2.17	6.91
• Off Selwyn River Mouth	127	0.20	2.84	**7.10**
• South of Timber Yard	128	0.20	2.67	**7.07**
• Taumutu	128	0.20	2.84	**7.10**

[A] Annual Mean

[B] Kaituna Lagoon is included for comparison only; it is not a trigger level site.

ECan has generally monitored the Mid Lake location on at least a monthly basis since July 1993. From July 1993 the mean annual (July to June) Total Phosphorus level has been 0.24mg L^{-1} (Figure 24).

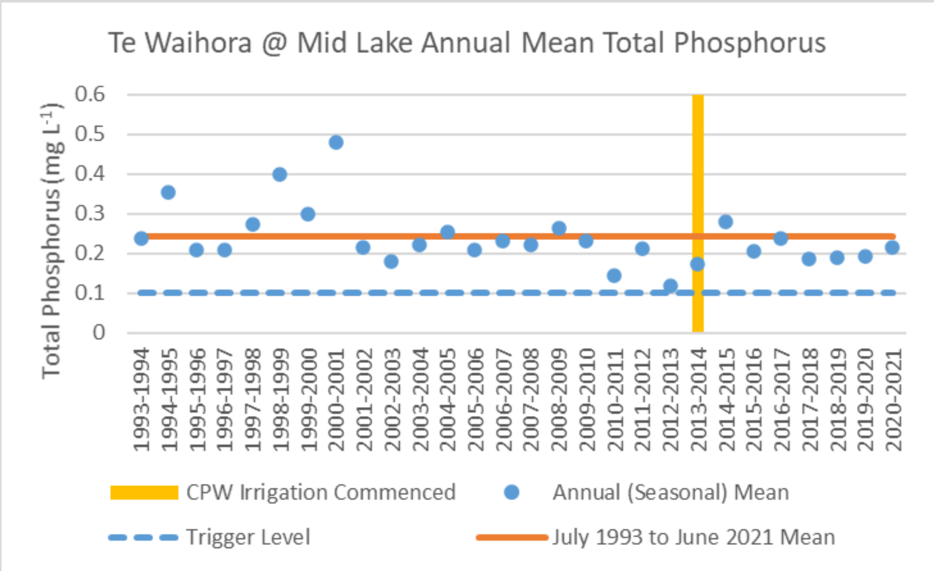


Figure 24. Total Phosphorus at Mid Lake in Te Waihora from 1993 - 2021

Figure 24 suggests that although the result for Total Phosphorus at 'Mid Lake' for 2020-2021 exceeded the trigger level, the level is not inconsistent with previous years' (pre CPWL scheme operation) results that ranged between 0.12mg/L and 0.48mg/L between 1993-94 and 2014-15. CPWL therefore suggests the exceedance of the phosphorus trigger at Mid Lake is consistent with elevated baseline levels and it is not possible to attribute any change resulting from CPWL related activities. Further monitoring will allow ongoing examination of any trends in future.

The mean annual (July to June) Chlorophyll *a* level since 1993-94 is 87μg L^{-1} (Figure 25).

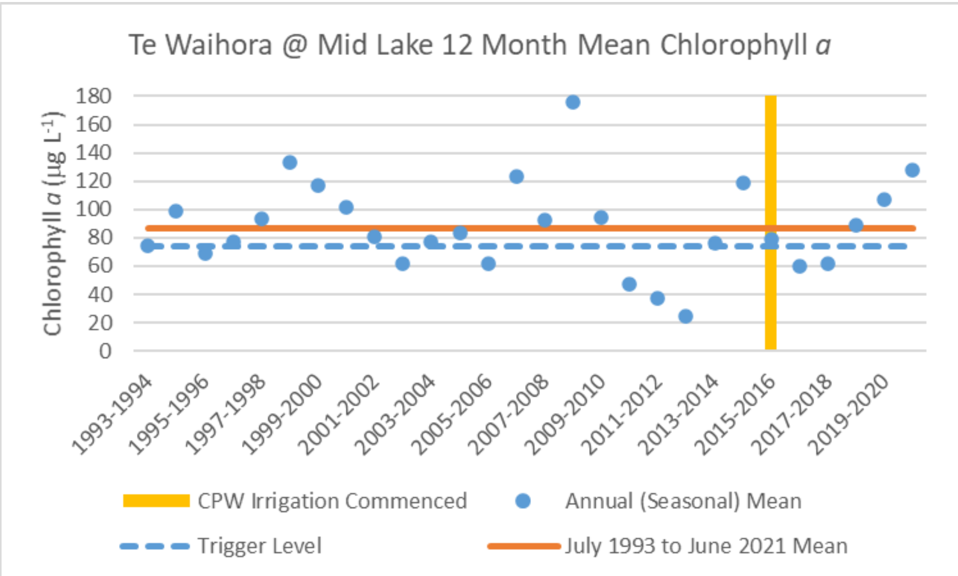


Figure 25. Chlorophyll *a* at Mid Lake in Te Waihora from 1993 - 2021

Figure 25 suggests that although the result for Chlorophyll *a* at 'Mid Lake' for 2020-2021 exceeded the trigger level, the level is not inconsistent with previous years' (pre CPWL scheme operation) results that ranged between 25µg L^{-1} and 176µg L^{-1} between 1993-94 and 2014-15. CPWL therefore suggests the exceedance of the Chlorophyll *a* trigger at Mid Lake is consistent with elevated baseline levels and it is not possible to attribute any change resulting from CPWL related activities. Further monitoring will allow ongoing examination of any trends in future. The 12-month mean Chlorophyll *a* concentration has increased for every 12-month period following 2016-17. While there have been similar multi-year increases in the past, the 12-month mean Chlorophyll *a* concentration will require increasing scrutiny should this trend be maintained.

The Trophic Level Index (TLI_3) is an indicator of lake water quality specifically developed for New Zealand lakes. The TLI_3 is derived from a number of water quality measures including total nitrogen, total phosphorus and chlorophyll *a* (found in Phytoplankton). Triggers were exceeded at all lake water monitoring sites (see Table 6).

A review of monitoring data from the Mid Lake monitoring site from 1997-98 (Monthly monitoring of Total Nitrogen (needed for TLI_3 calculation) started in October 1996)) (see Figure 26), illustrates that it is not possible to attribute any change resulting from CPWL related activities on Mid Lake TLI_3 trigger level exceedances.

The 12-month mean TLI_3 has increased for every 12-month period following 2017-18. While there have been similar multi-year increases in the past, the 12-month mean TLI_3 will require further scrutiny should this trend be maintained.

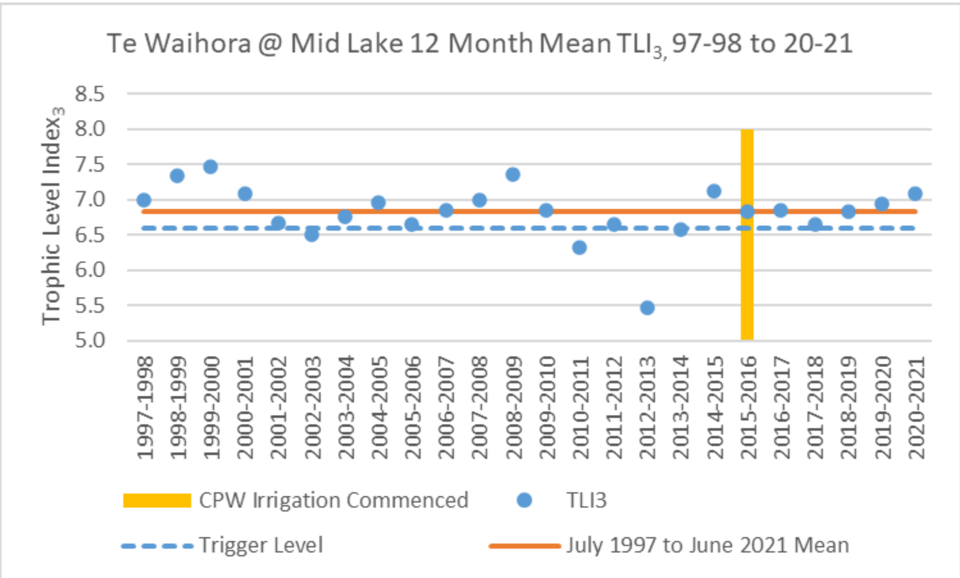


Figure 26. Trophic Level $Index_3$ at Mid Lake in Te Waihora from 1997 – 2021

A review of monitoring data from the three Lake Margin sites from 1997-98 (refer to Figure 27), that have trigger levels, also suggests that it is not possible to attribute any change resulting from CPWL related activities on Lake Margin TLI_3 trigger level exceedances.

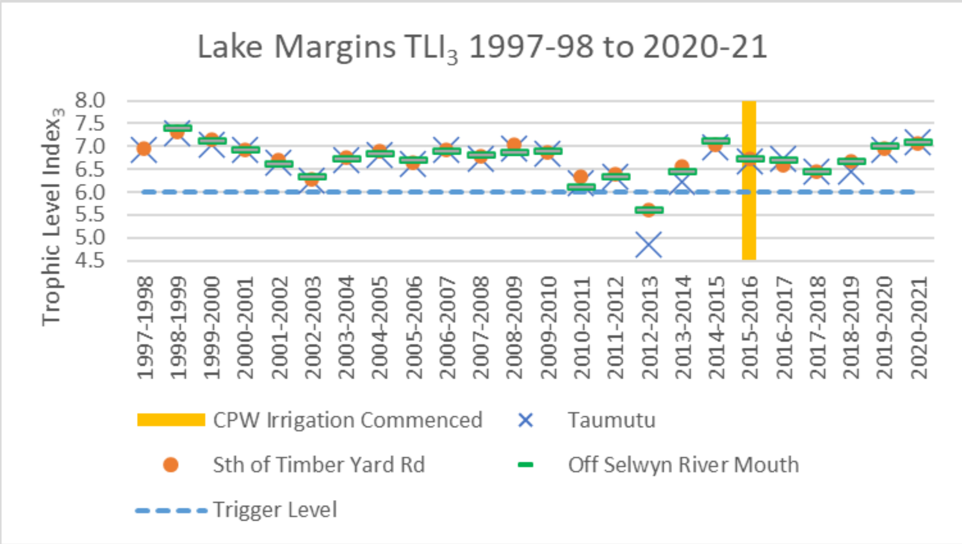


Figure 27. Trophic Level Index $_3$ at Lake Margins in Te Waihora from 1997 – 2021

Since 1997-98, the Total Nitrogen 12-month mean for the Mid Lake site has only exceeded the 3.4mg L^{-1} trigger limit on two occasions, 1999-2000 and 2000-2001 (refer to Figure 28).

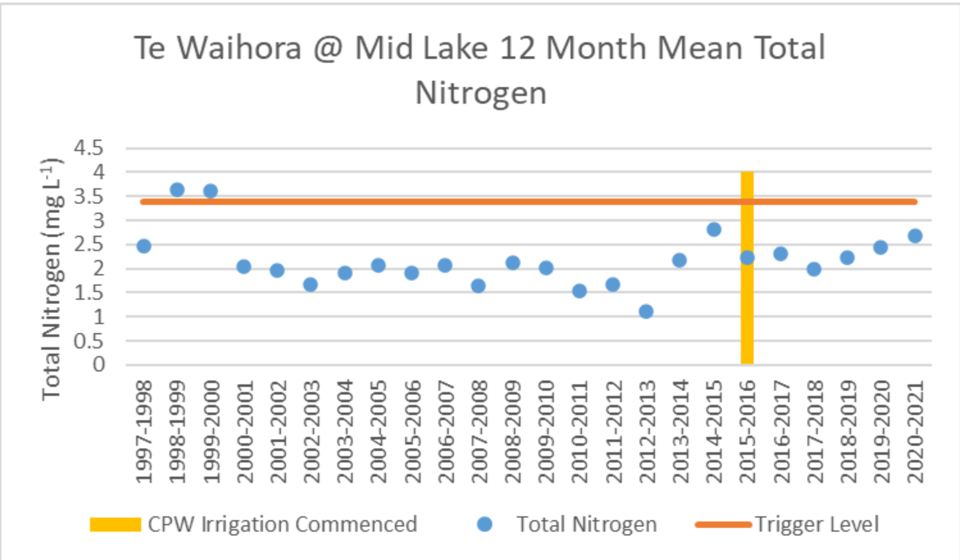


Figure 28. Total Nitrogen at Mid Lake in Te Waihora from 1997 – 2021

The discharge of phosphate laden sediment to surface waters is not a significant issue for CPWL farms when compared to farms in the lowland areas surrounding Lake Ellesmere/Te Waihora. The discharge of Nitrogen is a more significant issue for (but not exclusive to), CPWL Scheme farms. It is noted that whilst the lake Trophic Level Index was exceeded, the trigger level for total Nitrogen concentration was not (see Table 6).

4.3. Groundwater Quality

There were 18 positive detections of E. coli from 80 routine samples during 2020-21. Five positive detections were from Stage 1, one from Sheffield and 12 from Stage 2. Thirteen of the positive detections came from the June 2021 sampling round that took place after a significant rain event. Two Stage 2 bores exceeded the *E. coli* trigger level.

Exceedance of the Nitrate-N trigger level occurred in some Stage 1 bores, but this was from bores that exhibited elevated Nitrate-N levels prior to the commencement of CPWL supplied irrigation. A statistically significant increase in Nitrate-N concentrations has not yet been shown in Stage 1 bores that have exceeded the Nitrate-N trigger level. Likewise, no statistically significant increase can be shown for Nitrate-N levels from Stage 2 bores.

Analysis of samples taken from the two Sheffield monitoring bores suggests there has been no appreciable change in either Nitrate-N concentrations or detection of *E. coli* since the commencement of CPWL supplied irrigation.

CPWL have trigger levels in place for *E. coli* and Nitrate-N (Table 7). Water has been supplied to the Stage 1 area for six seasons so an assessment against the Nitrate-N trigger level can be made for the Stage 1 bores that intercept shallow groundwater (water table <50m below ground). Assessment against the Nitrate-N trigger cannot be made until December 2022 for the Sheffield Scheme and December 2024 for Stage 2.

Table 7. Groundwater Quality Trigger Levels

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 (water table <50 metres below groundwater level)

(b) Measured over the length of record

There are however several CPWL monitoring bores across both Stage 1 and Stage 2 where Nitrate-N concentrations have been found to be consistently greater than 7.65mg/L (refer to Tables 10 and 13 and Figures 10, 33 and 45).

4.3.1. Stage 1

E. coli

During routine monitoring within the operational Stage 1 area of the Scheme during 2020-21, *E. coli* was detected from five bores on a single occasion each (15.6% of samples [2019-20 - 9.4% of samples]). This however, did not result in the trigger level being exceeded. Three of the detections occurred in the June 2021 sampling round, which occurred shortly after a significant rain event.

Occasional occurrences of *E. coli* in groundwater bores are not uncommon particularly during wet weather sampling. ECan's annual regional groundwater surveys from 2009 to 2020 detected *E. coli* in 3.7% to 14% of bores [Spring 2020 = 11%, Spring 2019 = 6%]. There is also the possibility that positive *E. coli* readings may result from the sample collection and handling procedures.

Rainfall data for up to a week preceding positive detections of *E. coli* are shown in Table 8. References made regarding rainfall associated with Stage 1 monitoring refers to ECan's Ridgen Road Monitoring site.

Table 8. Rainfall[A] associated with bore water samples that had positive detections of *E. coli*

Bore	Sample Date	Site Condition	E. coli (MPN/100ml)	Rainfall (mm)			
				Sample Day	Previous 24hrs	Previous 48hrs	Previous week
BX22/0041	7/12/2020	No stock or manure	2	0	0	3	9.5
BX21/0018	2/03/2021	No stock or manure	>200.5	0	0	0	0
	16/03/2021	No stock or manure	<1	0.5	0	0	12
BX22/0042	22/06/2021	No stock, minimal sheep dung within 3m of bore	88.5	0*	5.5	32.5	44.5
	28/06/2021		2	0.5	0	3	8.5
BX22/0043	22/06/2021	No stock or manure, pooled water within 20m of bo	3.1	0*	5.5	32.5	44.5
BX22/0044	24/06/2021	No stock or manure	32.4	0	0	0	44
	2/07/2021	No stock or manure, paddock recently cultivated	<1	0	0	0	3.5

[A] Rainfall from ECan's Ridgen's Road monitoring site.

* Rain observed in Stage 1 this day.

When groundwater *E. coli* trigger levels are exceeded, CPWL works through a response flowchart as per Figure 50 of this report. Instances where *E. coli* concentrations are found at a similar or lower level, to those recorded prior to commencement of CPWL irrigation, are considered to reflect baseline groundwater quality, and as such no further action is generally taken at the time. Likewise, retesting is not generally undertaken when an *E. coli* concentration of < 10MPN/100ml is detected as when retesting has occurred under this circumstance, 60% of the time *E. coli* is not detected.

No apparent factors were noted on site that may have contributed to the positive *E. coli* detections from BX22/0041 in December 2020 and BX21/0018 in March 2021. A resampling of BX21/0018 two weeks after the initial sampling did not find *E. coli* above the detection limit.

Table 8 shows that more than 40mm of rain fell in the week prior to samples from BX22/0042, BX22/0043 and BX22/0044 tested positive for *E. coli* in June 2021. Approximately four weeks prior to sampling these three bores, 162.5mm of rain was recorded at ECan's Ridgens Road site between 28 May and 1 June 2021. The large reduction in *E. coli* levels determined after resampling BX22/0042 and BX22/0044 suggest that the cause of the detection was relatively short lived.

There are no potable water bores within several hundred meters of BX21/0018, BX22/0042 and BX22/0043.

There is a dwelling located within 100m (downgradient) of BX22/0041, however the potable water supply for the dwelling is sourced from one of two 100m deep bores located several hundred metres from BX22/0041, which had water depths between 20.15 - 21.12mbgl for 2020-21.

Potable water for the dwelling located adjacent to BX22/0044 is sourced from a 62 metre deep bore. BX22/0044 had static water levels of between 4.80 - 5.33mbgl at the times of monitoring during 2020-21.

In summary, the E. coli detections reported here do not appear to have threatened any drinking-water supplies.

Nitrate-Nitrogen

Five year Annual Means >7.65mg/L

The five-year annual mean trigger level (7.65mg L^{-1}) was exceeded for four of the eight Stage 1 monitoring bores (Refer to Table 9). The same four bores also exceeded the five-year annual mean trigger level for 2015-16 to 2019-20.

Table 9. Stage 1 Nitrate-N trigger level exceedance bores

Bore	Nitrate-N (mg L^{-1})	
	2020-21	2019-20
BX21_0017	12.9	12.2
BX22_0043	12.4	12.8
BX22_0053	9.2	9.1
BX22_0046	15.9	15.5

BX21/0017 is located south of Hororata township, and BX22_0053 and BX22_0046 are located at the eastern extent of Stage 1 (refer to Figure 10). BX22/0043 is also located towards the eastern extent of the Stage 1 but is approximately 4km due west of BX22/0053.

This is the second report that can assess monitoring results against the 5-year annual mean Nitrate-N trigger level, so a more detailed analysis is useful to identify any potential effects of CPWL supplied irrigation.

The annual (12-month) data that contributed to the (2016-17 to 2020-21) five-year annual mean is displayed in Figure 29.

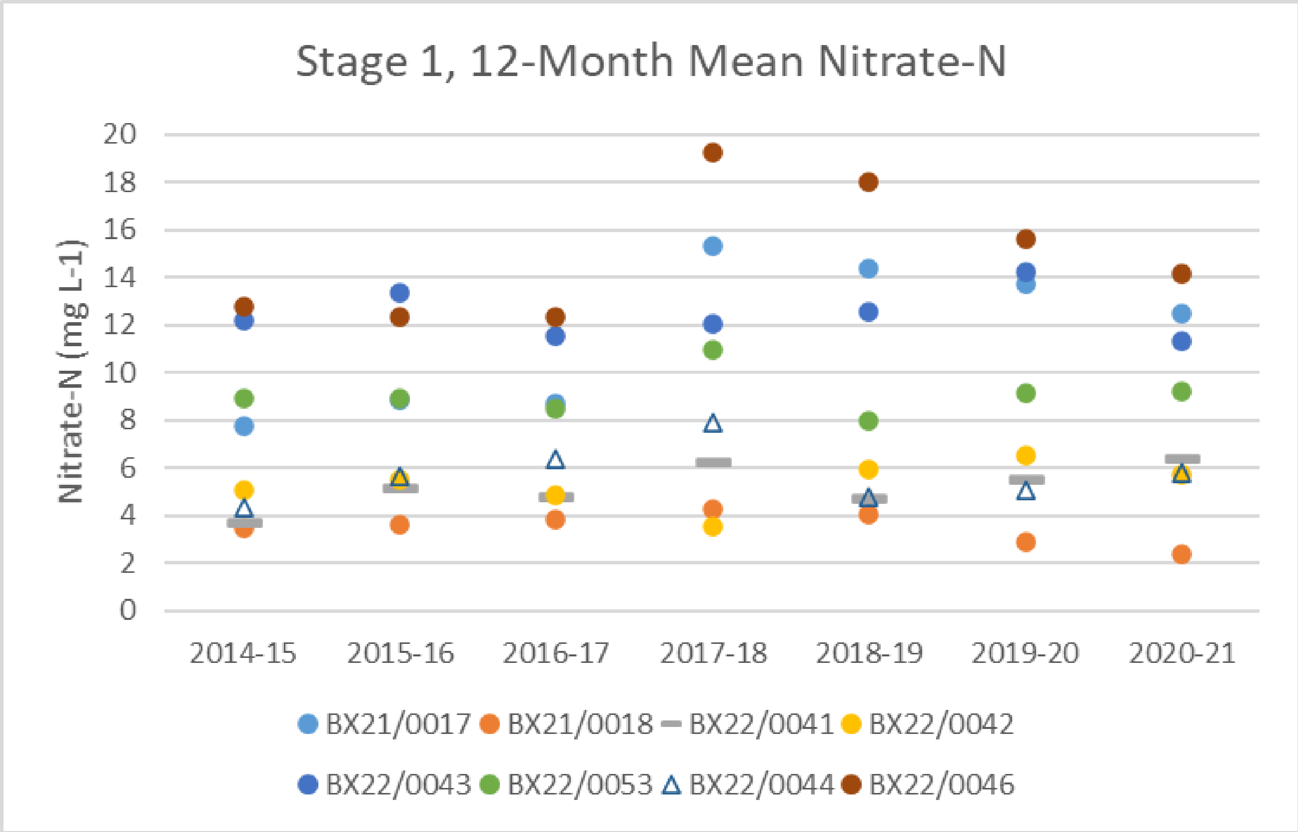


Figure 29. Stage 1 - 12-month Mean Nitrate-N
* Data from 2014-15 was collected prior to commencement of CPW Irrigation and is included here for comparative purposes.

Four Stage 1 bores had a mean Nitrate-N concentration for the 2020-21 monitoring period greater than 7.65mg/L, namely BX21/0017, BX22/0043, BX22/0053 and BX22/0046 (see blue shaded columns in Table 10, and Figure 29). These four bores also had mean Nitrate-N concentrations greater than 7.65mg/L for the five previous 12-month monitoring periods, and for the 2014-15 period which is prior to the commencement of CPWL supplied irrigation.

However, there is no statistically significant trend of increasing Nitrate-N concentration from BX21/0017, BX22/0043, BX22/0053 and BX22/0046. CPWL concludes that exceedance of the trigger level for Stage 1 bores is generally consistent with what is expected based on the combined effects of historic pre-CPWL land use, namely time lagged effects still coming from that pre-CPWL land use, and the consented new activities under CPWL that will also be contributing to the observed Nitrate-N concentrations. For the 2020-21 season, Stage 1 shareholders were 34% below their total nitrogen discharge allowance (refer to Appendix 6.7 for more detail about CPWL's nitrogen discharge allowance).

BX22/0041 showed its highest annual mean Nitrate-N concentration to date in 2020-2021 (6.34mg L^{-1}). This was marginally greater than the 6.27mg L^{-1} recorded for 2017-18. Bores BX22/0042 and BX22/0043 showed their highest annual mean Nitrate-N concentrations to date in 2019-2020. All other Stage 1 bores showed their highest annual mean Nitrate-N concentrations measured so far during the 2017-18 period.

ECan's Ridgens Road Rain Gauge has data available for 1 July to 30 June periods since 2006-07. During the 2020-21 period, 597mm of rain was recorded. This is similar to 2019-20 (575.5mm) and 2018-19 (603mm) periods.

The 1 July to 30 June mean from 2006-7 to 2020-21 is 644mm. During the 2017-18 period, which included a significant rainfall event in July, 925mm of rainfall was recorded.

Table 10. Stage 1 Bores Nitrate-N Results (mg/L) March 2014 to June 2021

Date	BX21/0017	BX21/0018	BX22/0041	BX22/0042	BX22/0043	BX22/0053	BX22/0044	BX22/0046
Jun 2021	15	2.11	6.23	3.9	8.57	8.11	8.41	14.1
Mar 2021	12.5	2.58	6.32	4.94	8.73	7.59	4.22	14.1
Dec 2020	11.5	2.22	8.57	5.98	14.9	10.7	5.43	14.3
Sep 2020	10.9	2.67	4.25	8.2	13.2	10.6	5.05	14.3
Jun 2020	11.8	3.34	4.93	8.04	15.7	11.0	4.15	14.6
Mar 2020	12.6	2.63	6.11	7.45	15.2	10.2	4.30	15.1
Dec 2019	13.0	3.00	5.14	2.17	15.4	8.86	4.78	16.2
Sep 2019	17.4	2.65	5.73	8.52	10.7	6.63	6.93	16.5
Jun 2019	19.0	3.65	5.4	8.67	13.7	6.15	5.07	18.5
Mar 2019	13.6	3.55	5.36	1.12	14.6	11.2	4.51	18.3
Dec 2018	12.3	3.99	3.77	7.88	10.3	6.60	4.61	16.8
Sep 2018	12.6	4.87	4.19	6.21	11.6	7.94	4.90	18.6
Jun 2018	13.0	4.98	5.02	4.76	11.2	9.35	5.46	16.8
Mar 2018	16.7	4.04	6.97	2.42	11.2	10.7	7.19	18.9
Dec 2017	14.4	4.22	6.31	2.86	14.9	10.5	6.46	19.2
Sep 2017	17.3	3.79	6.77	4.18	11.0	13.3	12.6	22.2
Jun 2017	14.0	3.2	4.8	3.8	10.4	8.3	7.2	13.9
Mar 2017	8.8	5.4	5.5	5.2	9.4	9.7	6.3	11.8
Dec 2016	5.2	3.5	4.9	5.5	12.7	8.3	6.7	11.9
Sep 2016	6.8	3.3	4.0	5.0	13.7	7.8	5.2	11.9
Jun 2016	9.2	3.6	4.5	5.4	13.0	9.0	5.9	12.2
Mar 2016	8.5	4.4	6.7	5.7	13.0	9.8	5.0	12.3
Dec 2015	9.1	3.5	5.3	6.1	13.1	8.5	5.6	12.4
Sep 2015	8.5	2.9	4.1	4.9	14.3	8.3	6.0	12.5
Jun 2015	5.9	3.2	2.7	5.2	14.6	10.5	4.5	12.6
Mar 2015	7.1	4.0	3.1	3.5	10.9	11.0	4.6	12.8
Dec 2014	7.9	3.6	4.9	6.2	13.0	8.0	3.9	12.4
Sep 2014	10.2	3.1	3.9	5.5	10.2	6.3	4.5	13.2
Jun 2014	11.2	4.3	4.6	5.7	9.9	-	7.4	14.4
Mar 2014	7.8	-	4.3	5.3	13.6	-	4.1	12.9
2020-21 Mean	12.5	2.4	6.3	5.8	11.4	9.3	5.8	14.2
2019-20 Mean	13.7	2.9	5.5	6.5	14.3	9.2	5.0	15.6
2018-19 Mean	14.4	4.0	4.7	6.0	12.6	8.0	4.8	18.1
2017-18 Mean	15.4	4.3	6.3	3.6	12.1	11.0	7.9	19.3
2016-17 Mean	8.7	3.9	4.8	4.9	11.6	8.5	6.4	12.4
2015-16 Mean	8.8	3.6	5.2	5.5	13.4	8.9	5.6	12.4
2014-15 Mean	7.8	3.5	3.7	5.1	12.2	9.0	4.4	12.8
5yr Annual Mean	12.9	3.5	5.5	5.3	12.4	9.2	6.0	15.9
All Data Mean	11.5	3.5	5.1	5.3	12.4	9.1	5.7	14.9
Screened Interval (mbgl)	1.1 - 11.1	55.1 - 105.1	10.1 - 40.1	29.4 - 69.4	20.1 - 70.1	20.3 - 50.3	1.0 - 9.0	1.0 - 30.0
Water level range (mbgl)	6.4 - 9.9	75.3 - 93.7	18.6 - 23.8	40.1 - 49.5	50.7 - 65.2	32.9 - 46.4	4.3 - 7.6	7.1 - 14.4

Figure 30 shows the land use, and Figure 31 the irrigation type, of CPWL shareholder farmland located up-gradient of the monitoring bores that had mean annual Nitrate-N concentrations of greater than 7.65mg.

Figure 30. Shareholder Land Use Up-Gradient of the Stage 1 Elevated Nitrate-N Bores

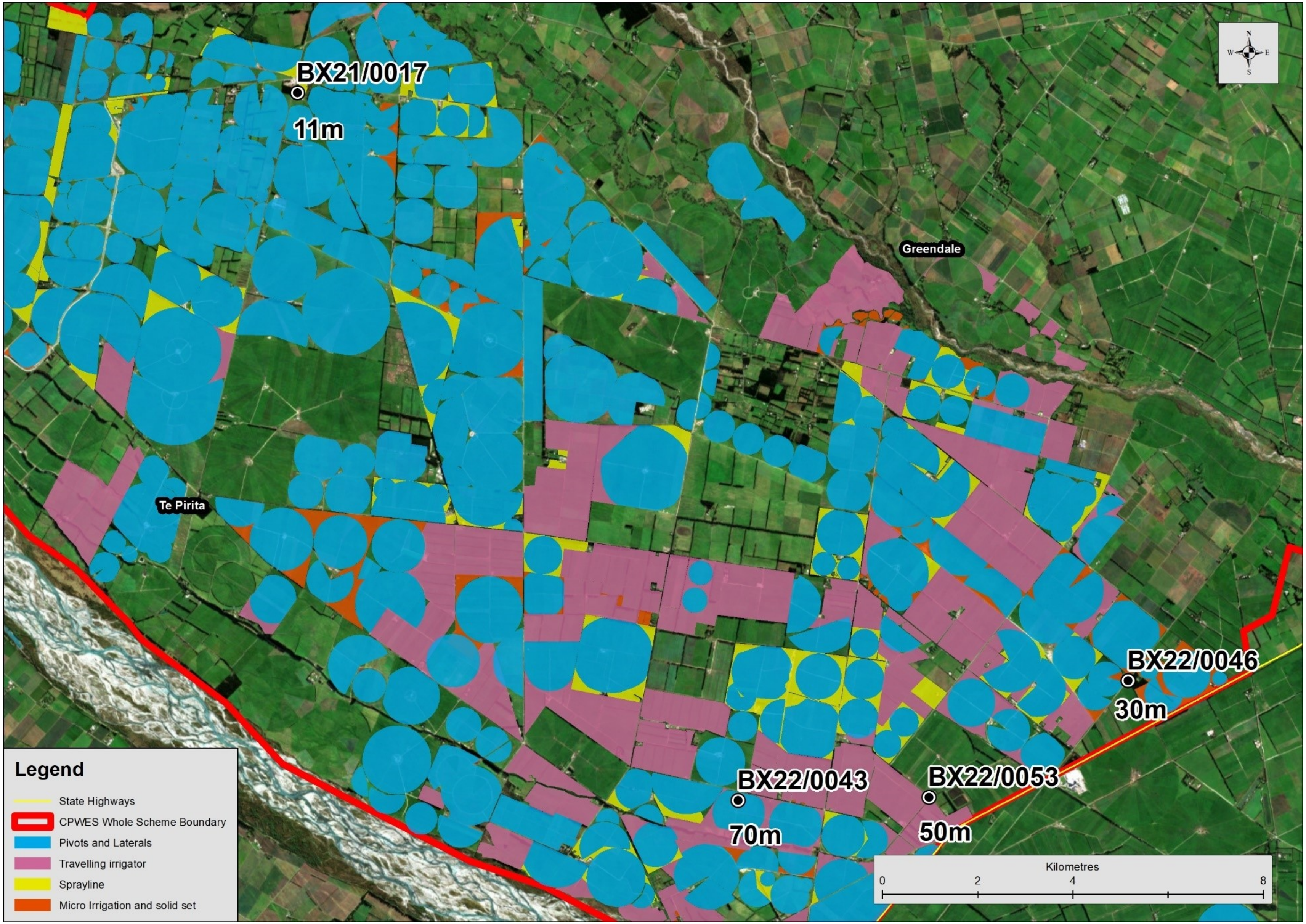


Figure 31. CPWL Shareholder Irrigation Types for Farms Up-Gradient of Stage 1 Elevated Nitrate-N Bores

Bores with new maximum Nitrate-N concentrations measured within the last 12 months

In addition to its highest measured Mean annual Nitrate-N concentration occurring for the 2020-21 period, BX22/0041 had its highest measured discrete Nitrate-N concentration occur during the last 12 months, with a concentration of 8.57mg L^{-1} recorded on 7 December 2020 (Refer to Figure 32). There is only a weak correlation between depth to water vs concentration of Nitrate-N for bore BX22/0041. This doesn't adequately explain the new maximum Nitrate-N concentration (Refer to Figure 33 and 34). The sample from 7 December 2020 tested positive for *E. coli* as detailed earlier in this section of the report.

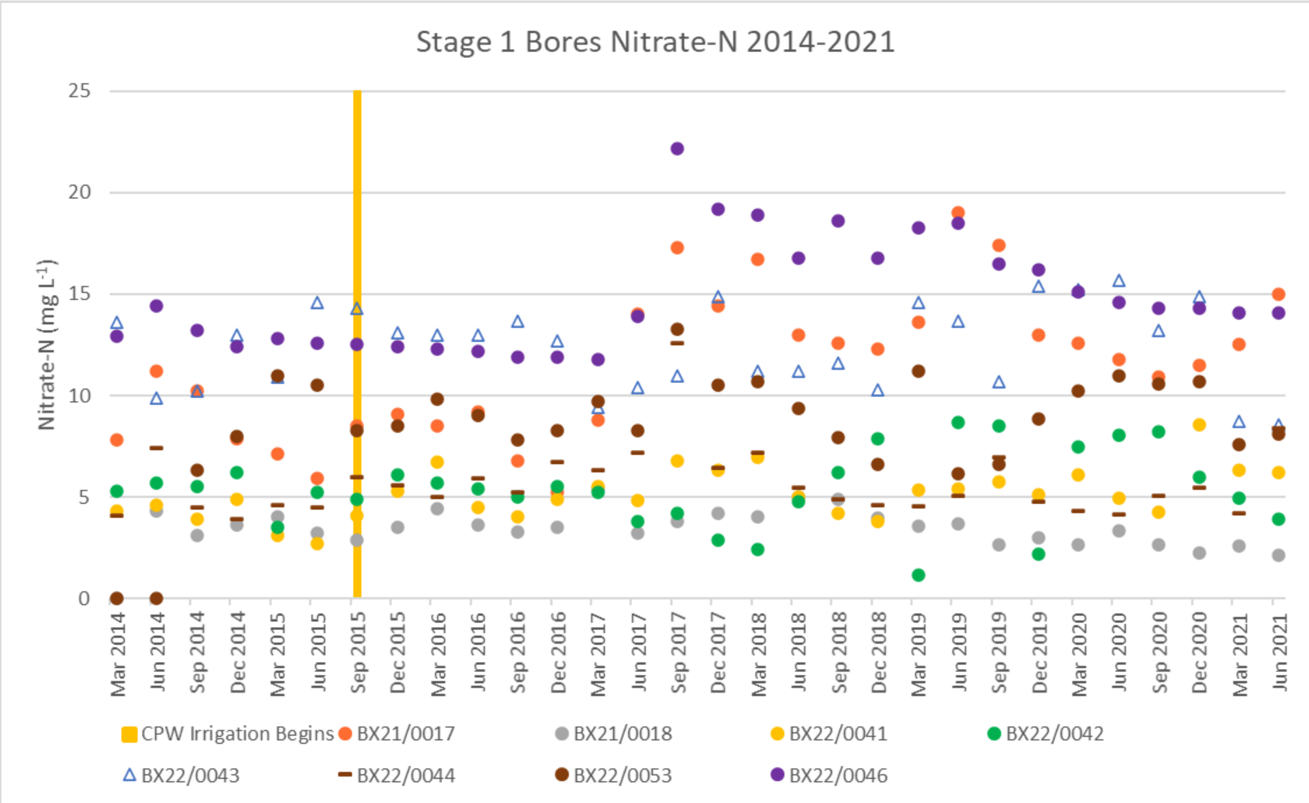


Figure 32. Stage 1 Groundwater Nitrate-N; March 2014 to June 2021

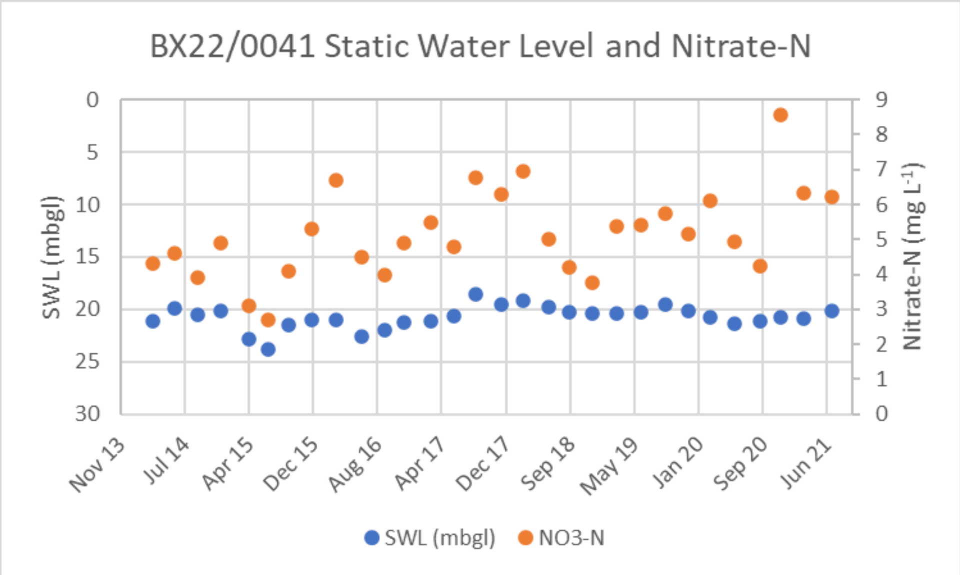


Figure 33. BX22/0041 Nitrate-N and Static Water Level

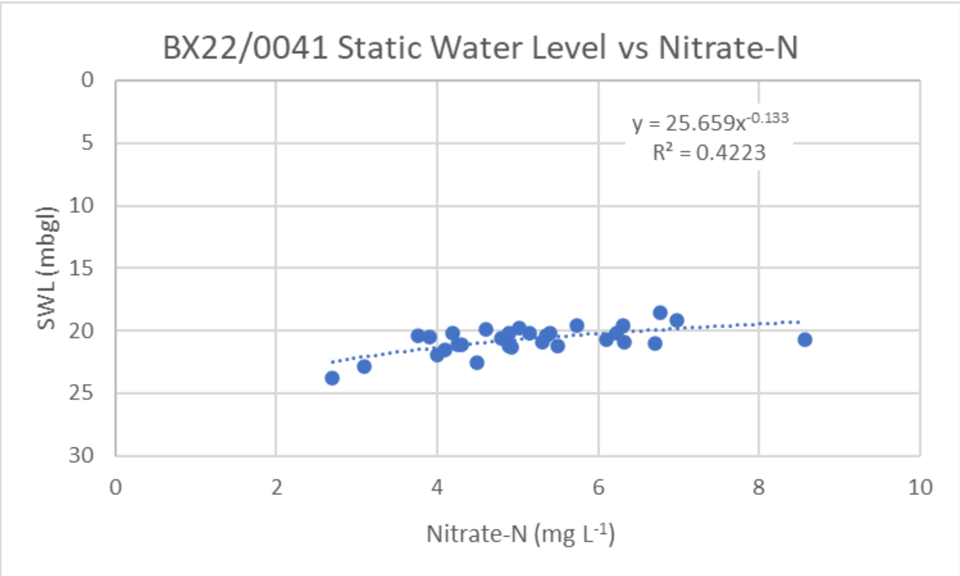


Figure 34. BX22/0041 Nitrate-N vs Static Water Level

Table 3 from the CPWL's Baseline Water Quality assessment (Part 1 of the Ground and Surface Water Plan) contains a summary of ECAN monitoring data (to June 2013), which showed Nitrate-N levels have been recorded as high as 36.9mg/L.

For comparison, four out of 10 Stage 2 monitoring bores showed new maximum discrete Nitrate-N concentrations during the 2020-21 monitoring period.

4.3.2. Sheffield

E. coli

E. coli was detected in the June 2021 sample from BW22/0042. This is the first time since March 2018 that *E. coli* has been detected in one of CPW's Sheffield bores.

Groundwater levels in the two Sheffield bores were recorded at their highest levels since monitoring began (refer to Figure 35)

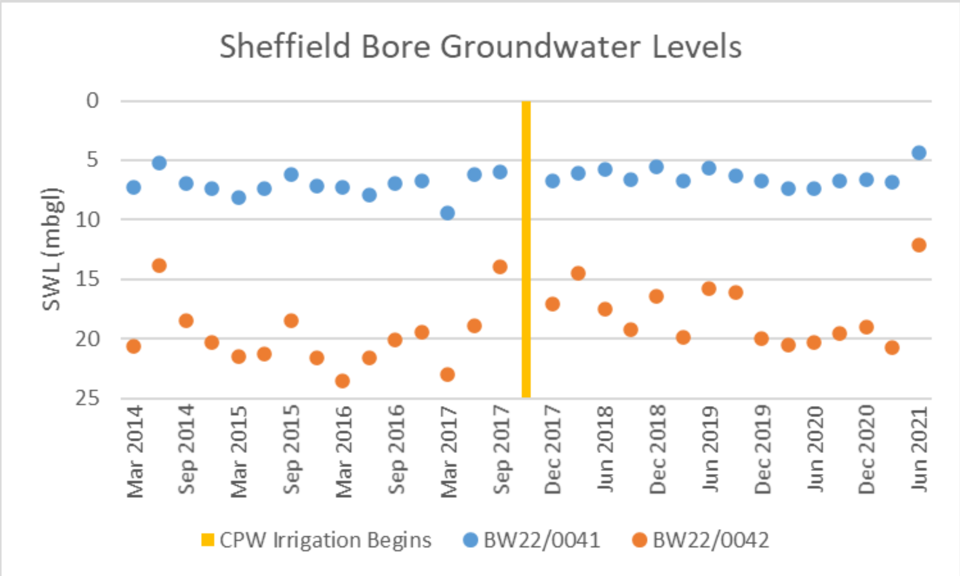


Figure 35 Static Water Levels measured in CPWLs Sheffield Monitoring Bores

Nitrate-Nitrogen

Nitrate-N levels measured in the two Sheffield monitoring bores between September 2020 and June 2021 were within the ranges previously measured (before such time as the Sheffield Scheme was operating) (refer to Figure 36). Annual Median Nitrate-N concentrations were 4.7mg L^{-1} for BW22/0041 and 6.1mg L^{-1} for BW22/0042.

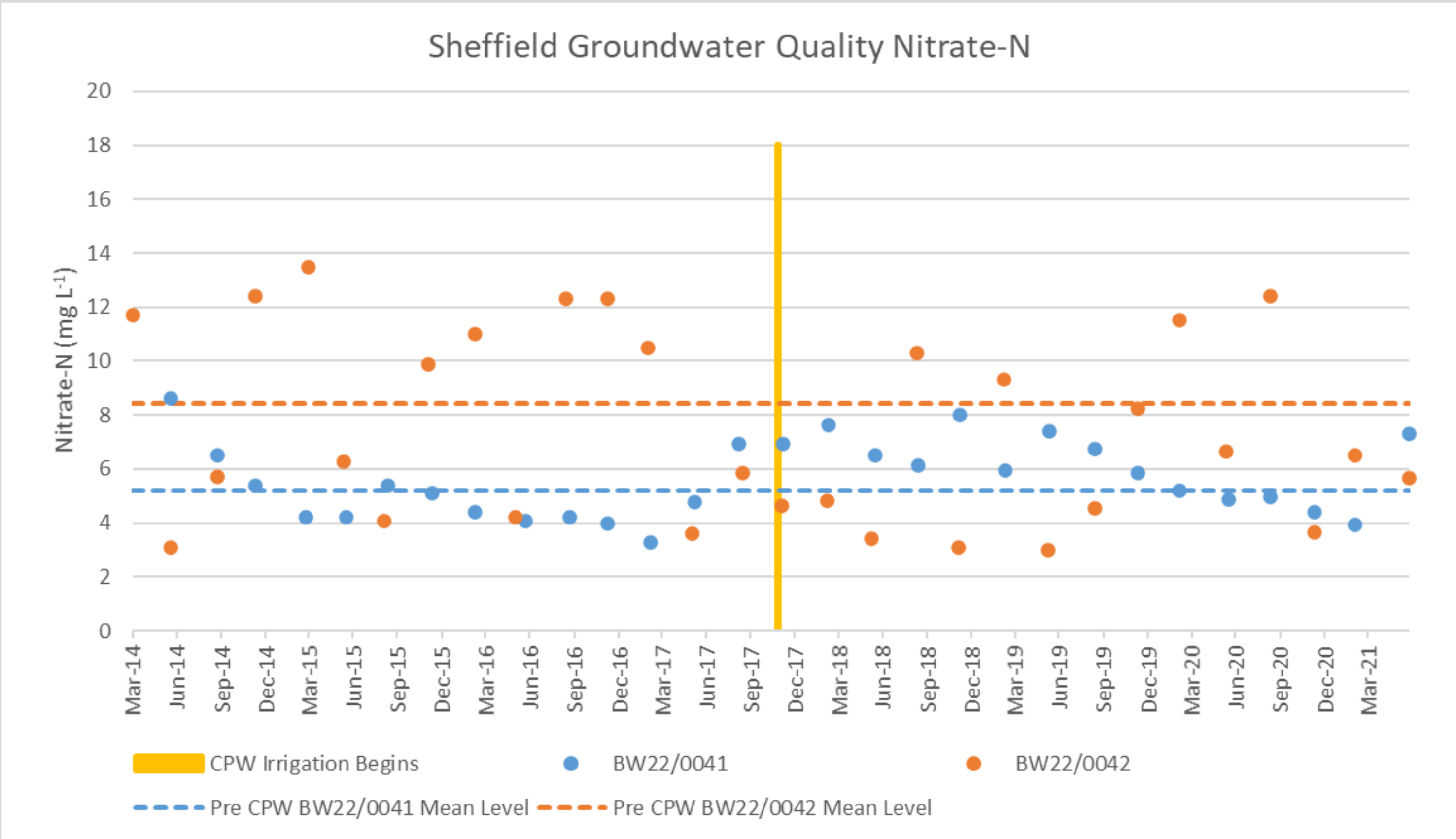


Figure 36. Nitrate-N Concentrations in CPWLs Sheffield Monitoring Bores

4.3.3. Stage 2

E. coli

CPWL commenced supplying irrigation water to the Stage 2 area during October 2018. This has meant assessment against *E. coli* trigger levels (a median of <1 organism per 100ml over the length of record) can now be made. However, as the 'length of record', post commencement of CPWL supplied irrigation only stands at less than three years' worth of monitoring results (n=11), any exceedance of trigger level should be considered with caution.

BX22/0065 returned positive *E. coli* detections in March and June 2021. This bore also returned positive *E. coli* detections in December 2019 and March 2020. This bore has tested positive for *E. coli* on six out of 11 occasions during routine monitoring post commencement of CPWL irrigation supply and has therefore exceeded the trigger level.

BX22/0067 returned positive *E. coli* detections in December 2020, and March and June 2021. This bore also returned positive *E. coli* detections in the December, March and June sampling rounds in the 2019-20 period. This bore has now tested positive for *E. coli* on eight out of 11 occasions during routine monitoring post commencement of CPWL irrigation supply and has therefore exceeded the trigger level.

Both BX22/0065 and BX22/0067 had a history of *E. coli* detections before receiving CPWL water (refer to Table 11).

Table 11. Bores BX22/0067 and BX22/0065 *E. coli* Results (MPN/100ml) Prior to CPWL Irrigation

Sample Date	BX22/0067 E. coli (MPN/100ml)	Sample Date	BX22/0065 E. coli (MPN/100ml)
12/09/2018	<1	6/09/2018	<1
14/06/2018	16	5/06/2018	<1
-	-	14/3/2018	1
13/03/2018	<1	2/03/2018	4
12/12/2017	2	-	-
5/12/2017	29	7/12/2017	12
12/09/2017	<1	12/09/2017	<1
13/06/2017	0	6/06/2017	0
8/03/2017	78	1/03/2017	0
10/01/2017	34	10/01/2017	0
13/12/2016	>201	6/12/2016	3
14/09/2016	0	7/09/2016	0
22/06/2016	2	2/06/2016	0
10/03/2016	5	02/03/2016	0
10/12/2015	>201	10/12/2015	12
8/09/2015	0	7/09/2015	0
18/06/2015	0	16/06/2015	0

Prior to the start of CPWL irrigation, BX22/0065 tested positive for *E. coli* on 4 out of 14 occasions, while BX22/0067 tested positive for *E. coli* on 7 out of 14 occasions. For BX22/0067, this means the trigger level was exceeded for the period before Stage 2 Irrigation commenced.

The detection of *E. coli* continues to occur at a higher frequency in bores from Stage 2 bore compared to Stage 1. For the 2020-21 monitoring period, *E. coli* was detected in 30% of routine Stage 2 samples compared to 15.6% of for Stage 1 [2019-20 – 22.5% for Stage 2 compared to 9.4% for Stage 1].

A significant contributor to the 30% detection rate for Stage 2 in 2020-21 were the results from June 2021 where nine out of the ten Stage 2 monitoring bores [or 22.5% of the total number of routine Stage 2 samples taken during 2020-21] returned positive detections for *E. coli*. Routine groundwater sampling in June 2021 was carried out from the 16th to the 23rd. ECans Ridgens Road rain gauge recorded 162.5mm over the 28 May to 1 June 2021 period.

Rainfall data for up to a week preceding positive detections of *E. coli* are shown in Table 12. References made regarding rainfall associated with Stage 2 monitoring refers to ECan's Ridgen Road Monitoring site.

Table 12. Rainfall[A] associated with bore water samples that had positive detections of *E. coli*.

Bore	Sample Date	Site Condition that may affect results	E. coli (MPN/100ml)	Rainfall (mm)			
				Sample Day	Previous 24hrs	Previous 48hrs	Previous week
BX22/0067	8/12/2020	no notable adverse factors	>200.5	0	0	0	3
BX22/0067	5/03/2021	no notable adverse factors	34.4	0	0	0	0
	16/03/2021	no notable adverse factors	5.3	0.5	0	0	12
BX22/0065	8/03/2021	no notable adverse factors	15	0	4.5	6	6
	16/03/2021	Rotorainer and K-line operating nearby (~40-400m upgradient)	16.4	0.5	0	0	12
BX22/0071	16/06/2021	no notable adverse factors	11.1	0	0.5	0.5	1
	28/06/2021	Aspirated Water at ~40mbgl, ~28m above SWL.	1	0.5	0	3	8.5
BX22/0072	17/06/2021	no notable adverse factors	1	5.5	0	0.5	1
BX22/0066	17/06/2021	running water audible from bore	5.3	5.5	0	0.5	1
BX22/0070	21/06/2021	strong air discharge from bore	2	5.5	27	27.5	39
BX22/0068	21/06/2021	Sheep in paddock, pooled water adjacent to bore	40.6	5.5	27	27.5	39
	28/06/2021	Aspirated Water at ~50mbgl, ~12m above SWL.	12.4	0.5	0	3	8.5
BX23/0424	23/06/2021	Aspirated Water at ~30mbgl, ~20m above SWL.	13.7	0	0	5.5	44
	2/07/2021	Aspirated Water at ~21mbgl, ~28m above SWL.	<1	0	0	0	3.5
BX23/0423	23/06/2021	no notable adverse factors	4.2	0	0	5.5	44
BX22/0065	23/06/2021	no notable adverse factors	50.4	0	0	5.5	44
	2/07/2021	no notable adverse factors	13.7	0	0	0	3.5
BX22/0067	23/06/2021	Pooled water ~10m from bore. Running water audible. Aspirated water at ~26mbgl, ~5m above SWL.	12.4	0	0	5.5	44
	2/07/2021	Pooled water ~10m from bore. Running water audible.	1	0	0	0	3.5

[A] Rainfall from ECan's Ridgens Road Monitoring Site.

The water testing laboratory failed to notify CPW of the positive *E. coli* detection from the BX22/0067 sample taken on 8 December 2020 so subsequently no retest of the bore was made.

During 2020-21 the presence of rain does not appear to be a consistent factor in positive *E. coli* detections from Stage 2 bores. On 10 out of 12 occasions where *E. coli* was detected during routine monitoring there was a maximum of 6mm of rainfall recorded at the Ridgens Road Monitoring site on either the day of, or two days prior to, groundwater sampling taking place. Between 0 and 44mm rain was recorded in the week prior to all 12 positive detections of *E. coli*.

Other than bores BX22/0065 and BX22/0067, no other Stage 2 bore had more than a single positive detection from routine monitoring during 2020-21 season (this was also true for 2019-2020).

There does not appear to be a relationship between *E. coli* concentration and either Nitrate-N concentration or Static Water level at BX22/0067 (refer to figures 37 and 38). NB: In figures 37-40, concentrations of *E. coli* at >200MPN/100ml have been plotted at 200MPN/100ml and concentrations of *E. coli* at <1MPN/100ml have been plotted at 0MPN/100ml.

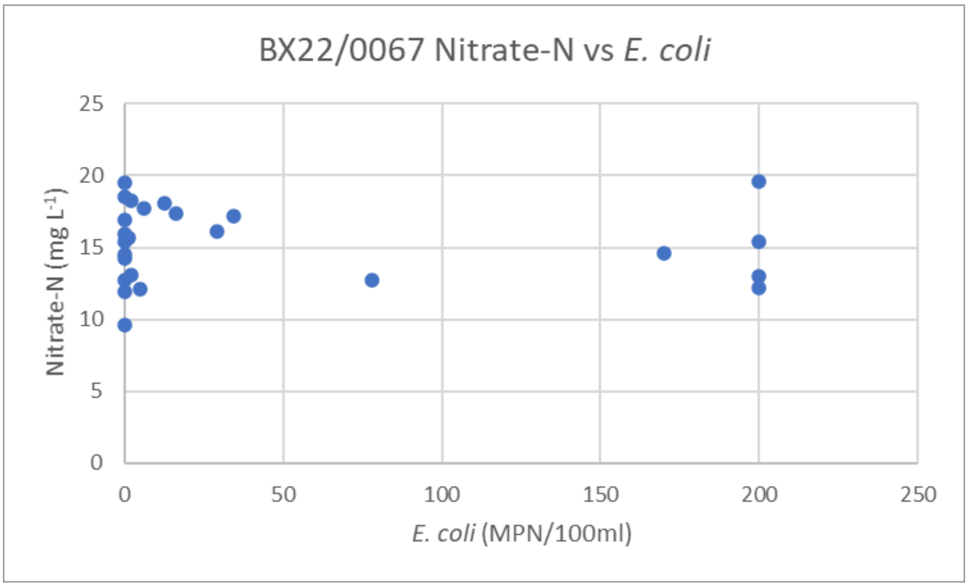


Figure 37. BX22/0067 *E. coli* vs Nitrate-N

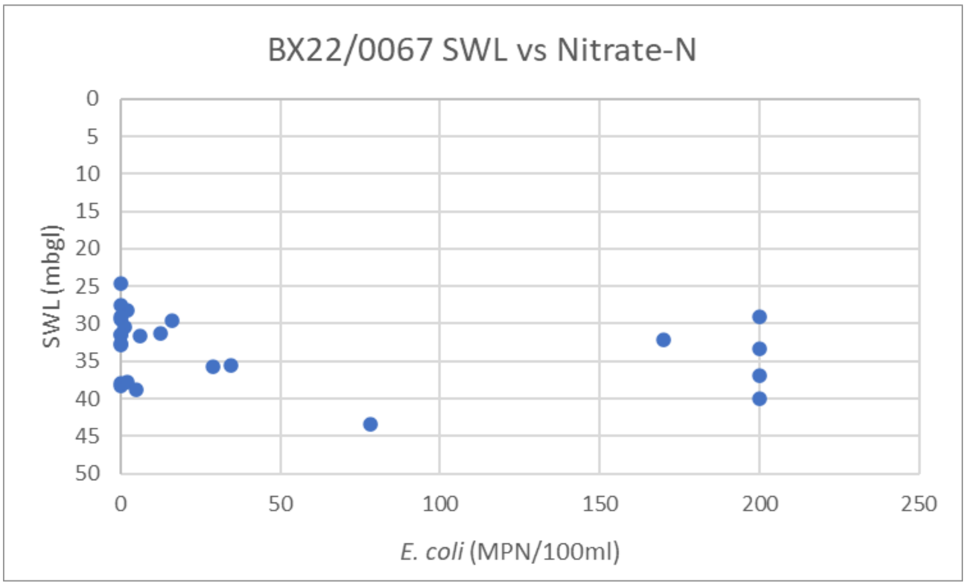


Figure 38. BX22/0067 *E. coli* vs Static Water Level (SWL)

There does not appear to be a relationship between *E. coli* concentration and either Nitrate-N concentration or Static Water level at BX22/0065 (refer to figures 40 and 41).

Dwellings are located within 100m of BX22/0065 and BX22/0067. However, their drinking water sources are located more than 1km and 250m away, at depths 30m and eight metres greater than the respective monitoring bores. Therefore, the positive *E. coli* detections in the monitoring bores are not considered to provide an indication of the quality of the drinking water for these dwellings.

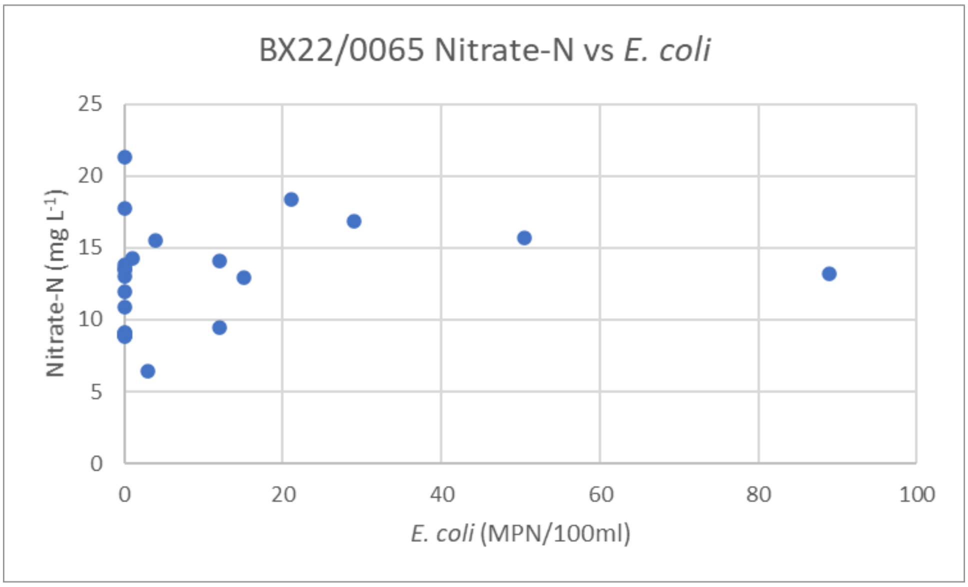


Figure 39. BX22/0065 *E. coli* vs Nitrate-N

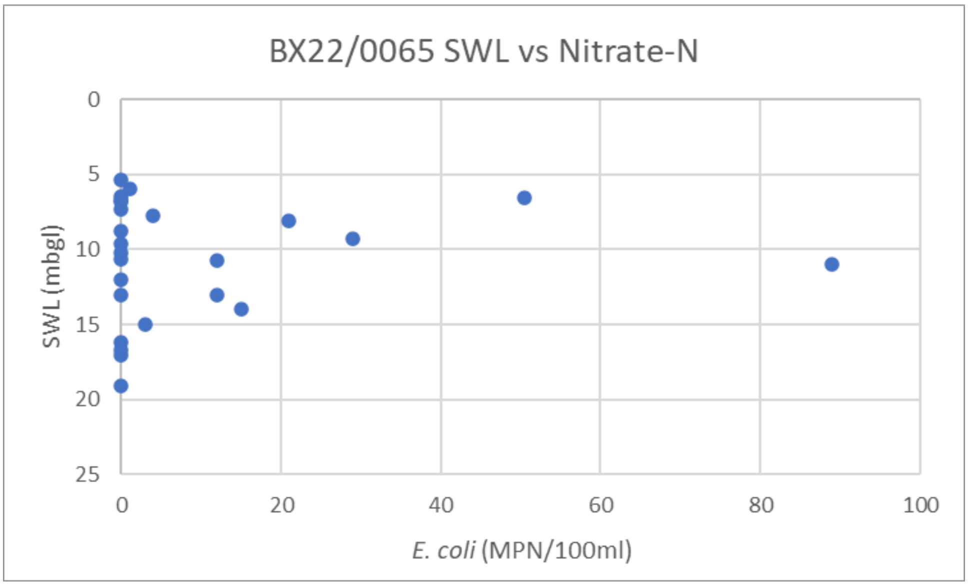
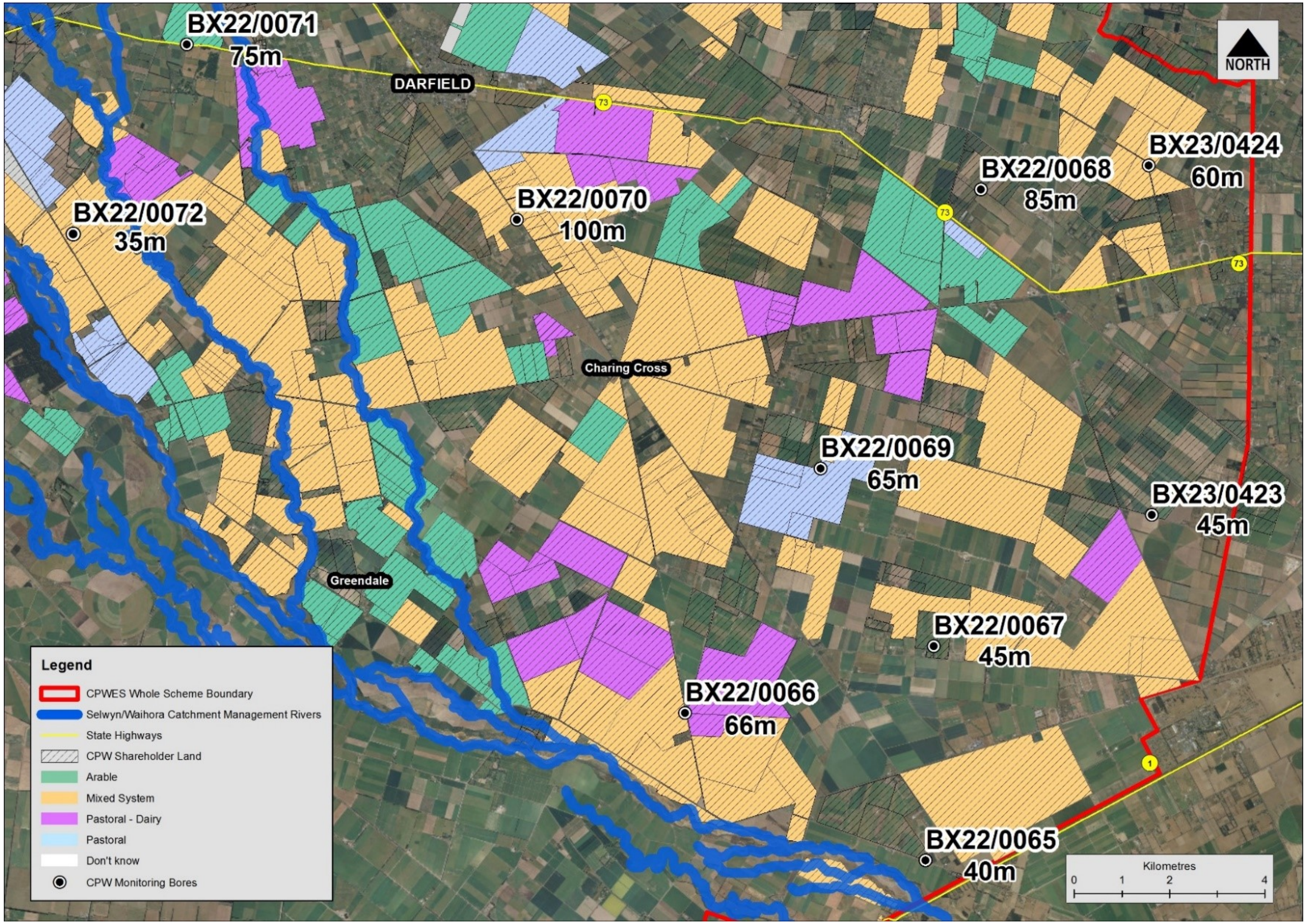


Figure 40. BX22/0065 *E. coli* vs Static Water Level (SWL)

Figures 41 and 42 display the land use and irrigation type used by farms up-gradient of the groundwater that gave samples positive for *E. coli* in 2020-21.



Data current at 2017-2018

Figure 41. Land use of Stage 2 farms located up-gradient of *E. coli p*ositive, and/or elevated Nitrate-N, bores.

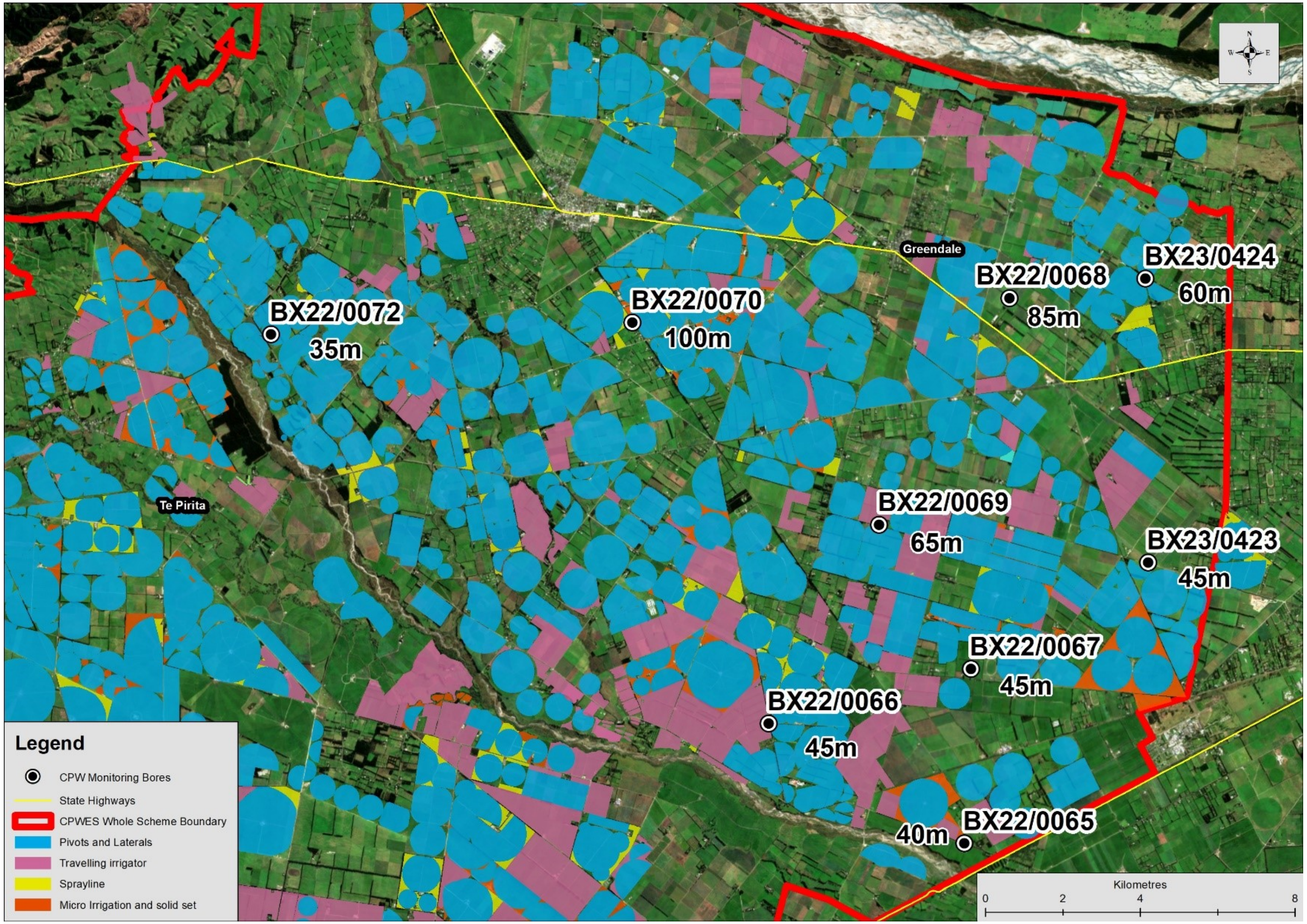


Figure 42. Irrigation status of Stage 2 farms located up-gradient of *E. coli* positive, and/or elevated Nitrate-N, bores.

Nitrate-Nitrogen

CPWL commenced supplying irrigation water to the Stage 2 area during October 2018 so an assessment against the five-year annual mean Nitrate-N trigger level concentration of 7.65mg L^{-1} cannot yet be made.

Eight of the ten Stage 2 bores had a 12-month mean Nitrate-N concentration of greater than 7.65mg/L (Refer to Table 13). With the exception of BX22/0071, whose 12-month mean Nitrate-N concentration has never exceeded 7.65mg L^{-1}, all bores have recorded a 12-month mean Nitrate-N concentration of greater than 7.65mg L^{-1} on at least one occasion prior to the commencement of CPWL irrigation (i.e. up to 2017-18).

Table 13 Stage 2 Bores Nitrate-N Results (mg/L) June 2015 to June 2021

Date	BX22/0072	BX22/0071	BX22/0070	BX22/0066	BX22/0069	BX22/0065	BX22/0067	BX22/0068	BX23/0424	BX23/0423
Jun 2021	10.4	3.86	15.9	7.2	16.8	15.7	18.1	29.9	12.5	13.8
Mar 2021	9.85	2.9	7.39	5.06	11	12.9	17.2	5.7	8.69	14.2
Dec 2020	11.9	3.28	7.04	5.62	11.3	13.6	19.6	6.31	8.98	17.7
Sep 2020	3.77	3.46	6.96	6.61	11.2	13.8	15.4	3.74	13.2	12.2
Jun 2020	6.12	3.36	7.65	11.2	11.4	13.0	15.7	4.81	12.4	8.97
Mar 2020	8.49	3.85	8.79	12	10.9	13.2	14.6	13	15.9	18.3
Dec 2019	13.9	3.25	8.47	9.68	13.2	18.4	15.4	14.5	14.6	13.3
Sep 2019	17.3	3.89	8.1	8.5	16.5	8.99	19.5	21.5	12.5	14.2
Jun 2019	9.3	4.96	8.30	7.92	10.3	8.87	18.3	4.26	14.9	11.1
Mar 2019	12.8	2.75	8.54	4.99	10.4	16.9	17.7	7.12	12.5	9.39
Dec 2018	13.7	2.91	8.52	4.75	10.2	14.3	15.9	9.30	11.5	19.3
Sep 2018	11.8	2.89	8.89	4.72	10.8	8.94	14.2	7.13	12.3	10.7
Jun 2018	14.6	3.40	9.47	5.21	9.76	13.5	17.4	15.7	10.7	18.2
Mar 2018	15.00	3.51	10.1	5.87	13.5	15.5	16.9	17.7	16	17.9
Dec 2017	16.6	3.34	9.48	3.88	11.7	14.1	16.1	15.7	13.1	17.5
Sep 2017	15.2	3.59	14.6	6.54	15.7	21.3	18.5	24.8	13	18.1
Jun 2017	11.3	3	7.6	3	well dry	17.8	11.9	2.8	7.5	11.2
Mar 2017	6.4	2.9	well dry	4.1	well dry	8.9	12.7	2.5	7.6	well dry
Dec 2016	7.5	3	7.7	3.9	9.7	6.4	12.2	3.3	7.8	4.4
Sep 2016	7.2	3	7.5	7.2	9.4	9.1	9.6	2.8	7.9	4.9
Jun 2016	4.6	3.6	7.6	13.1	9.6	9.1	13.1	2.9	7.9	10.3
Mar 2016	5.8	3.2	7.7	8.9	9.8	8.9	12.1	3.3	8.1	5.5
Dec 2015	7.4	2.8	7.6	6.2	10.2	9.5	13	3.5	9	9.1
Sep 2015	9.0	3.1	7.5	4.9	9.9	10.9	14.5	11.9	11	10.7
Jun 2015	4.9	3.2	7.5	10.1	9.9	12.0	12.7	2.7	11.4	13.9
2020-21 Mean	9.0	3.4	9.3	6.1	12.6	14.0	17.6	11.4	10.8	14.5
2019-20 Mean	11.5	3.6	8.3	10.3	13.0	13.4	16.3	13.5	13.9	13.7
2018-19 Mean	11.9	3.4	8.6	5.6	10.4	12.3	16.5	7.0	12.8	12.6
2017-18 Mean	15.4	3.5	10.9	5.4	12.7	16.1	17.2	18.5	13.2	17.9
2016-17 Mean	8.1	3.0	7.6	4.6	9.6	10.6	11.6	2.9	7.7	6.8
2015-16 Mean	6.7	3.2	7.6	8.3	9.9	9.6	13.2	5.4	9.0	8.9
All Data Mean	10.2	3.3	8.7	6.8	11.4	12.6	15.3	9.5	11.2	12.7
Screened Interval (mbgl)	10.0 - 35.2	35.0 - 79.0	60.7 - 100.7	15.5 - 45.5	30.6 - 65.6	10.3 - 40.3	15.3 - 45.3	39.6 - 84.6	15.3 - 60.3	20.0 - 47.4
Water Level Range (mbgl)	6.7 - 21.5	46.7 - 71.0	77.3 - 99.3	15.8 - 36.4	47.7 - 63.6	5.3 - 19.1	24.6 - 43.4	58.7 - 70.2	37.3 - 53.5	24.5 - 41.8

NB: If static water levels are found to be outside of a bore's screened interval, water is sampled from a point level with the top of the screen rather than 1m below the water level. This was required once for BX22/0065 during 2020-21.

The Mann Kendall trend test on five 12-month periods (2015-16 to 2020-21) showed an upward trend for Nitrate-N concentration for all ten bores but the trends were not statistically significant. Figure 43 displays the 12-month mean Nitrate-N data used in the Mann Kendall analysis.

BX22/0067's highest 12-month mean Nitrate-N concentration measured to date occurred in 2020-2021. The nine other Stage 2 bores showed their highest 12-month mean Nitrate-N concentrations during either the 2017-18 or 2019-20 periods.

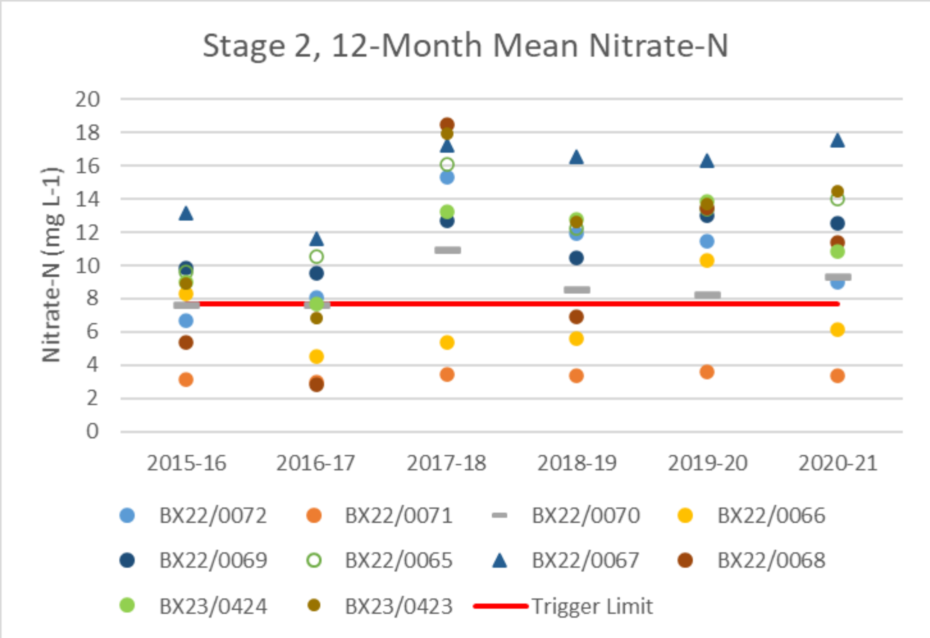


Figure 43. Stage 2 Groundwater Nitrate 12-Month Mean September 2015 to June 2021

<u>Bores with new maximum Nitrate-N concentrations measured within the last 12 months</u>

Discrete Nitrate-N concentrations from Bores BX22/0067, BX22/0068, BX22/0069 and BX22/0070, reached new maxima during the 2020-21 monitoring period, with BX22/0068, BX22/0069 and BX22/0070 exhibiting the greatest concentration in June 2021, and BX22/0067 in September 2020 (refer to Figure 44). There is no apparent relationship between the elevated Nitrate-N readings and amount of rainfall that fallen on either the day of, and 6 days prior to, or the day of and 29 days prior to sampling taking place.

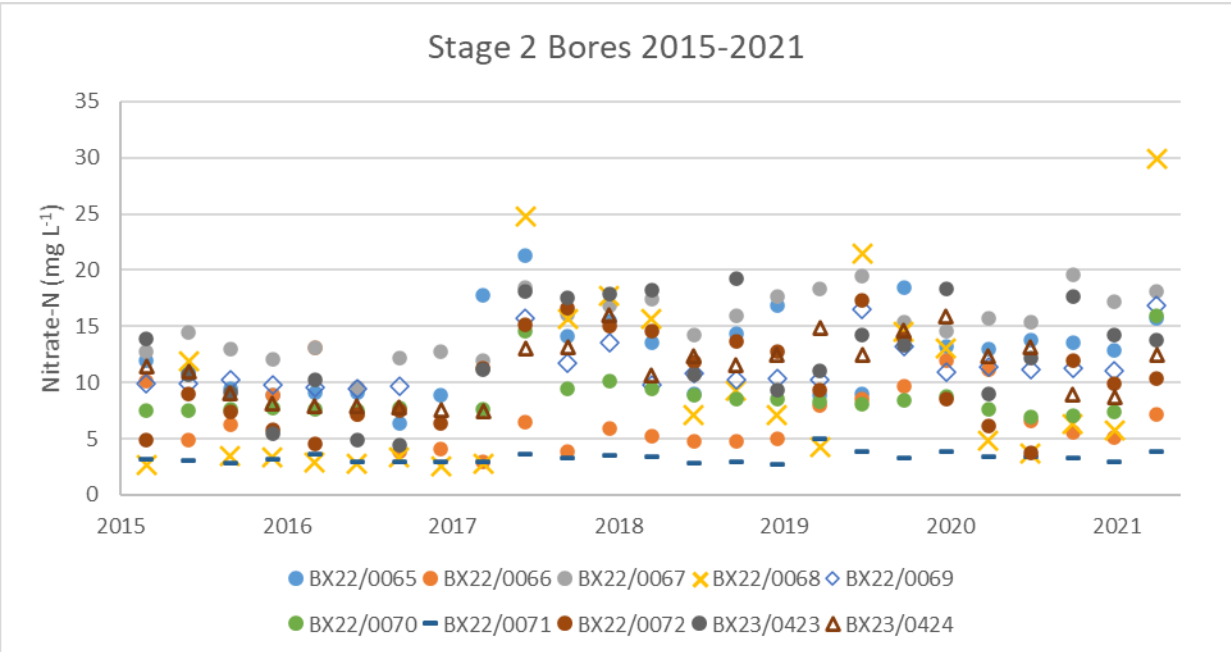


Figure 44. Stage 2 Groundwater Nitrate; June 2015 to June 2021

Overall, apart from BX22/0044, which in 2017-18 had a Mean Nitrate-N concentration greater than 7.65mg L^{-1} but in every other 12-month period had a Mean Nitrate-N concentration of less than 7.65 mg L^{-1}, all Stage 1 bores have had their Mean 12-monthly Nitrate-N concentrations remain either consistently above or below 7.65 mg L^{-1} for all seven 12-month monitoring periods for which data exists.

For Stage 2, bores are more variable with regards to whether their Annual Mean Nitrate-N concentrations are found to be greater than 7.65mg L^{-1} or not over the six 12-month periods that have been monitored to date. Four bores' Annual Mean Nitrate-N concentrations have remained greater than 7.65mgL^{-1} for every period, one bore's concentration has remained below 7.65mg L^{-1} for every period, and five bores have shown Nitrate-N concentrations both above and below 7.65mg L^{-1}.

Figure 45 displays which of CPWL's 20 monitoring bores had a 2020-21 mean Nitrate-N concentration of more than 7.65 mg L^{-1}. NB: Trigger levels for Nitrate-N in groundwater are based on a five-year annual average so cannot be assessed against the Sheffield scheme until the December 2022, and for Stage 2 until the December 2024, groundwater monitoring rounds are completed.

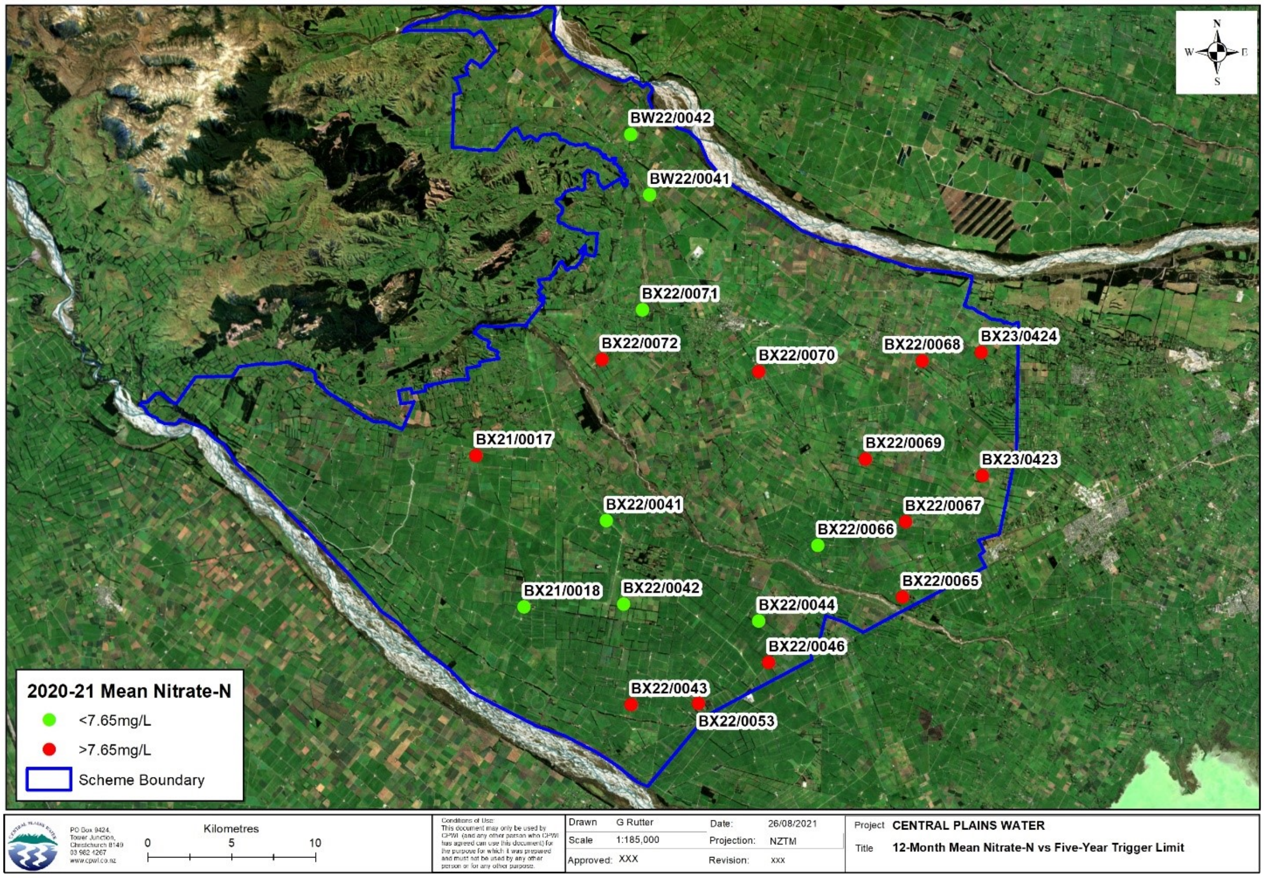


Figure 45. Groundwater monitoring bores 2020-21 Mean Nitrate-N

4.4 Lowland Groundwater Level Monitoring

The Lowland groundwater level triggers are set at the 95th percentile of the (at least 40 year) historical record.

Between July 2020 and June 2021, no Lowland groundwater trigger levels were exceeded.

The nearest any measured groundwater level came to a CPWL trigger was at bore M36/0424 on 21 July 2020, where the groundwater level was 0.18m below the trigger level, and at bore M36/7880 on 16 June 2021, where the groundwater level was 0.03m below the trigger level. Figures 46 and 47 show the respective groundwater levels of M36/0424 and M36/7880 since the commencement of CPWL supplied irrigation.

During the 2019-20 period, M36/0424 and M36/7880 exceeded their trigger levels in the July 2019 monitoring round by 1 centimetre and three centimetres respectively. These were the only Lowland groundwater level trigger exceedances during 2019-20.

There was a single trigger level exceedance during 2018-19 and 16 trigger level exceedances from five bores during 2017-18. No trigger levels were exceeded during the 2015-16 and 2016-17 monitoring periods.

CPWL did not receive any complaints concerning regarding elevated groundwater levels, or impacts on land drainage or on-site wastewater systems, in the Lowland Plains Area.

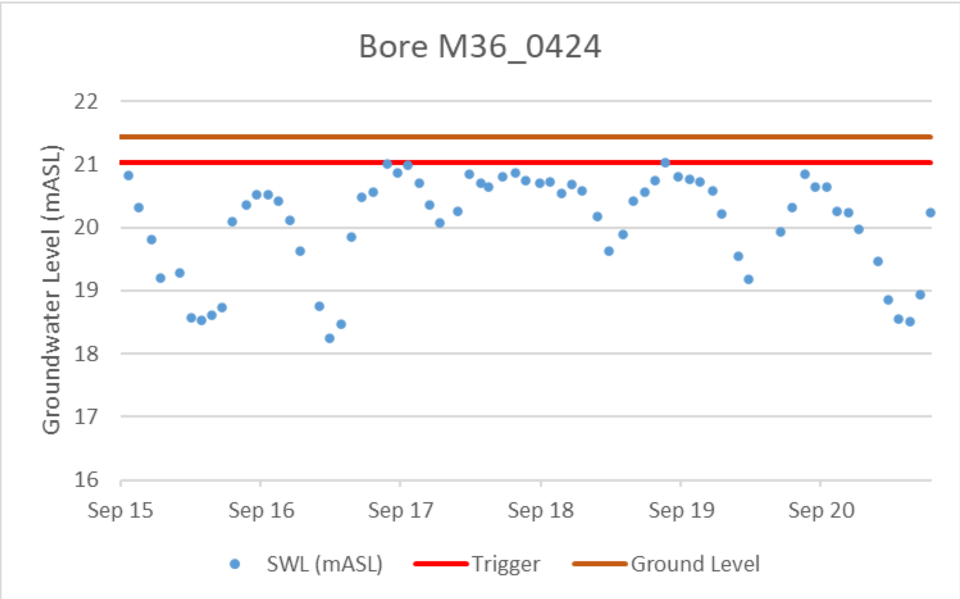


Figure 46. Lowland Monitoring Bore M36/0424 post commencement of CPWL irrigation

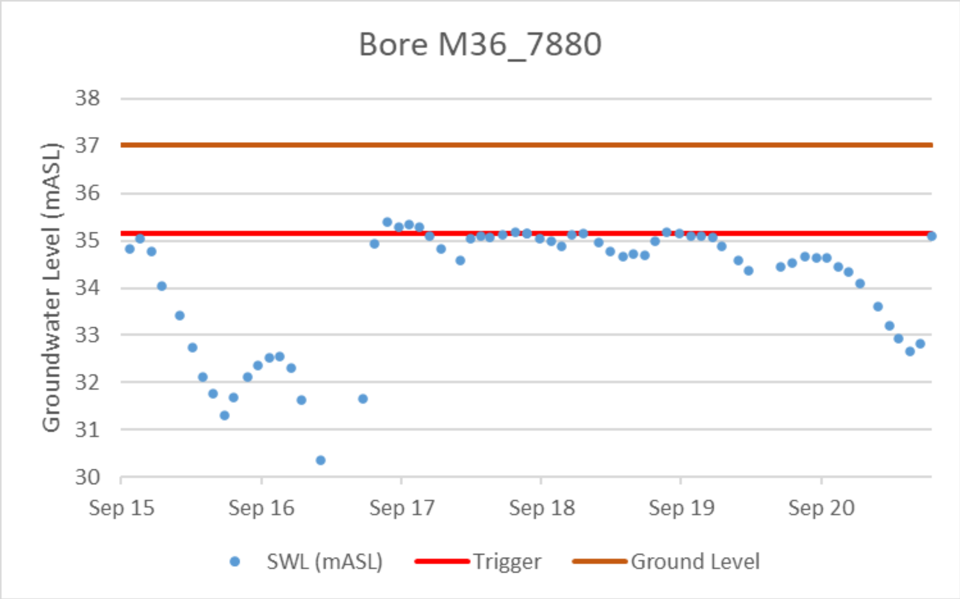


Figure 47. Lowland Monitoring Bore M36/7880 post commencement of CPWL irrigation

5. Conclusion

Central Plains Water has now supplied irrigation water to the Stage one area for six seasons, to the Sheffield Scheme area for four seasons, and the Stage two area for three seasons.

Although some surface water and lake water quality trigger levels were exceeded, the levels were found to be consistent with results from previous years (prior to the CPWL Scheme operating) in all cases where historic data is available.

Nitrate-N Trigger levels were exceeded at eight surface water sites during 2020-21. This is a decrease from ten sites during the 2019-20 period but more than the six from 2018-19.

The 2020-21 Annual median and Annual 95th percentile Nitrate-N levels from the Selwyn River 'Spring-source', (Chamberlain's Ford), and the Annual median Nitrate-N levels from the Doyleston Drain and Harts Creek 'source' sites, exceeded trigger levels and were at the highest levels measured since monitoring began in 2015-16.

Annual median and annual 95th percentile Nitrate-N levels from the Selwyn River 'downstream' (Coe's Ford) site reached new maximums in 2020-21 but appears to be within the bounds of an increasing trend that has been occurring since the early 1990's.

No lowland groundwater trigger levels were exceeded during 2020-21.

No complaints were received during 2020-21 concerning any adverse environmental effects of the Scheme on groundwater or surface water, including more specifically, impacts on land drainage, or on-site wastewater systems.

During routine monitoring, *E. coli* was detected from five Stage 1 monitoring bores on a single occasion during 2020-21. *E. coli* was detected in a significantly lower number of Stage 1 bore water samples compared to Stage 2 bore samples.

E. coli was detected on a single occasion from a Sheffield monitoring bore in 2020-21. This is the first time since March 2018 that *E. coli* has been detected in one of CPW's Sheffield bores.

Nitrate-N levels measured in the Sheffield monitoring bores were found to be within ranges previously encountered before the Scheme commenced operating.

New maximum annual mean Nitrate-N concentrations were measured in one of eight Stage 1, and one of ten Stage 2, monitoring bores during 2020-21. In the absence of long-term records from dedicated long-screen monitoring bores, it is not certain whether these new measured maximum Nitrate-N concentrations represent new absolute maximum concentrations present in the environment.

The 5-year annual mean trigger for Nitrate-N was exceeded for four Stage 1 bores. Annual Nitrate-N concentrations in all four bores, peaked in 2017-18 and were above the trigger level concentration prior to CPWL irrigation commencing.

At the conclusion of the 2020-21 period, no statistically significant upward or downward trends in Nitrate-N concentrations can be confirmed from any groundwater bore or surface water site monitored as part of the CPWL monitoring programme.

In general, the monitoring results from three years of full Scheme operation (Stage 1 has received CPWL water for six years, Sheffield four years and Stage 2 three years) are insufficient to confidently detect and attribute any effects of the Scheme on water quality, particularly when compared against some existing elevated and increasing contaminant trends caused by historic land uses and practices whose effects are time-lagged.

Some years of further water quality monitoring will be necessary, together with on-going assessment of CPWL and other land use change patterns in the catchment, to determine any significant change to existing elevated Nitrate-N concentrations and increasing trends, and whether any cause is attributable to CPWL, to previous land use changes and/or to improving practices through time. Until the main cause(s) responsible for trigger exceedances and increasing trends of Nitrate-N concentrations identified in this report can be accurately attributed, CPWL will assess its operations against its Sustainability Protocol, ensure all Farm Environment Plans are audited, including compliance with nitrogen application limits, and use/application of Good Management Practice/Matrix of Good Management. A summary of compliance with all these elements of the Sustainability Protocol is provided in Appendix 6.7 of this report.

Notwithstanding the inability to currently attribute the effect of the CPWL Scheme on water quality, the trigger exceedances and increasing trends identified in the report are a concern to keep watching. CPWL must continue to comply with the conditions of its resource consents to minimise its contribution to water quality deterioration.

6. Appendices

6.1. Ground and Surface Water Plan Part II – Trigger Limits and Trigger Response Processes

Table 14. Surface water quality triggers (Nitrate-N (mg/L)) for the CPWL monitoring programme

River Type	pLWRP Variation 1		CPWL surface water monitoring	
	Annual Median	Annual 95th percentile	Annual Median	Annual 95th percentile
Spring-fed plains	6.9	9.8	5.2	7.4
Hill-fed lower	2.4	3.5	1.8	2.6

Table 15. Water quality triggers for CPWL lake water quality monitoring

Monitoring Location	TLI[(a)]	Total Phosphorus (mg/L)[(b)]	Total Nitrogen (mg/L)[(b)]	Chlorophyll A (µg/L)[(b)]
Mid-Lake	6.6	0.1	3.4	74
Lake Margins	6	n/a	n/a	n/a

(a) TLI assumed to be calculated as TLI3 (using TP, TN and chl a)

(b) As a maximum annual average

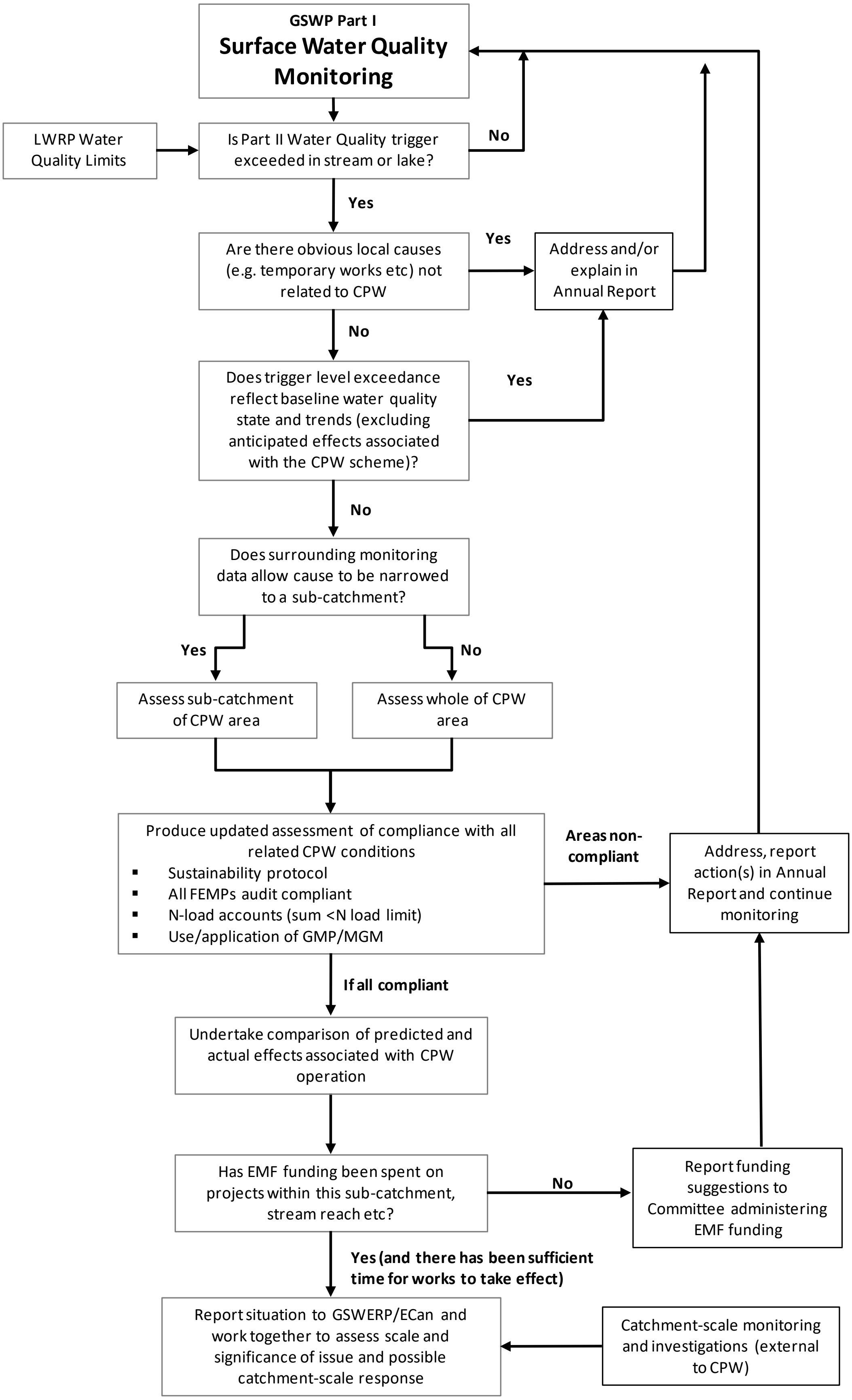


Figure 48. CPWL response to surface water quality trigger level exceedance

The CPWL response initiated following an exceedance of lake water quality triggers is consistent with that established for surface water quality monitoring.

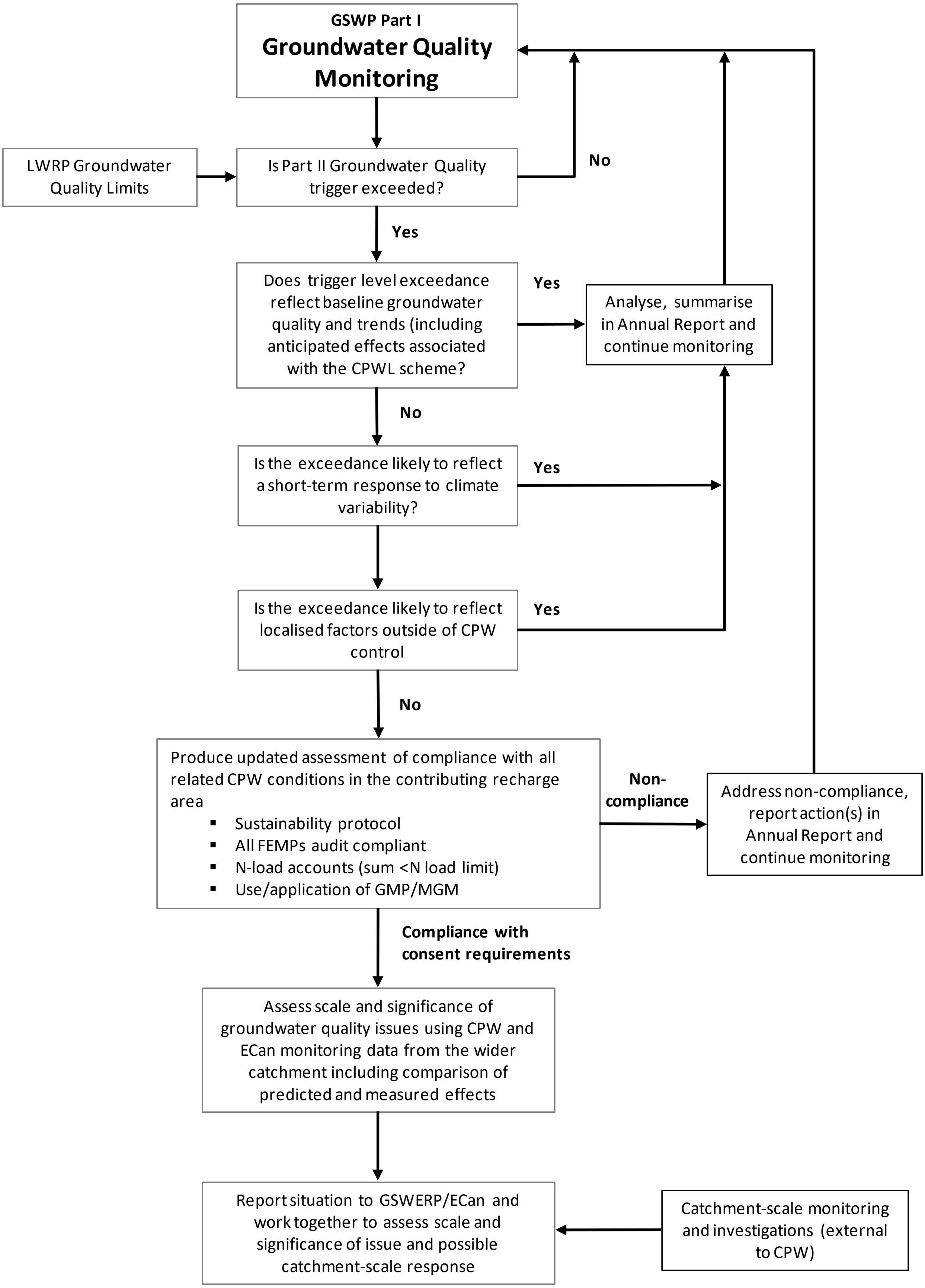


Figure 49. CPWL response to groundwater quality trigger level exceedance

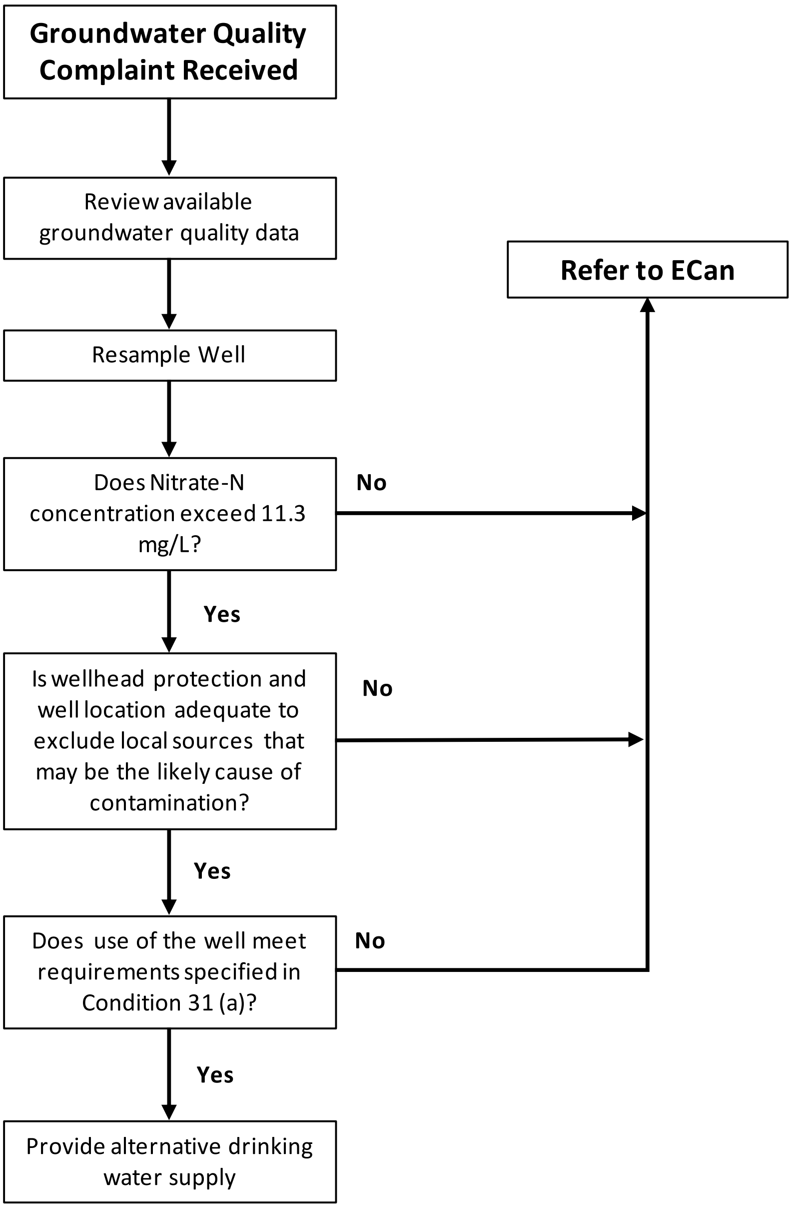


Figure 50. CPWL response to groundwater quality complaints

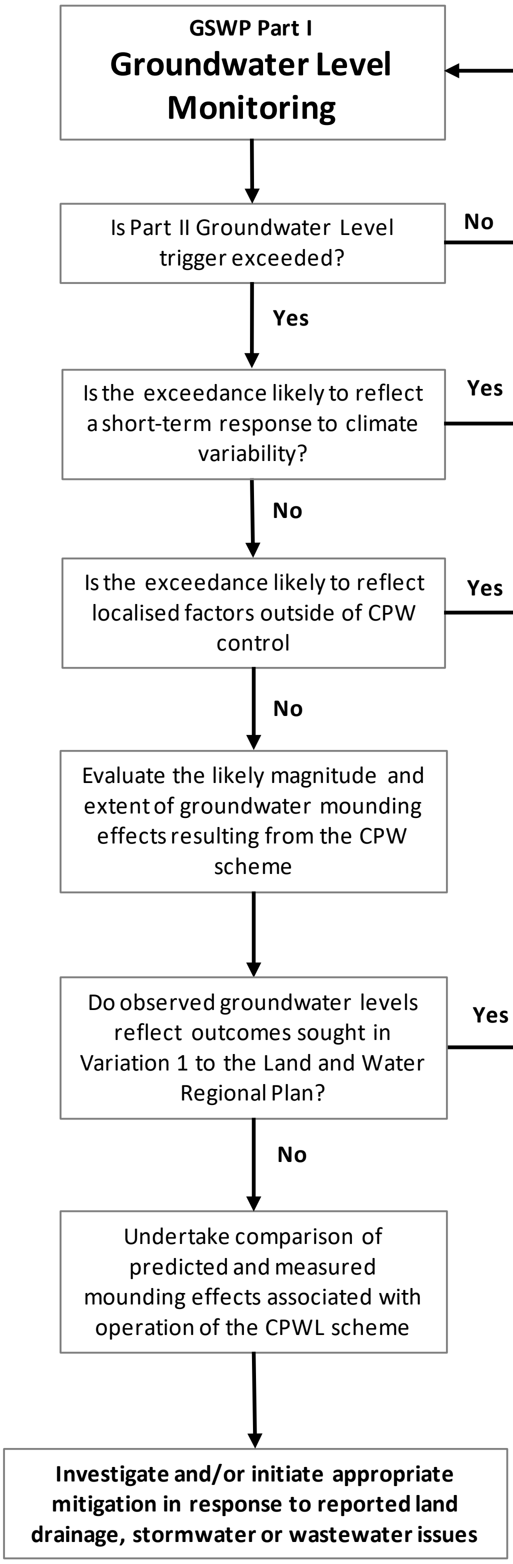


Figure 51. CPWL response to groundwater level trigger exceedance

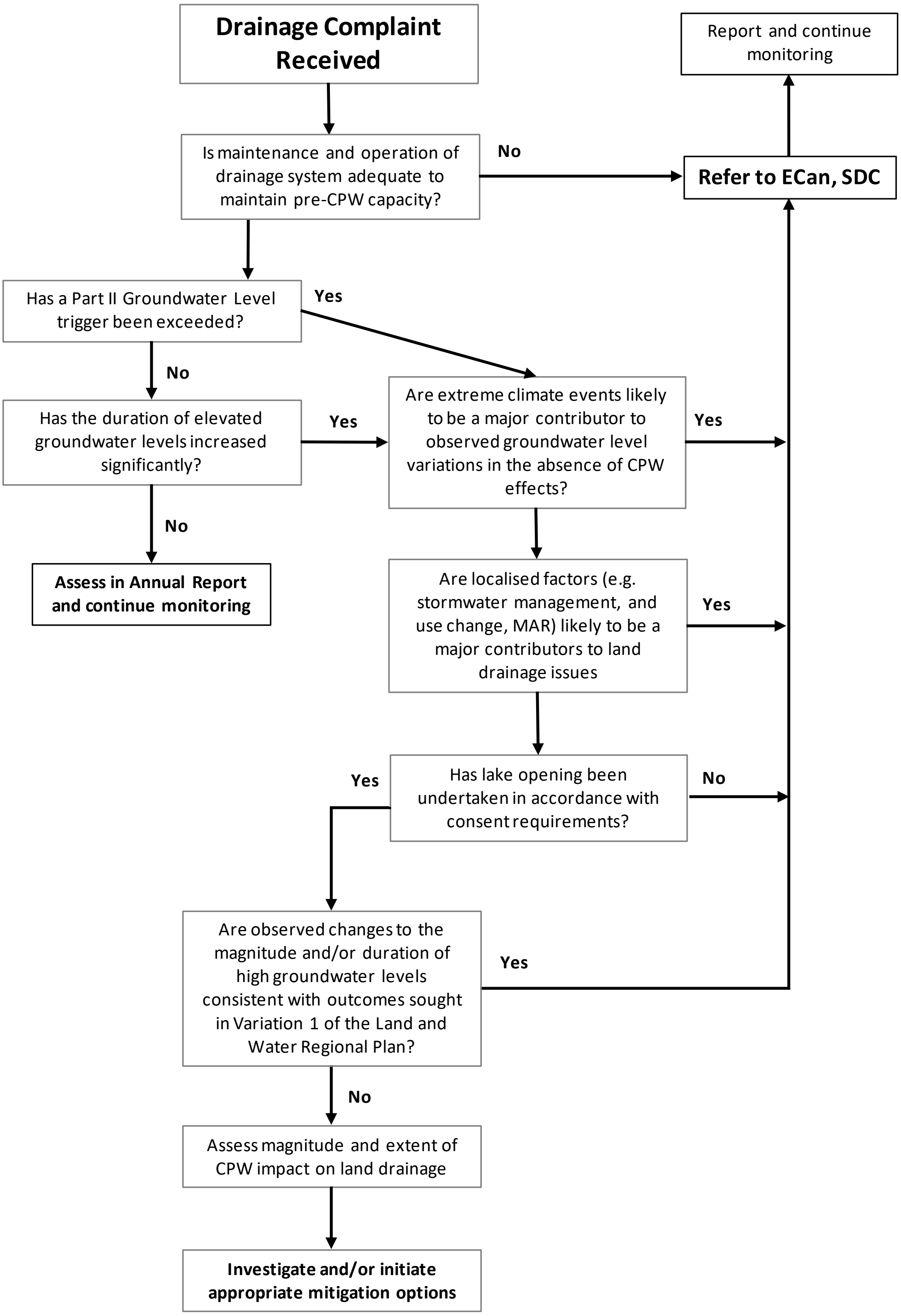


Figure 52. CPWL land drainage complaint response procedure

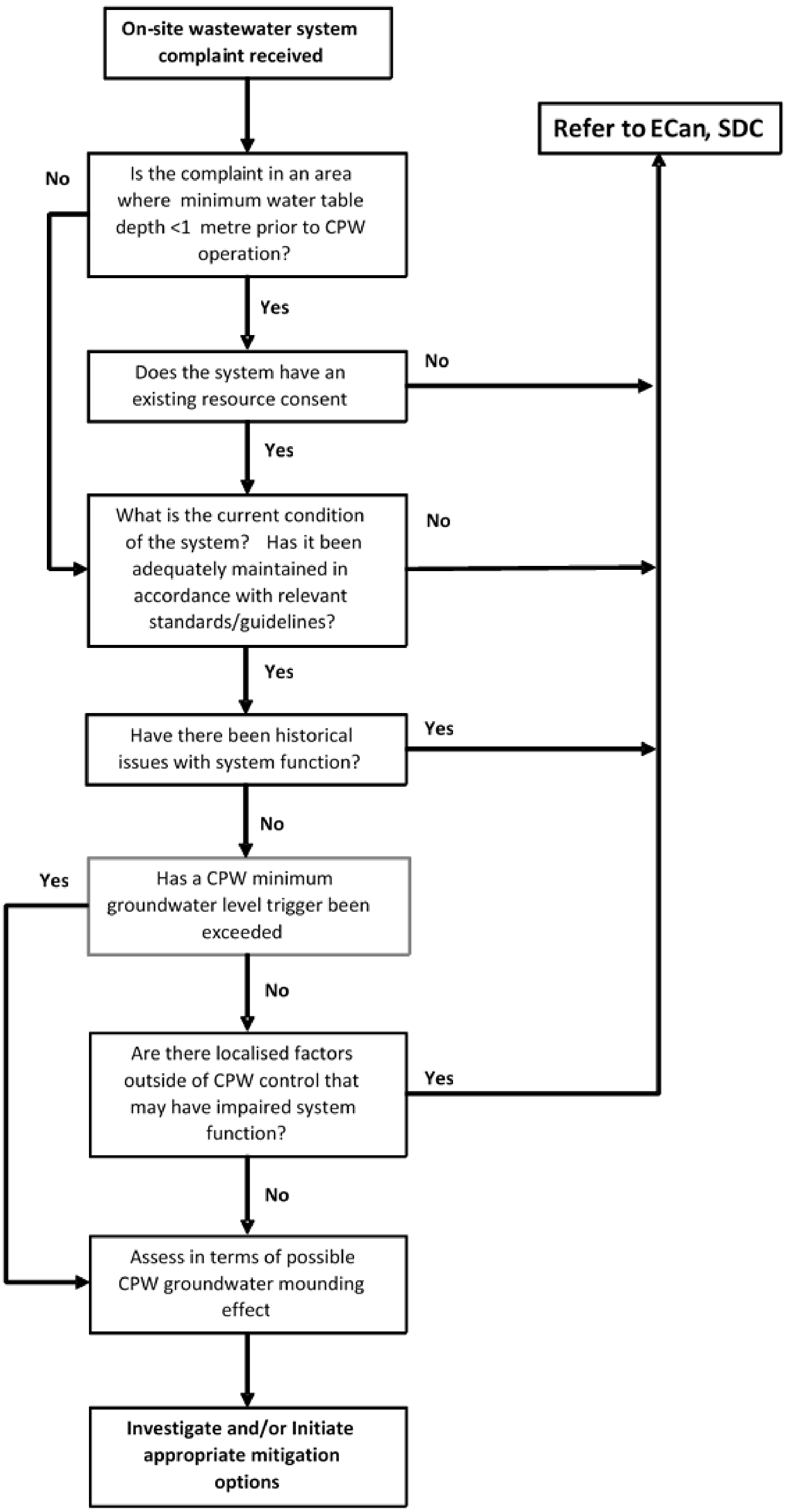


Figure 53. CPWL on-site wastewater complaint response procedure

6.2. Central Plains Water Ltd Annual Compliance Report 2020/2021 Irrigation Season

6.3. River and Stream Monitoring Data (ECan data shown blue)

US1	22/07/2020	18/08/2020	22/09/2020	16/10/2020	16/11/2020	15/12/2020	12/01/2021	17/02/2021	11/03/2021	13/04/2021	7/05/2021	8/06/2021
Nitrate + Nitrite-N (mg/L)	0.657	0.508	0.848	1.00	0.717	0.500	0.940	0.397	0.255	0.177	0.236	1.19
Total Ammoniacal-N (mg/L)	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	1.01	0.54	0.98	1.24	0.89	0.61	1.11	0.61	0.58	0.34	0.32	1.37
E. coli (MPN/100ml)	78	13.7	25.4	144.5	73.8	56	144.5	78.2	> 200.5	78.2	17.8	30.6
Dissolved Reactive Phosphorus (mg/L)	0.009	0.006	0.006	<0.005	0.007	<0.005	0.008	0.005	0.008	<0.005	<0.005	0.007
Total Phosphorus (mg/L)	0.047	0.006	0.009	0.016	0.014	0.010	0.009	0.010	0.029	0.011	0.006	0.015
Electrical Conductivity (µS/cm)	83	95.3	80.9	83.7	84.5	97.3	84.5	90.7	99.3	111.1	114.6	67.1
Dissolved Oxygen (% Sat.)	99.5	99.3	96.1	96.8	101.0	102.5	101.8	101.6	95.1	98.9	99.6	96.3
pH	7.38	7.67	7.72	7.35	7.73	7.74	7.80	7.62	7.54	7.61	7.67	7.09
Temperature (DegC)	5.8	4.8	9.8	4.9	12.5	11.2	11.4	8.2	11.2	11.3	5.3	6.8
Turbidity (NTU)	8.58	0.44	1.05	2.52	1.02	0.47	1.16	0.85	1.24	0.38	0.45	2.75
Flow (cumec)	0.328	0.083	0.312	0.461	0.215	0.091	0.369	0.143	0.155	0.031	0.025	-

No flow data available for June 2021 due to flood damage sustained late in May 2021.

US2	22/07/2020	18/08/2020	22/09/2020	16/10/2020	16/11/2020	15/12/2020	12/01/2021	17/02/2021	11/03/2021	13/04/2021	7/05/2021	3/06/2021
Nitrate + Nitrite-N (mg/L)	0.380	0.564	0.323	0.348	0.058	dry	0.005	dry	dry	dry	dry	2.24
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	dry	0.01	dry	dry	dry	dry	0.03
Total Nitrogen (mg/L)	0.68	0.77	0.70	1.07	0.53	dry	0.44	dry	dry	dry	dry	2.98
E. coli (MPN/100ml)	56	83.1	88.5	> 200.5	144.5	dry	200.5	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.007	0.006	0.006	0.007	0.007	dry	0.008	dry	dry	dry	dry	0.015
Total Phosphorus (mg/L)	0.029	0.014	0.029	0.081	0.047	dry	0.029	dry	dry	dry	dry	0.092
Electrical Conductivity (µS/cm)	191	176.7	151.9	174.7	164.7	dry	158.4	dry	dry	dry	dry	138.5
Dissolved Oxygen (% Sat.)	125.3	97.1	102.3	94.0	104.8	dry	98.6	dry	dry	dry	dry	95.7
pH	9.45	6.69	7.41	7.40	7.17	dry	7.66	dry	dry	dry	dry	6.83
Temperature (DegC)	8.2	9.1	11.5	11.0	18.1	dry	18.7	dry	dry	dry	dry	7.6
Turbidity (NTU)	1.93	0.76	2.52	13.5	1.27	dry	1.12	dry	dry	dry	dry	30.0
Flow (cumec)	0.100	0.028	0.145	0.202	0.020	dry	0.060	dry	dry	dry	dry	1.605

US3	23/07/2020	20/08/2020	16/09/2020	15/10/2020	18/11/2020	15/12/2020	20/01/2021	16/02/2021	23/03/2021	21/04/2021	21/05/2021	16/06/2021
Nitrate + Nitrite-N (mg/L)	0.510	0.470	0.400	0.330	0.400	0.290	0.200	0.240	0.250	0.230	0.270	0.540
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Nitrogen (mg/L)	0.60	0.53	0.51	0.51	0.47	0.37	0.32	0.33	0.29	0.29	0.30	0.65
E. coli (MPN/100ml)	31	12	44	1414	84	18	238	236	18	29	25	55
Dissolved Reactive Phosphorus (mg/L)	0.002	0.002	0.001	<0.0010	0.002	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.004
Total Phosphorus (mg/L)	0.005	0.004	0.004	0.017	<0.004	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	0.061
Electrical Conductivity (µS/cm)	97	101	93	91	104	103	101	105	108	109	106	100
Dissolved Oxygen (% Sat.)	103.1	106.6	104.8	102.0	115.5	105.6	107.2	101.3	101.4	101.6	108.1	98.8
pH	7.60	7.25	7.71	6.99	7.08	7.33	7.49	7.50	7.11	7.12	7.10	6.68
Temperature (DegC)	7.1	8.4	6.5	7.2	11.9	15.0	12.6	13.0	13.1	12.4	10.3	9.2
Turbidity (NTU)	0.60	0.30	1.10	3.20	0.40	0.10	1.10	0.40	0.30	0.40	0.30	45.00
Flow (cumec)	2.548	1.360	3.719	4.887	2.051	1.423	2.958	1.903	0.983	0.835	0.749	3.160

US4	3/07/2020	3/08/2020	2/09/2020	1/10/2020	4/11/2020	1/12/2020	12/01/2021	17/02/2021	11/03/2021	13/04/2021	7/05/2021	8/06/2021
Nitrate + Nitrite-N (mg/L)	0.867	0.388	0.410	0.422	0.283	0.142	0.145	0.098	0.079	<0.005	0.030	0.942
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total Nitrogen (mg/L)	1.05	0.51	1.10	0.63	0.48	0.94	0.34	0.46	0.51	0.18	0.18	1.45
E. coli (MPN/100ml)	89	34.4	> 200.5	42.9	118.4	> 200.5	118.4	> 200.5	> 200.5	43	101.3	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.006	0.009	0.007	0.008	0.013	0.012	0.013	0.011	0.012	0.006	<0.005	0.020
Total Phosphorus (mg/L)	0.019	0.012	0.060	0.020	0.023	0.074	0.024	0.039	0.072	0.020	0.014	0.053
Electrical Conductivity (µS/cm)	83	64.9	141.2	92.5	89.0	64.6	80.5	66.0	81	101	102.9	87.1
Dissolved Oxygen (% Sat.)	97.5	94.9	97.9	94.8	96.0	94.8	99.6	97.4	95.2	95.2	95.7	95.5
pH	7.32	7.46	7.33	7.22	7.41	7.29	7.58	7.27	7.30	7.30	7.27	7.03
Temperature (DegC)	4.2	8.6	9.7	6.2	12.7	9.7	14.1	10.5	12.1	13.0	8.9	8.4
Turbidity (NTU)	1.72	0.59	8.68	1.03	1.16	9.29	1.35	5.62	8.47	0.58	0.40	4.09
Flow (cumec)	0.541	0.097	0.435	0.165	0.127	1.168	0.219	0.482	0.668	0.039	0.036	1.024

IS1	22/07/2020	18/08/2020	22/09/2020	16/10/2020	16/11/2020	15/12/2020	12/01/2021	17/02/2021	11/03/2021	13/04/2021	7/05/2021	8/06/2021
Nitrate + Nitrite-N (mg/L)	2.570	2.29	1.51	1.38	1.14	0.977	1.09	0.785	0.848	dry	dry	3.26
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	dry	dry	0.02
Total Nitrogen (mg/L)	<0.05	2.39	1.68	1.70	1.36	1.13	1.30	1.00	0.99	dry	dry	3.57
E. coli (MPN/100ml)	165	40.6	165.2	> 200.5	165.2	> 200.5	> 200.5	> 200.5	> 200.5	dry	dry	200.5
Dissolved Reactive Phosphorus (mg/L)	0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.007	<0.005	<0.005	dry	dry	0.017
Total Phosphorus (mg/L)	<0.005	<0.005	0.005	0.018	0.008	0.009	0.006	0.006	0.010	dry	dry	0.029
Electrical Conductivity (µS/cm)	136	1338.0	122.7	121.5	119.2	121.1	120.6	126.2	124.1	dry	dry	138.1
Dissolved Oxygen (% Sat.)	105.0	114.0	102.8	98.4	119.6	112.8	108.4	99.6	88.2	dry	dry	91.2
pH	7.52	8.53	7.26	7.51	8.48	8.14	7.80	7.55	7.34	dry	dry	6.92
Temperature (DegC)	8.6	9.0	8.7	8.0	14.1	13.1	13.1	10.8	12.8	dry	dry	9.8
Turbidity (NTU)	0.25	0.33	0.47	1.69	0.28	0.43	0.87	0.37	0.26	dry	dry	2.93
Flow (cumec)	0.185	0.101	0.699	0.627	0.365	0.110	0.371	0.020	0.003	dry	dry	2.458

IS2	22/07/2020	13/08/2020	17/09/2020	15/10/2020	9/11/2020	2/12/2020	12/01/2021	17/02/2021	11/03/2021	14/04/2021	7/05/2021	3/06/2021
Nitrate + Nitrite-N (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	2.96
Total Ammoniacal-N (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.02
Total Nitrogen (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	3.73
E. coli (MPN/100ml)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.028
Total Phosphorus (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.093
Electrical Conductivity (µS/cm)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	131.6
Dissolved Oxygen (% Sat.)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	92.3
pH	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	6.75
Temperature (DegC)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	7.6
Turbidity (NTU)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	25.1
Flow (cumec)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	1.783

IS3	22/07/2020	13/08/2020	17/09/2020	21/10/2020	9/11/2020	2/12/2020	12/01/2021	17/02/2021	11/03/2021	14/04/2021	7/05/2021	11/06/2021
Nitrate + Nitrite-N (mg/L)	dry	dry	dry	0.539	0.572	0.552	dry	dry	dry	dry	dry	0.856
Total Ammoniacal-N (mg/L)	dry	dry	dry	<0.01	<0.01	<0.01	dry	dry	dry	dry	dry	<0.01
Total Nitrogen (mg/L)	dry	dry	dry	0.62	0.98	0.64	dry	dry	dry	dry	dry	0.98
E. coli (MPN/100ml)	dry	dry	dry	< 1	> 200.5	> 200.5	dry	dry	dry	dry	dry	27.1
Dissolved Reactive Phosphorus (mg/L)	dry	dry	dry	<0.005	0.006	<0.005	dry	dry	dry	dry	dry	0.009
Total Phosphorus (mg/L)	dry	dry	dry	0.006	0.048	0.012	dry	dry	dry	dry	dry	0.010
Electrical Conductivity (µS/cm)	dry	dry	dry	97.3	93.7	100.8	dry	dry	dry	dry	dry	103.0
Dissolved Oxygen (% Sat.)	dry	dry	dry	103.1	98.7	96.7	dry	dry	dry	dry	dry	93.6
pH	dry	dry	dry	7.12	7.42	7.11	dry	dry	dry	dry	dry	7.13
Temperature (DegC)	dry	dry	dry	17.6	10.5	12.3	dry	dry	dry	dry	dry	8.9
Turbidity (NTU)	dry	dry	dry	1.08	9.52	1.30	dry	dry	dry	dry	dry	1.45
Flow (cumec)	dry	dry	dry	0.050	2.816	0.688	dry	dry	dry	dry	dry	2.113

IS4	8/06/2021	7/05/2021	13/04/2021	11/03/2021	17/02/2021	12/01/2021	1/12/2020	4/11/2020	1/10/2020	2/09/2020	3/08/2020	3/07/2020
Nitrate + Nitrite-N (mg/L)	2.26	1.20	1.18	1.30	1.16	1.40	1.44	1.35	1.45	1.79	1.88	1.920
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	2.47	1.33	1.20	1.41	1.39	1.53	1.44	1.48	1.59	1.92	1.95	2.03
E. coli (MPN/100ml)	118.4	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	165.2	165.2	88.5	28.8	200.5	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.014	<0.005	<0.005	0.005	0.007	0.007	0.007	<0.005	0.005	0.005	0.008	0.010
Total Phosphorus (mg/L)	0.021	0.013	0.012	0.012	0.012	0.009	0.010	0.006	0.014	0.005	0.012	0.020
Electrical Conductivity (µS/cm)	132.9	124.8	124.2	133.5	132.0	131.2	133.2	129.1	133.6	347.5	140.0	136
Dissolved Oxygen (% Sat.)	88.5	93.8	94.0	94.7	99.2	98.5	94.0	99.7	93.4	102.8	93.6	92.5
pH	7.02	7.35	7.28	7.35	7.47	7.43	7.35	7.40	7.35	7.56	7.25	7.23
Temperature (DegC)	11.1	9.8	12.2	13.3	13.9	15.0	11.6	15.0	9.9	8.6	10.3	7.8
Turbidity (NTU)	1.77	1.56	0.61	0.62	1.07	1.24	0.82	0.98	0.95	0.78	0.88	3.42
Flow (cumec)	3.703	0.056	0.145	0.514	0.713	1.228	1.460	1.229	1.406	0.834	1.238	1.837

SWT1	6/07/2020	3/08/2020	7/09/2020	5/10/2020	9/11/2020	2/12/2020	14/01/2021	18/02/2021	12/03/2021	14/04/2021	10/05/2021	2/06/2021
Nitrate + Nitrite-N (mg/L)	0.035	0.017	0.018	<0.005	0.021	0.025	<0.005	0.021	<0.005	<0.005	<0.005	0.125
Total Ammoniacal-N (mg/L)	<0.01	0.05	<0.01	<0.01	0.03	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	0.05	0.07	0.27	0.08	0.19	0.12	0.08	0.14	0.10	0.07	0.05	0.26
E. coli (MPN/100ml)	41	22.2	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	>200.5	> 200.5	> 200.5	> 200.5	165.2
Dissolved Reactive Phosphorus (mg/L)	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Phosphorus (mg/L)	<0.005	0.010	0.044	0.014	0.050	0.013	0.012	0.036	0.021	0.043	0.005	0.089
Electrical Conductivity (µS/cm)	71	69.0	72.3	59.6	50.9	64.4	65.0	68	61.5	51.7	67.2	59.9
Dissolved Oxygen (% Sat.)	100.0	100.3	97.4	99.3	100.6	99.4	100.4	101.9	101.1	103.9	101.6	100.7
pH	7.60	7.94	7.60	7.81	7.50	7.63	7.56	7.61	7.55	7.72	7.63	7.32
Temperature (DegC)	8.0	11.1	8.5	13.7	11.5	12.3	18.6	12.5	13.9	12.2	13.1	8.0
Turbidity (NTU)	2.66	7.15	12.8	13.1	33.9	3.71	2.89	16.40	4.35	62.1	2.60	99.7
Flow (cumec)	0.052	0.060	0.059	0.059	0.055	0.058	0.044	0.060	0.048	0.077	0.061	0.049

SWT2	6/07/2020	11/08/2020	7/09/2020	15/10/2020	9/11/2020	2/12/2020	14/01/2021	18/02/2021	11/03/2021	13/04/2021	7/05/2021	2/06/2021
Nitrate + Nitrite-N (mg/L)	<0.005	<0.005	<0.005	0.009	0.014	<0.005	dry	dry	dry	dry	dry	dry
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	dry	dry	dry	dry	dry	dry
Total Nitrogen (mg/L)	0.07	0.13	0.12	0.24	0.39	0.20	dry	dry	dry	dry	dry	dry
E. coli (MPN/100ml)	59	19.2	45.3	> 200.5	> 200.5	45.3	dry	dry	dry	dry	dry	dry
Dissolved Reactive Phosphorus (mg/L)	0.009	0.007	<0.005	<0.005	0.014	<0.005	dry	dry	dry	dry	dry	dry
Total Phosphorus (mg/L)	0.020	0.021	0.016	0.036	0.077	0.018	dry	dry	dry	dry	dry	dry
Electrical Conductivity (µS/cm)	72	68.6	70.7	70.0	49.6	57.3	dry	dry	dry	dry	dry	dry
Dissolved Oxygen (% Sat.)	94.5	98.7	94.6	102.4	105.0	108.6	dry	dry	dry	dry	dry	dry
pH	7.16	7.51	7.36	7.49	7.51	8.55	dry	dry	dry	dry	dry	dry
Temperature (DegC)	7.3	8.7	9.1	10.3	13.6	13.1	dry	dry	dry	dry	dry	dry
Turbidity (NTU)	0.70	2.98	3.47	14.7	15.1	1.92	dry	dry	dry	dry	dry	dry
Flow (cumec)	0.010	0.010	0.010	0.025	0.005	0.001	dry	dry	dry	dry	dry	dry

SWT3	6/07/2020	11/08/2020	7/09/2020	7/10/2020	17/11/2020	15/12/2020	14/01/2021	18/02/2021	12/03/2021	19/04/2021	12/05/2021	11/06/2021
Nitrate + Nitrite-N (mg/L)	1.010	0.619	0.515	0.360	0.046	<0.005	0.009	<0.005	0.088	0.186	0.466	1.10
Total Ammoniacal-N (mg/L)	<0.01	<0.01	0.02	0.040	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Total Nitrogen (mg/L)	1.08	0.73	0.61	0.63	0.32	0.21	0.25	0.14	0.29	0.29	0.75	1.37
E. coli (MPN/100ml)	8	40.6	> 200.5	>200.5	> 200.5	> 200.5	> 200.5	145	59.1	28.8	> 200.5	13.7
Dissolved Reactive Phosphorus (mg/L)	0.005	0.005	<0.005	0.006	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Total Phosphorus (mg/L)	0.005	0.008	0.006	0.021	0.023	0.016	0.019	0.008	0.012	0.007	0.013	0.010
Electrical Conductivity (µS/cm)	96	87.4	95.4	89	85.7	81.2	82.1	88	91.2	82.9	93.4	90.2
Dissolved Oxygen (% Sat.)	92.5	106.0	88.3	80.9	77.9	99.0	72.5	75.4	64.3	88.6	87.1	107.1
pH	7.27	7.84	7.23	7.11	7.10	7.36	6.94	6.89	6.82	7.08	7.05	7.61
Temperature (DegC)	7.4	7.5	7.7	9.2	14.2	24.5	18.1	12.7	14.5	10.2	10.0	9.8
Turbidity (NTU)	2.77	1.48	0.88	3.92	2.15	1.05	1.05	1.85	1.17	0.42	0.89	1.37
Flow (cumec)	0.018	0.010	0.003	0.006	0.010	0.008	0.006	0.010	0.009	0.007	0.007	0.010

SWT4	17/07/2020	11/08/2020	4/09/2020	15/10/2020	16/11/2020	16/12/2020	13/01/2021	16/02/2021	24/03/2021	23/04/2021	17/05/2021	9/06/2021
Nitrate + Nitrite-N (mg/L)	0.123	0.089	2.62	0.029	0.009	<0.005	0.010	<0.005	0.025	0.037	0.073	0.164
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	0.05	0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.02
Total Nitrogen (mg/L)	0.17	0.15	2.63	0.11	0.07	0.08	<0.05	0.08	0.08	0.09	0.10	0.25
E. coli (MPN/100ml)	130	53.1	40.6	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	200.5	129.8
Dissolved Reactive Phosphorus (mg/L)	0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	0.005	0.008
Total Phosphorus (mg/L)	0.008	0.010	0.024	0.022	0.017	0.012	0.009	0.012	0.015	0.013	0.032	0.076
Electrical Conductivity (µS/cm)	76	79.8	74.1	61.2	64.9	71.5	73.3	73.4	75.0	69.8	60.7	75.2
Dissolved Oxygen (% Sat.)	101.8	99.6	99.6	98.6	99.8	101.5	95.4	96.8	96.1	102.1	99.5	95.3
pH	7.59	7.73	7.98	7.74	7.92	7.96	7.52	7.47	7.38	7.65	7.27	7.41
Temperature (DegC)	6.2	7.4	9.5	10.0	17.9	19.1	18.0	16.0	15.9	12.3	8.0	7.6
Turbidity (NTU)	4.05	4.44	1.54	19.7	10.4	2.79	2.34	5.60	5.29	2.30	20.5	74.5
Flow (cumec)	0.144	0.131	0.160	0.182	0.168	0.126	0.191	0.195	0.194	0.177	0.162	0.131

SWSH	3/07/2020	11/08/2020	7/09/2020	7/10/2020	9/11/2020	2/12/2020	14/01/2021	18/02/2021	8/03/2021	19/04/2021	10/05/2021	11/06/2021
Nitrate + Nitrite-N (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	1.96
Total Ammoniacal-N (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	<0.01
Total Nitrogen (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	2.20
E. coli (MPN/100ml)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	17.8
Dissolved Reactive Phosphorus (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.010
Total Phosphorus (mg/L)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.012
Electrical Conductivity (μS/cm)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	126.9
Dissolved Oxygen (% Sat.)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	93.6
pH	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	7.36
Temperature (DegC)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	11.0
Turbidity (NTU)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.74
Flow (cumec)	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	3.500

SF1	13/07/2020	10/08/2020	4/09/2020	7/10/2020	17/11/2020	15/12/2020	13/01/2021	16/02/2021	10/03/2021	19/04/2021	12/05/2021	9/06/2021
Nitrate + Nitrite-N (mg/L)	3.220	3.41	3.43	3.160	2.94	3.00	2.80	2.35	2.77	2.72	1.73	2.97
Total Ammoniacal-N (mg/L)	0.070	0.04	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.08
Total Nitrogen (mg/L)	3.51	3.61	3.50	3.53	3.19	3.17	2.97	2.75	2.87	3.00	2.40	3.60
E. coli (MPN/100ml)	>200.5	> 200.5	> 200.5	>200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.017	0.017	0.015	0.014	0.015	0.031	0.025	0.019	0.013	0.017	0.012	0.022
Total Phosphorus (mg/L)	0.094	0.073	0.061	0.040	0.025	0.050	0.039	0.045	0.029	0.039	0.156	0.124
Electrical Conductivity (µS/cm)	233	223.8	216.7	211	210.0	201.6	204.9	199.3	201.5	201.5	164.8	224.5
Dissolved Oxygen (% Sat.)	85.8	92.3	97.3	111.4	97.2	100.0	117.8	106.6	98.4	97.7	84.4	82.1
pH	7.30	7.46	7.57	8.02	7.62	8.94	8.33	8.00	8.01	7.53	7.16	7.26
Temperature (DegC)	9.8	11.2	11.4	14.0	13.9	17.9	18.6	14.6	15.4	12.5	11.3	11.8
Turbidity (NTU)	19.90	17.9	8.56	4.19	1.06	0.55	1.73	2.74	1.43	0.85	22.2	18.8
Flow (cumec)	0.633	0.686	0.581	0.488	0.451	0.310	0.359	0.325	0.266	0.250	0.564	0.487

SF2	13/07/2020	10/08/2020	4/09/2020	7/10/2020	9/11/2020	2/12/2020	13/01/2021	16/02/2021	15/03/2021	19/04/2021	13/05/2021	3/06/2021
Nitrate + Nitrite-N (mg/L)	4.040	4.07	4.17	4.050	4.28	4.24	4.08	3.66	4.05	3.96	4.16	3.98
Total Ammoniacal-N (mg/L)	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01
Total Nitrogen (mg/L)	3.95	4.03	4.15	4.37	4.43	4.16	4.14	4.02	4.06	4.17	4.20	4.11
E. coli (MPN/100ml)	34	11.1	16.4	no result	42.9	129.8	109.1	118.4	59.1	45.3	73.8	59.1
Dissolved Reactive Phosphorus (mg/L)	0.013	0.013	0.008	0.011	0.010	0.005	0.007	0.008	0.010	0.011	0.012	0.012
Total Phosphorus (mg/L)	0.009	0.011	0.008	0.012	0.016	0.009	0.008	0.008	0.009	0.019	0.013	0.014
Electrical Conductivity (µS/cm)	225	223.5	223.7	224	228.6	225.1	226.6	225.6	224.7	223.4	223.9	225.2
Dissolved Oxygen (% Sat.)	80.5	77.2	78.7	75.1	83.7	86.4	74.5	70.9	65.0	69.9	74.0	84.7
pH	6.88	6.86	6.86	6.89	6.83	7.06	6.92	6.87	6.85	6.85	6.82	6.96
Temperature (DegC)	12.4	12.8	12.4	12.6	14.3	13.9	14.2	13.2	13.1	13.1	11.7	13.4
Turbidity (NTU)	0.24	0.35	0.32	0.37	0.88	0.59	0.45	0.43	0.30	0.21	1.93	0.45
Flow (cumec)	0.085	0.094	0.078	0.072	0.076	0.072	0.069	0.058	0.061	0.073	0.072	0.083

SF3	17/07/2020	11/08/2020	4/09/2020	6/10/2020	5/11/2020	2/12/2020	15/01/2021	19/02/2021	12/03/2021	19/04/2021	12/05/2021	9/06/2021
Nitrate + Nitrite-N (mg/L)	8.200	7.78	8.95	9.070	9.24	8.15	8.63	8.760	9.40	9.41	9.01	3.05
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Total Nitrogen (mg/L)	8.19	8.88	8.98	9.23	9.84	9.48	9.41	9.58	9.63	9.73	9.58	3.50
E. coli (MPN/100ml)	32	23.8	28.8	38	94.5	62.4	94.5	66	53.1	59.1	> 200.5	40.6
Dissolved Reactive Phosphorus (mg/L)	0.012	0.008	0.006	0.007	0.008	0.007	0.011	0.011	0.010	0.008	0.008	0.012
Total Phosphorus (mg/L)	0.009	0.014	0.005	0.008	0.009	0.009	0.011	0.010	0.007	0.013	0.006	0.017
Electrical Conductivity (µS/cm)	265	267.8	268.6	269	275.7	277.1	277.5	276	272.6	273.2	275.9	148.3
Dissolved Oxygen (% Sat.)	94.9	93.2	95.1	0.0	85.9	84.5	74.1	76.1	83.0	78.9	78.1	90.5
pH	7.19	7.26	7.33	7.24	7.17	7.19	7.06	7.00	7.16	7.21	7.06	7.15
Temperature (DegC)	9.5	10.5	11.7	14.0	16.6	14.1	16.8	15.8	16.8	15.1	12.4	11.2
Turbidity (NTU)	0.24	0.28	0.34	0.39	0.37	0.23	0.33	0.15	0.16	0.17	0.22	2.71
Flow (cumec)	0.704	0.727	0.684	0.529	0.318	0.303	0.253	0.060	0.045	0.060	0.080	6.280

SF4	3/07/2020	3/08/2020	2/09/2020	1/10/2020	5/11/2020	1/12/2020	14/01/2021	18/02/2021	11/03/2021	13/04/2021	7/05/2021	14/06/2021
Nitrate + Nitrite-N (mg/L)	dry	3.11	dry	1.70	1.22	1.07	0.925	dry	dry	dry	dry	5.54
Total Ammoniacal-N (mg/L)	dry	0.06	dry	<0.01	<0.01	<0.01	0.01	dry	dry	dry	dry	0.02
Total Nitrogen (mg/L)	dry	3.17	dry	1.88	1.38	1.15	1.03	dry	dry	dry	dry	5.65
E. coli (MPN/100ml)	dry	118.4	dry	144.5	> 200.5	200.5	> 200.5	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	dry	0.011	dry	<0.005	<0.005	<0.005	0.010	dry	dry	dry	dry	0.032
Total Phosphorus (mg/L)	dry	0.014	dry	0.009	<0.005	0.008	0.010	dry	dry	dry	dry	0.035
Electrical Conductivity (µS/cm)	dry	158.5	dry	139.5	131.5	132.2	137.2	dry	dry	dry	dry	203.6
Dissolved Oxygen (% Sat.)	dry	103.7	dry	122.2	97.5	101.8	54.7	dry	dry	dry	dry	71.9
pH	dry	6.80	dry	7.04	6.86	6.87	6.68	dry	dry	dry	dry	6.62
Temperature (DegC)	dry	11.0	dry	11.9	13.9	13.1	14.3	dry	dry	dry	dry	11.6
Turbidity (NTU)	dry	0.22	dry	0.43	0.44	0.43	0.41	dry	dry	dry	dry	0.84
Flow (cumec)	dry	0.092	dry	0.062	0.053	0.108	0.027	dry	dry	dry	dry	0.137

SF5	3/07/2020	6/08/2020	3/09/2020	5/10/2020	5/11/2020	1/12/2020	15/01/2021	18/02/2021	12/03/2021	14/04/2021	10/05/2021	1/06/2021
Nitrate + Nitrite-N (mg/L)	2.920	3.18	3.60	2.99	2.21	2.75	1.65	dry	dry	dry	dry	2.94
Total Ammoniacal-N (mg/L)	0.020	<0.01	<0.01	<0.01	0.02	<0.01	0.02	dry	dry	dry	dry	0.11
Total Nitrogen (mg/L)	3.64	3.63	3.98	3.36	2.71	3.12	2.11	dry	dry	dry	dry	4.53
E. coli (MPN/100ml)	> 200.5	200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.185	0.007	<0.005	0.009	0.025	0.054	0.022	dry	dry	dry	dry	0.550
Total Phosphorus (mg/L)	0.260	0.013	0.015	0.034	0.051	0.085	0.041	dry	dry	dry	dry	0.730
Electrical Conductivity (µS/cm)	323	351.4	293.9	249.1	229.5	220.4	210.4	dry	dry	dry	dry	248.0
Dissolved Oxygen (% Sat.)	92.4	115.8	106.7	106.6	112.5	112.2	110.3	dry	dry	dry	dry	83.6
pH	7.14	7.21	7.23	7.37	8.14	8.35	8.13	dry	dry	dry	dry	7.00
Temperature (DegC)	7.2	9.9	7.3	12.2	18.5	14.9	18.9	dry	dry	dry	dry	10.4
Turbidity (NTU)	10.80	0.55	0.88	2.17	3.16	1.49	1.76	dry	dry	dry	dry	46.4
Flow (cumec)	0.242	0.058	0.062	0.049	0.001	0.054	0.017	dry	dry	dry	dry	0.540

SF6	6/07/2020	6/08/2020	3/09/2020	12/10/2020	17/11/2020	16/12/2020	14/01/2021	18/02/2021	12/03/2021	14/04/2021	10/05/2021	2/06/2021
Nitrate + Nitrite-N (mg/L)	5.420	5.07	4.99	5.12	4.97	5.46	4.76	4.980	5.07	5.32	4.82	5.65
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total Nitrogen (mg/L)	5.30	5.72	5.34	5.70	5.31	5.55	5.20	5.47	5.52	5.44	4.96	6.05
E. coli (MPN/100ml)	43	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	> 200.5	>200.5	> 200.5	> 200.5	200.5	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.008	0.005	<0.005	0.005	0.007	0.007	0.005	0.009	0.005	<0.005	0.007	0.014
Total Phosphorus (mg/L)	0.008	0.009	0.009	0.022	0.011	0.008	0.014	0.008	0.011	0.008	0.006	0.023
Electrical Conductivity (µS/cm)	244	246.1	242.9	232.5	228.0	232.3	227.7	231	232.5	230.8	228.7	274.8
Dissolved Oxygen (% Sat.)	81.2	76.7	81.9	86.4	97.2	79.6	85.6	87.7	87.4	102.1	88.5	67.2
pH	6.68	6.68	6.68	6.81	6.77	6.75	6.74	6.75	6.69	6.87	6.86	6.67
Temperature (DegC)	11.7	10.3	9.7	13.3	16.3	13.5	16.5	15.5	15.6	15.9	14.3	11.4
Turbidity (NTU)	0.60	0.76	1.04	3.62	0.62	0.70	0.48	1.31	0.91	1.05	0.44	1.65
Flow (cumec)	0.079	0.068	0.064	0.055	0.060	0.045	0.064	0.052	0.051	0.044	0.044	0.131

SF7	6/07/2020	5/08/2020	2/09/2020	5/10/2020	5/11/2020	1/12/2020	15/01/2021	18/02/2021	11/03/2021	13/04/2021	10/05/2021	2/06/2021
Nitrate + Nitrite-N (mg/L)	9.110	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	10.6
Total Ammoniacal-N (mg/L)	0.010	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	<0.01
Total Nitrogen (mg/L)	9.00	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	12.1
E. coli (MPN/100ml)	165	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.009	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.016
Total Phosphorus (mg/L)	0.014	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.035
Electrical Conductivity (µS/cm)	317	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	411.7
Dissolved Oxygen (% Sat.)	72.3	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	51.6
pH	6.73	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	6.53
Temperature (DegC)	10.4	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	10.1
Turbidity (NTU)	0.83	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	2.87
Flow (cumec)	0.001	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	0.010

SF8	17/07/2020	11/08/2020	7/09/2020	15/10/2020	20/11/2020	15/12/2020	15/01/2021	19/02/2021	12/03/2021	19/04/2021	12/05/2021	9/06/2021
Nitrate + Nitrite-N (mg/L)	10.200	10.4	10.2	10.2	dry	dry	dry	dry	dry	dry	dry	dry
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	dry	dry	dry	dry	dry	dry	dry	dry
Total Nitrogen (mg/L)	10.30	10.6	10.6	10.3	dry	dry	dry	dry	dry	dry	dry	dry
E. coli (MPN/100ml)	8	88.5	34.4	165.2	dry	dry	dry	dry	dry	dry	dry	dry
Dissolved Reactive Phosphorus (mg/L)	0.012	0.009	0.006	<0.005	dry	dry	dry	dry	dry	dry	dry	dry
Total Phosphorus (mg/L)	0.013	0.009	<0.005	0.017	dry	dry	dry	dry	dry	dry	dry	dry
Electrical Conductivity (µS/cm)	355	342.8	337.1	339.2	dry	dry	dry	dry	dry	dry	dry	dry
Dissolved Oxygen (% Sat.)	85.7	79.1	83.8	69.9	dry	dry	dry	dry	dry	dry	dry	dry
pH	6.84	6.81	6.85	6.78	dry	dry	dry	dry	dry	dry	dry	dry
Temperature (DegC)	11.7	12.6	12.4	11.7	dry	dry	dry	dry	dry	dry	dry	dry
Turbidity (NTU)	0.35	0.55	0.20	0.59	dry	dry	dry	dry	dry	dry	dry	dry
Flow (cumec)	0.034	0.001	0.029	0.010	dry	dry	dry	dry	dry	dry	dry	dry

T1	13/07/2020	10/08/2020	4/09/2020	7/10/2020	17/11/2020	15/12/2020	13/01/2021	16/02/2021	10/03/2021	19/04/2021	12/05/2021	9/06/2021
Nitrate + Nitrite-N (mg/L)	2.440	2.54	0.060	2.290	1.99	1.68	1.34	1.44	1.94	2.15	2.18	2.13
Total Ammoniacal-N (mg/L)	0.080	0.05	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10
Total Nitrogen (mg/L)	2.96	2.67	0.11	2.72	2.30	1.83	1.60	1.87	2.06	2.49	2.59	2.95
E. coli (MPN/100ml)	45	59.1	47.8	36	200.5	36.4	165.2	78.2	15	36.4	109.1	45.3
Dissolved Reactive Phosphorus (mg/L)	0.052	0.028	<0.005	0.012	0.033	0.029	0.016	0.029	0.012	0.023	0.010	0.087
Total Phosphorus (mg/L)	0.091	0.040	<0.005	0.034	0.058	0.043	0.041	0.065	0.032	0.052	0.049	0.144
Electrical Conductivity (μS/cm)	321	263.1	261.2	244	242.2	229.3	231.6	232.0	235.2	237.9	261.0	324.9
Dissolved Oxygen (% Sat.)	76.9	96.9	95.4	91.8	76.6	0.0	120.0	97.7	105.1	85.7	76.9	64.1
pH	7.20	7.74	7.68	7.64	7.55	8.91	8.72	7.68	8.19	7.35	7.26	7.03
Temperature (DegC)	9.4	10.2	10.1	14.5	17.2	19.1	20.4	17.3	16.4	13.2	12.8	11.6
Turbidity (NTU)	7.69	2.62	3.30	1.42	1.49	1.17	0.90	1.38	0.74	0.68	0.80	5.32
Flow (cumec)	2.971	2.270	2.334	2.043	1.584	1.160	1.215	1.227	1.158	1.327	1.800	-

No flow data available for June 2021 due to weed cutting.

T2	21/07/2020	18/08/2020	22/09/2020	23/10/2020	17/11/2020	18/12/2020	21/01/2021	18/02/2021	25/03/2021	20/04/2021	19/05/2021	24/06/2021
Nitrate + Nitrite-N (mg/L)	3.400	3.400	3.300	3.500	4.800	3.400	3.300	3.200	3.300	3.000	3.000	3.000
Total Ammoniacal-N (mg/L)	0.025	0.017	<0.010	0.012	0.011	<0.010	0.019	<0.010	<0.010	<0.010	<0.010	0.032
Total Nitrogen (mg/L)	3.50	3.70	3.50	3.60	5.50	3.80	3.60	3.40	3.50	3.60	3.10	3.60
E. coli (MPN/100ml)	67	122	249	1203	687	365	435	166	148	64	63	99
Dissolved Reactive Phosphorus (mg/L)	0.013	0.010	0.007	0.016	0.007	0.012	0.010	0.008	0.010	0.013	0.013	0.038
Total Phosphorus (mg/L)	0.032	0.019	0.020	0.029	0.014	0.018	0.013	0.009	0.012	0.014	0.015	0.057
Electrical Conductivity (µS/cm)	232	219	210	220	237	219	220	226	229	226	217	256
Dissolved Oxygen (% Sat.)	83.5	88.1	101.8	102.9	100.7	130.3	99.5	9.4	74.5	81.5	76.3	80.5
pH	7.11	7.40	7.42	7.23	7.37	7.91	7.39	7.15	7.01	7.12	7.06	7.00
Temperature (DegC)	11.8	11.8	13.6	15.1	15.0	18.9	14.9	14.1	14.2	12.8	11.2	11.2
Turbidity (NTU)	10.30	11.40	8.80	6.10	2.80	2.80	1.70	1.20	0.70	0.80	1.10	6.00
Flow (cumec)	2.364	2.249	2.320	1.757	1.552	1.166	1.140	1.142	1.051	1.301	1.592	2.597

T3	21/07/2020	18/08/2020	22/09/2020	21/10/2020	17/11/2020	18/12/2020	21/01/2021	18/02/2021	25/03/2021	20/04/2021	19/05/2021	24/06/2021
Nitrate + Nitrite-N (mg/L)	7.800	8.600	8.500	8.200	7.400	7.800	7.500	7.000	6.700	6.600	7.300	5.600
Total Ammoniacal-N (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.019
Total Nitrogen (mg/L)	8.30	7.80	8.00	8.00	8.10	8.20	7.30	6.30	7.20	7.10	7.60	5.70
E. coli (MPN/100ml)	261	291	326	866	2420	980	387	488	461	308	687	461
Dissolved Reactive Phosphorus (mg/L)	0.017	0.008	0.007	0.008	0.024	0.010	0.008	0.011	0.010	0.006	0.009	0.044
Total Phosphorus (mg/L)	0.019	0.008	0.008	0.012	0.032	0.011	0.008	0.008	0.009	0.006	0.008	0.055
Electrical Conductivity (µS/cm)	287	264	273	268	277	275	273	273	276	277	277	224
Dissolved Oxygen (% Sat.)	97.0	100.6	104.0	99.3	99.7	91.8	89.1	90.7	81.1	81.7	82.2	91.6
pH	7.41	7.44	7.65	7.61	7.35	7.12	7.33	7.39	7.07	6.94	7.98	7.06
Temperature (DegC)	10.4	8.6	12.6	13.7	15.6	16.8	15.2	16.6	15.8	12.6	9.7	9.1
Turbidity (NTU)	1.00	0.10	0.50	0.50	0.50	0.20	0.30	0.30	0.20	0.50	0.20	3.30
Flow (cumec)	1.368	1.189	1.081	0.627	0.573	0.346	0.245	0.118	0.098	0.105	0.190	24.950

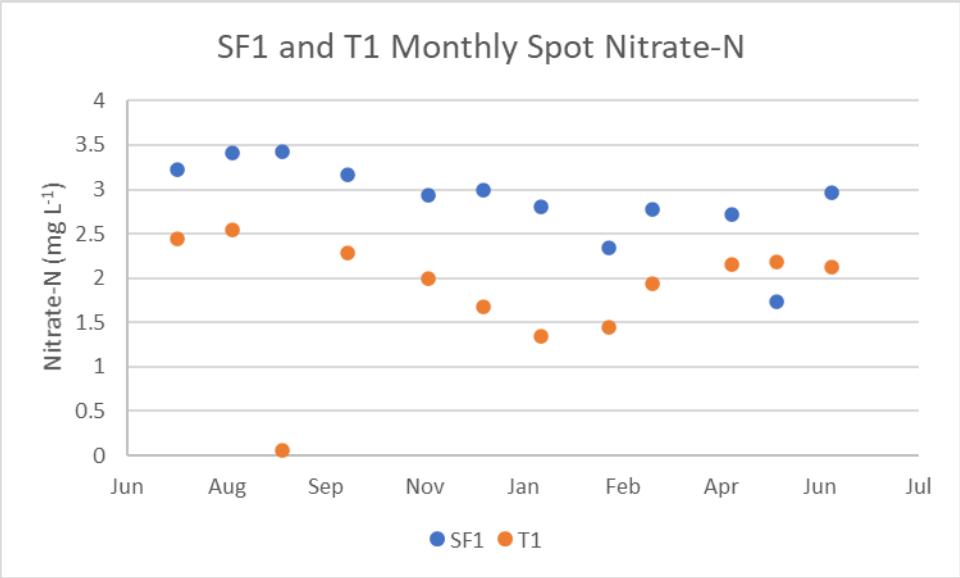
T4	3/07/2020	3/08/2020	2/09/2020	1/10/2020	20/11/2020	1/12/2020	14/01/2021	18/02/2021	11/03/2021	13/04/2021	10/05/2021	14/06/2021
Nitrate + Nitrite-N (mg/L)	0.032	0.093	<0.005	<0.005	<0.005	dry	dry	dry	dry	dry	dry	4.24
Total Ammoniacal-N (mg/L)	0.130	<0.01	<0.01	<0.01	0.68	dry	dry	dry	dry	dry	dry	0.02
Total Nitrogen (mg/L)	0.55	0.33	0.21	0.22	1.12	dry	dry	dry	dry	dry	dry	4.54
E. coli (MPN/100ml)	118	144.5	> 200.5	165.2	> 200.5	dry	dry	dry	dry	dry	dry	101.3
Dissolved Reactive Phosphorus (mg/L)	0.008	0.006	<0.005	<0.005	0.015	dry	dry	dry	dry	dry	dry	0.025
Total Phosphorus (mg/L)	0.079	0.012	0.005	0.009	0.341	dry	dry	dry	dry	dry	dry	0.032
Electrical Conductivity (µS/cm)	490	356.0	352.3	338.2	386.2	dry	dry	dry	dry	dry	dry	232.9
Dissolved Oxygen (% Sat.)	43.6	98.4	112.7	95.3	22.7	dry	dry	dry	dry	dry	dry	76.1
pH	6.68	7.43	8.16	7.40	6.85	dry	dry	dry	dry	dry	dry	6.95
Temperature (DegC)	6.9	10.3	10.8	10.0	12.7	dry	dry	dry	dry	dry	dry	10.6
Turbidity (NTU)	15.40	0.61	0.72	0.75	18.3	dry	dry	dry	dry	dry	dry	0.65
Flow (cumec)	0.010	0.133	0.112	0.068	0.004	dry	dry	dry	dry	dry	dry	0.795

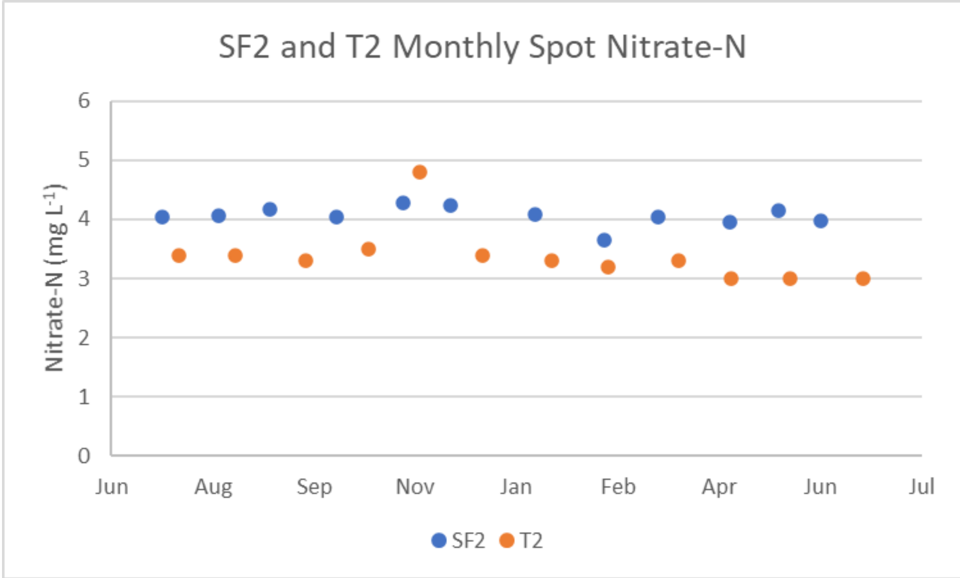
T5	3/07/2020	6/08/2020	3/09/2020	5/10/2020	5/11/2020	1/12/2020	15/01/2021	18/02/2021	12/03/2021	14/04/2021	10/05/2021	1/06/2021
Nitrate + Nitrite-N (mg/L)	2.440	1.37	1.59	0.795	0.012	0.067	0.288	dry	dry	dry	dry	2.02
Total Ammoniacal-N (mg/L)	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.60	dry	dry	dry	dry	0.11
Total Nitrogen (mg/L)	3.29	1.69	1.92	1.21	0.42	0.41	0.42	dry	dry	dry	dry	3.87
E. coli (MPN/100ml)	> 200.5	101.3	> 200.5	165.2	> 200.5	165.2	200.5	dry	dry	dry	dry	> 200.5
Dissolved Reactive Phosphorus (mg/L)	0.197	0.012	<0.005	<0.005	0.038	0.025	0.450	dry	dry	dry	dry	0.641
Total Phosphorus (mg/L)	0.278	0.017	0.011	0.026	0.065	0.040	0.055	dry	dry	dry	dry	0.957
Electrical Conductivity (µS/cm)	411	451.6	406.0	400.5	545.7	429.7	513.9	dry	dry	dry	dry	160.8
Dissolved Oxygen (% Sat.)	93.5	106.8	99.5	102.4	75.2	104.9	91.7	dry	dry	dry	dry	87.3
pH	7.31	8.00	7.82	7.91	7.68	8.23	7.72	dry	dry	dry	dry	7.02
Temperature (DegC)	6.8	9.7	6.8	12.8	16.3	12.3	19.2	dry	dry	dry	dry	10.3
Turbidity (NTU)	9.72	0.34	0.38	0.74	1.29	0.68	0.79	dry	dry	dry	dry	141
Flow (cumec)	0.302	0.096	0.081	0.039	0.003	0.005	0.002	dry	dry	dry	dry	1.565

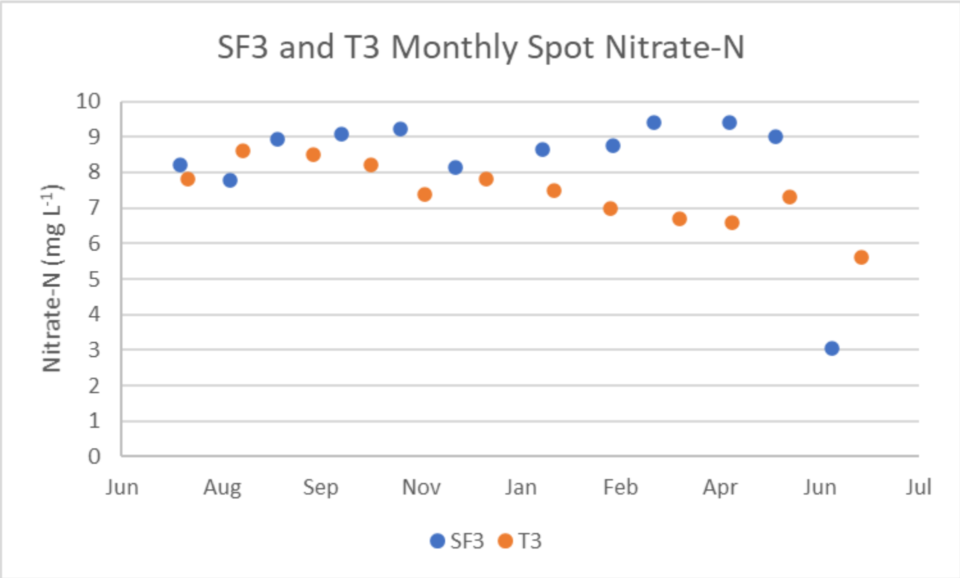
T6	6/07/2020	6/08/2020	3/09/2020	22/09/2020	12/10/2020	17/11/2020	16/12/2020	18/12/2020	14/01/2021	18/02/2021	12/03/2021	25/03/2021	14/04/2021	10/05/2021	2/06/2021	24/06/2021
Nitrate + Nitrite-N (mg/L)	4.22	4.50	4.80	4.90	4.71	4.79	4.64	4.80	4.76	4.64	4.65	4.80	5.36	4.93	5.06	5.00
Total Ammoniacal-N (mg/L)	0.020	0.01	<0.01	0.167	<0.01	0.01	<0.01	<0.010	0.04	0.020	<0.01	<0.010	<0.01	<0.01	0.07	0.025
Total Nitrogen (mg/L)	4.51	4.98	4.81	5.00	5.29	5.16	4.92	5.90	4.93	5.00	4.87	5.10	5.56	5.50	6.09	5.60
E. coli (MPN/100ml)	118	> 200.5	118.4	866	> 200.5	> 200.5	> 200.5	1414	> 200.5	>200.5	> 200.5	980	> 200.5	> 200.5	> 200.5	248
Dissolved Reactive Phosphorus (mg/L)	0.030	0.016	0.008	0.0120	<0.005	0.017	0.017	0.0197	0.021	0.0140	0.006	0.0192	0.006	0.015	0.126	0.049
Total Phosphorus (mg/L)	0.050	0.027	0.023	0.022	0.033	0.027	0.033	0.028	0.034	0.017	0.014	0.026	0.023	0.021	0.172	0.063
Electrical Conductivity (µS/cm)	383	338.2	323.2	302	288.3	294.4	287.2	276	280.6	269	270.2	260	269.8	273.6	397.7	405
Dissolved Oxygen (% Sat.)	91.9	100.7	98.7	102.1	93.8	95.6	87.0	98.6	90.0	93.8	93.1	91.2	92.3	86.8	88.4	92.8
pH	7.46	7.88	7.76	7.53	7.75	7.69	7.43	7.46	7.47	7.51	7.50	7.33	7.53	7.39	7.33	7.20
Temperature (DegC)	10.5	10.5	8.6	11.0	15.0	15.7	16.9	17.5	18.4	15.5	15.8	15.4	14.1	14.4	9.8	9.7
Turbidity (NTU)	2.92	1.69	1.33	2.20	2.52	0.56	0.55	0.80	0.77	0.83	0.54	1.50	0.79	0.87	4.46	2.70
Flow (cumec)	0.346	0.204	0.164	0.177	0.098	0.124	0.047	0.064	0.092	0.069	0.061	0.093	0.087	0.092	0.544	0.517

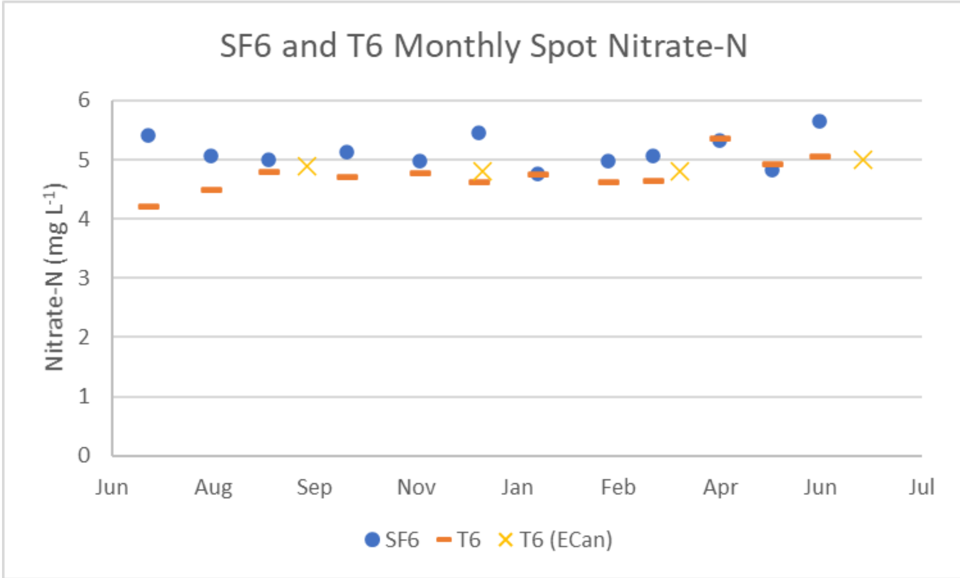
T7	6/07/2020	6/08/2020	2/09/2020	22/09/2020	5/10/2020	5/11/2020	1/12/2020	18/12/2020	15/01/2021	18/02/2021	11/03/2021	25/03/2021	13/04/2021	10/05/2021	2/06/2021	24/06/2021
Nitrate + Nitrite-N (mg/L)	3.54	2.82	2.58	2.20	0.427	0.168	0.222	0.17	0.020	<0.005	<0.005	<0.002	<0.005	0.235	4.77	5.40
Total Ammoniacal-N (mg/L)	0.010	<0.01	<0.01	0.012	0.04	0.03	0.02	0.029	0.01	<0.01	<0.01	<0.010	<0.01	0.02	0.03	<0.010
Total Nitrogen (mg/L)	3.89	3.39	3.05	2.40	0.83	0.67	0.53	0.40	0.25	0.25	0.27	0.24	0.26	0.50	6.13	5.60
E. coli (MPN/100ml)	36	> 200.5	200.5	866	129.8	> 200.5	> 200.5	>2420	144.5	145	12.4	23	50.4	34.4	201	44
Dissolved Reactive Phosphorus (mg/L)	0.029	0.006	<0.005	0.0039	0.009	0.019	0.024	0.0196	0.019	0.0100	0.015	0.0081	0.014	0.054	0.187	0.051
Total Phosphorus (mg/L)	0.038	0.016	0.012	0.015	0.031	0.061	0.036	0.028	0.024	0.012	0.019	0.010	0.020	0.055	0.233	0.058
Electrical Conductivity (µS/cm)	398	365.2	89.4	340	322.7	280.7	292.1	281	287.5	292	298.9	288	300.3	315.2	460.1	414
Dissolved Oxygen (% Sat.)	90.4	121.8	97.4	115.3	125.3	131.2	113.2	118.6	85.5	74.0	44.9	43.0	47.9	48.0	80.1	89.7
pH	7.33	8.58	7.26	7.69	8.18	8.04	7.63	7.54	7.19	7.16	6.98	6.83	7.02	7.09	7.06	7.18
Temperature (DegC)	10.5	11.4	5.1	12.0	15.3	21.4	17.6	19.2	18.2	16.5	15.9	13.9	14.3	14.2	9.6	9.4
Turbidity (NTU)	0.70	0.46	0.75	0.60	1.18	1.61	0.35	0.40	0.37	0.24	0.21	0.50	0.17	0.24	3.81	0.80
Flow (cumec)	0.292	0.127	0.098	0.083	0.018	0.007	0.014	0.005	0.005	0.003	0.002	0.003	0.004	0.006	0.243	0.303

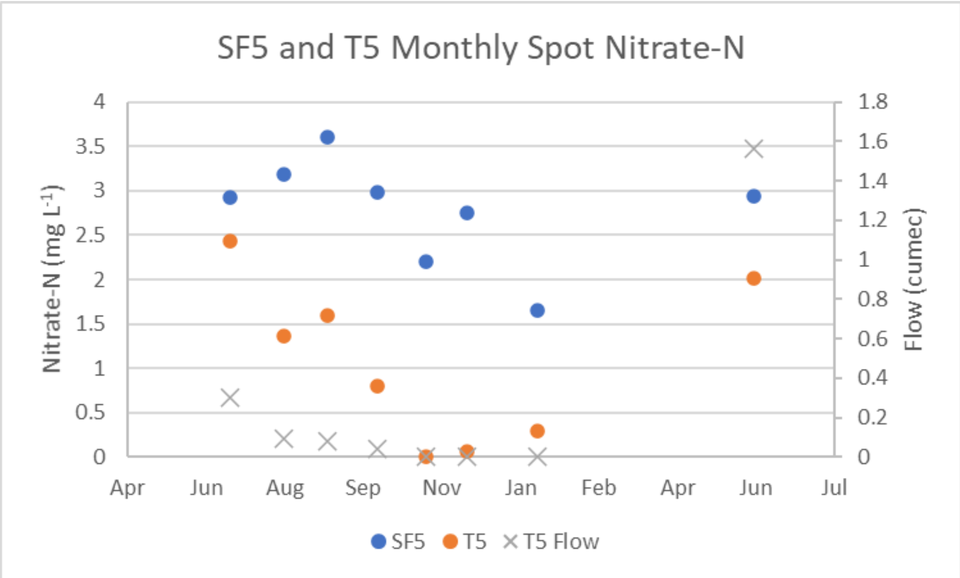
T8	21/07/2020	18/08/2020	22/09/2020	21/10/2020	17/11/2020	18/12/2020	21/01/2021	18/02/2021	25/03/2021	20/04/2021	19/05/2021	24/06/2021
Nitrate + Nitrite-N (mg/L)	7.900	8.200	8.100	7.800	7.100	7.600	7.300	7.300	7.000	7.400	7.500	7.600
Total Ammoniacal-N (mg/L)	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Nitrogen (mg/L)	7.10	7.40	7.60	7.90	7.10	7.40	7.10	6.90	7.10	7.10	7.30	7.20
E. coli (MPN/100ml)	193	111	548	816	727	770	461	435	548	435	980	124
Dissolved Reactive Phosphorus (mg/L)	0.010	0.008	0.006	0.006	0.007	0.007	0.008	0.008	0.010	0.007	0.009	0.015
Total Phosphorus (mg/L)	0.014	0.009	0.011	0.012	0.010	0.010	0.007	0.006	0.008	0.007	0.009	0.016
Electrical Conductivity (µS/cm)	276	264	269	252	255	247	245	242	240	248	250	273
Dissolved Oxygen (% Sat.)	87.3	91.5	91.4	92.5	102.8	86.5	89.6	90.4	86.8	86.8	82.4	86.9
pH	7.16	7.31	7.40	7.52	7.18	6.97	7.09	7.16	6.90	6.89	6.93	7.22
Temperature (DegC)	11.4	10.2	10.9	11.7	12.7	12.8	12.2	12.4	12.4	11.4	10.9	10.9
Turbidity (NTU)	4.60	4.10	1.20	1.00	0.60	0.80	1.10	1.60	1.50	0.90	1.70	1.50
Flow (cumec)	1.278	1.126	1.138	0.869	0.885	0.677	0.663	0.646	0.614	0.632	0.709	0.983


SF1 and T1 Monthly Spot Nitrate-N
Nitrate-N (mg L-1)
4
3.5
3
2.5
2
1.5
1
0.5
0
Jun
Aug
Sep
Nov
Jan
Feb
Apr
Jun
Jul
SF1
T1

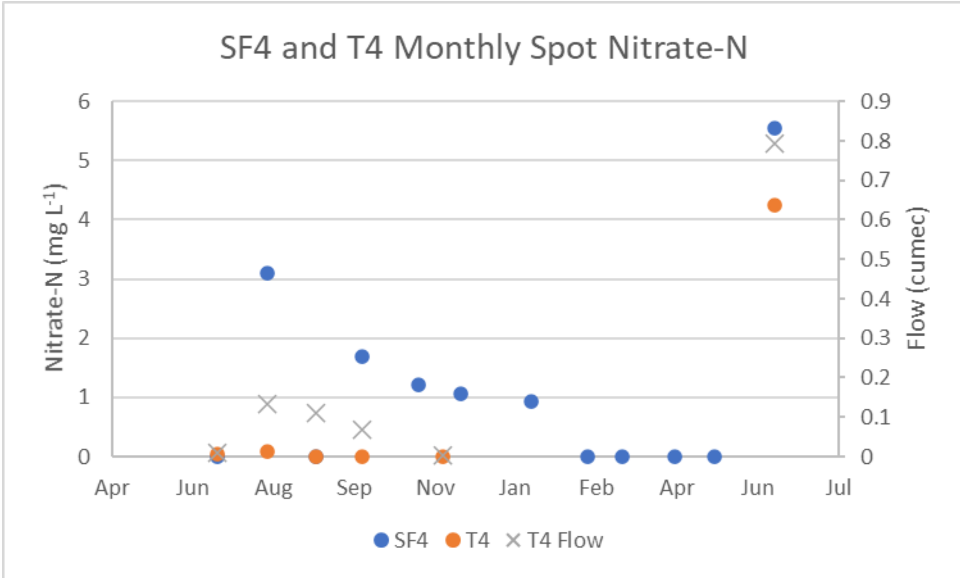

SF2 and T2 Monthly Spot Nitrate-N
Nitrate-N (mg L-1)
6
5
4
3
2
1
0
Jun
Aug
Sep
Nov
Jan
Feb
Apr
Jun
Jul
SF2
T2



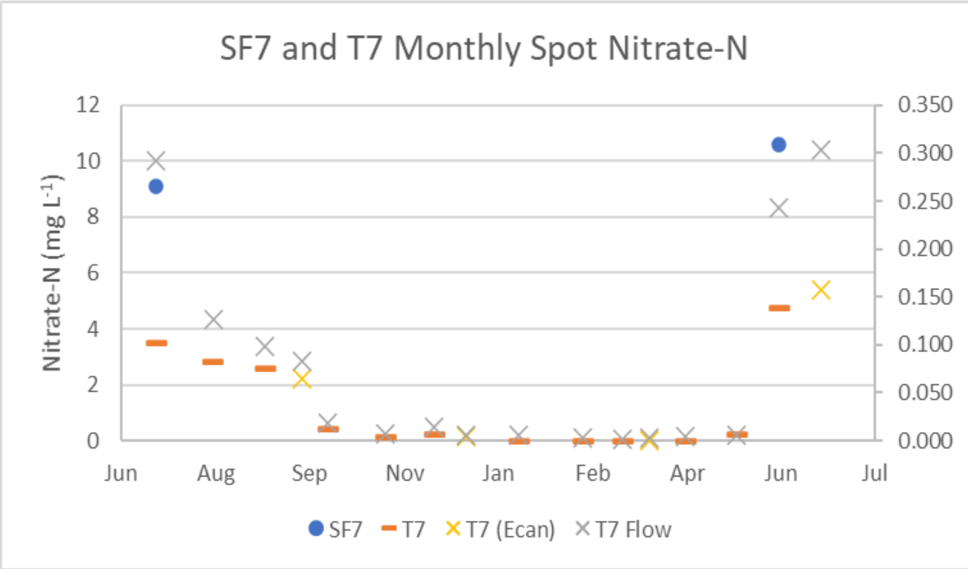


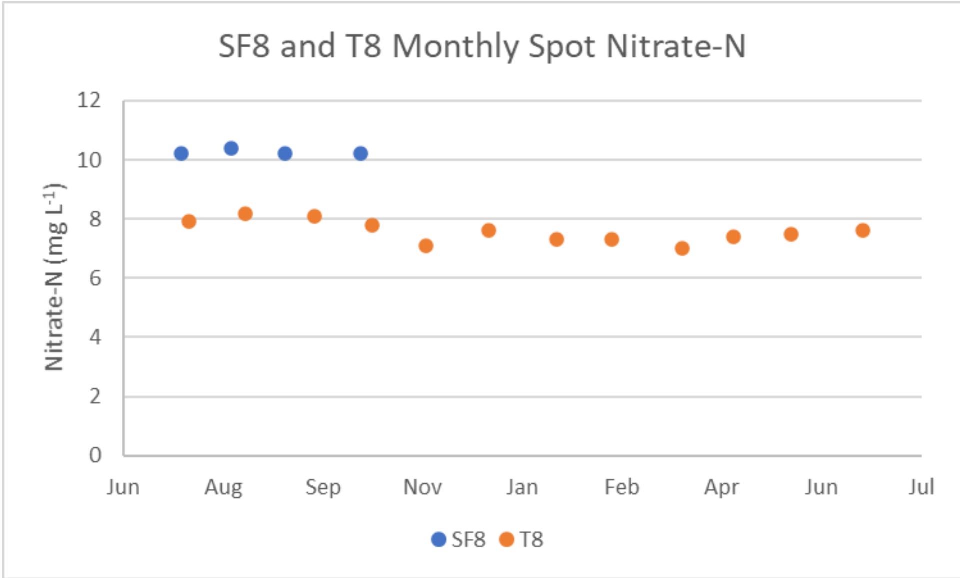


Results in the above Figure that were below the <0.005 detection limit have been displayed as 0.005 mg L^{-1}.

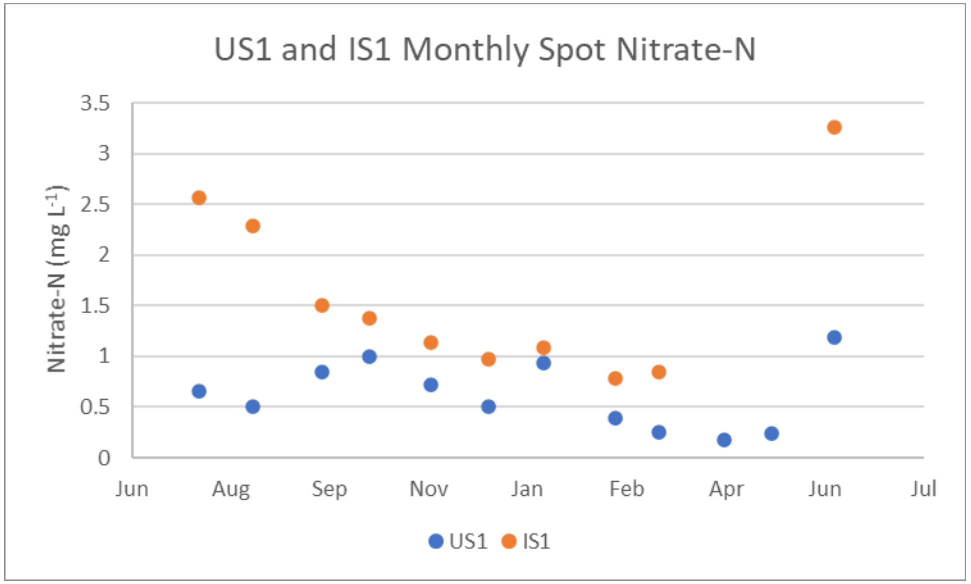


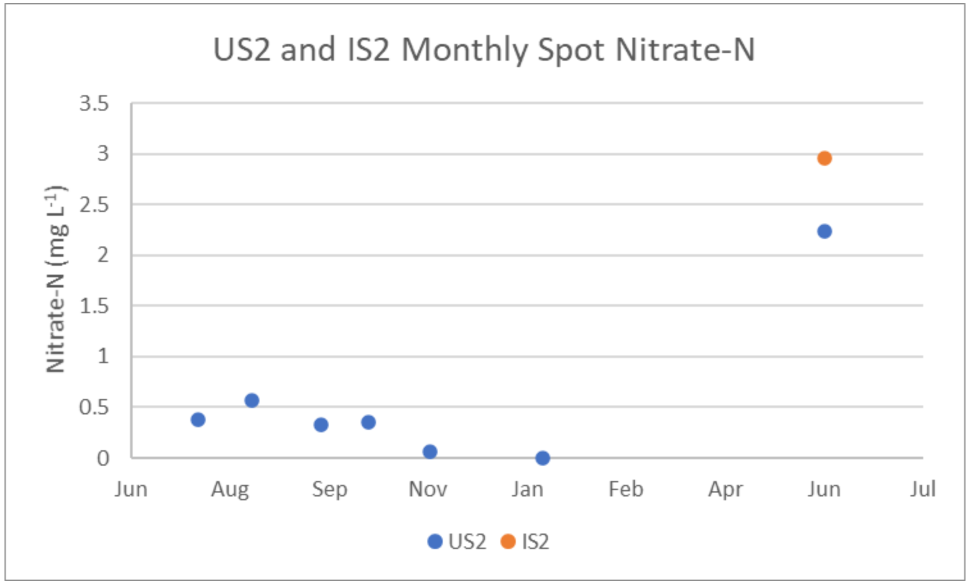
Results in the above Figure that were below the <0.005 detection limit have been displayed as 0.005 mg L^{-1}.

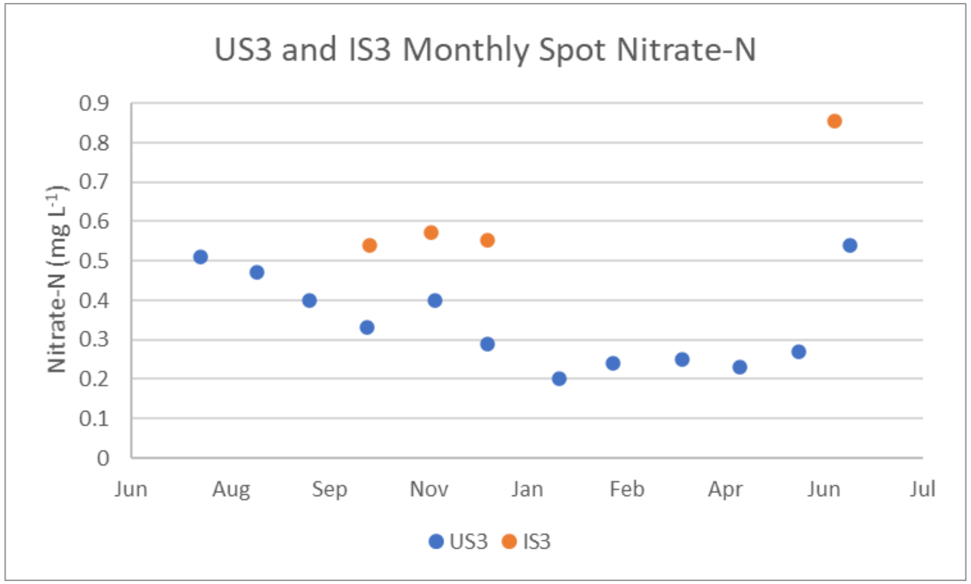


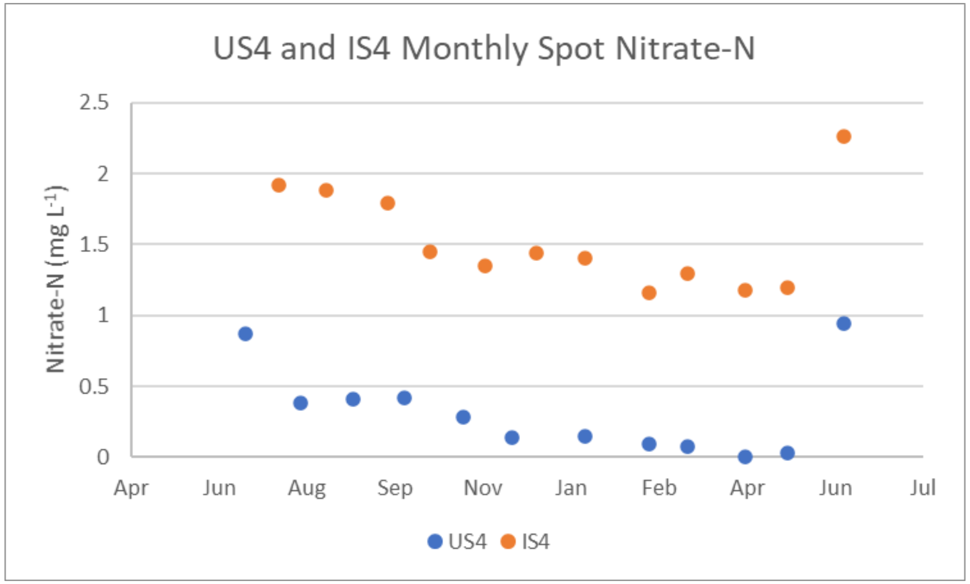


Results in the above Figure that were below the <0.005 detection limit have been displayed as 0.005 mg L^{-1}.

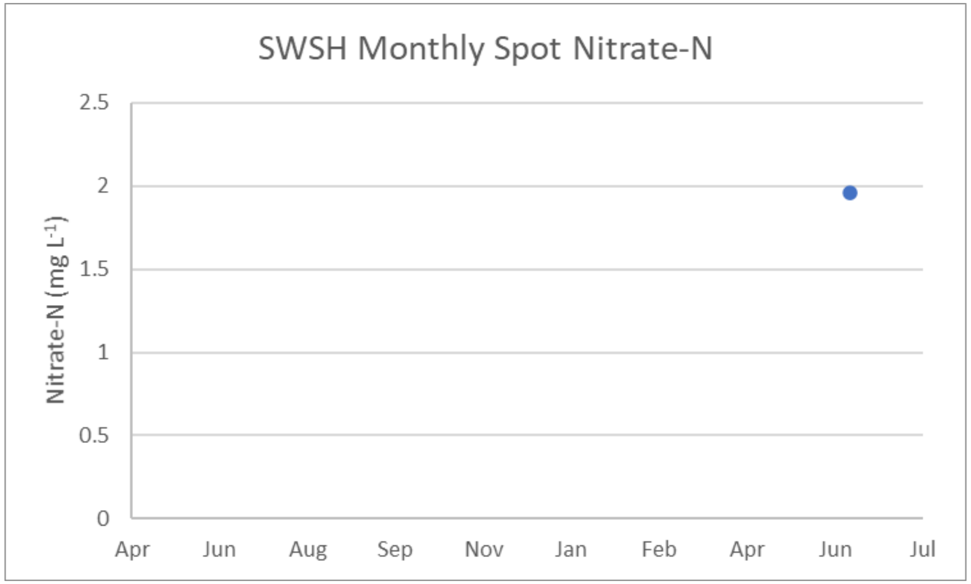


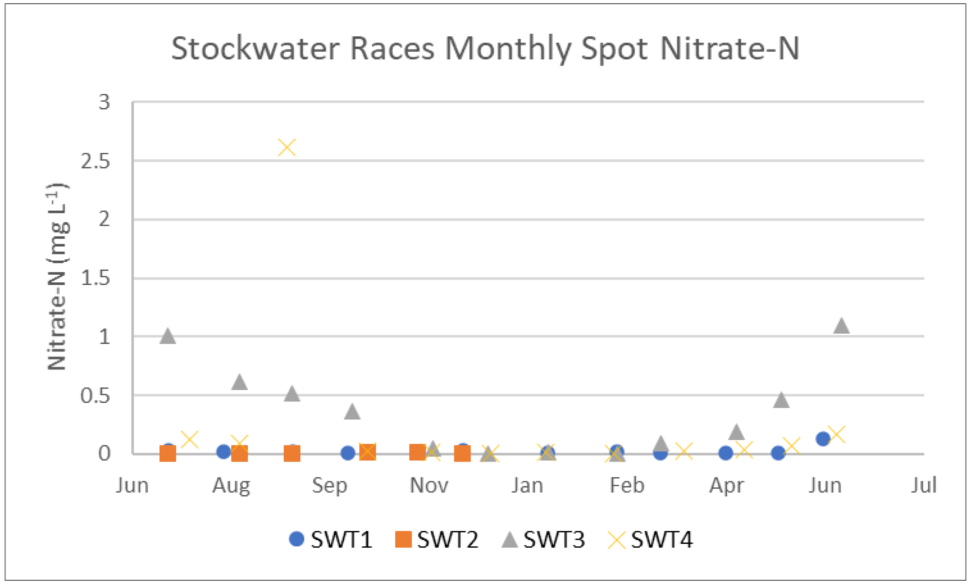






Results in the above Figure that were below the <0.005 detection limit have been displayed as 0.005 mg L^{-1}.





Results in the above Figure that were below the <0.005 detection limit have been displayed as 0.005 mg L^{-1}.

6.4. Lake Water Quality Monitoring Results (ECan data)

Kaituna Lagoon	24-Jul-20	26-Aug-20	21-Sep-20	19-Oct-20	11-Nov-20	15-Dec-20	14-Jan-21	15-Feb-21	19-Mar-21	20-Apr-21	25-May-21	Jun-21
Ammoniacal-N (mg/L)	0.011	0.008	0.009	0.01	0.016	0.005	0.009	0.008	<0.050	<0.005	<0.005	-
Nitrate + Nitrite-N (mg/L)	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Total Nitrogen (mg/L)	2.3	2.3	2.4	1.78	2.5	2.1	2.2	1.53	2.5	2.3	1.95	-
Chlorophyll A (µg/L)	90	110	100	77	75	70	70	73	129	120	73	-
Dissolved Oxygen	66.5	82.2	99.5	134.1	84.1	94.1	67.3	121.4	71.2	99.3	103.2	-
Electrical Conductivity (mS/m)	782.5	850	-	1426	1491.7	1610.1	1678.6	1532.6	1803.6	1721.2	1571.1	-
E coli (MPN/100ml)	148	441	299	148	235	52	63	708	74	122	171	-
Dissolved Reactive Phosphorus (mg/L)	0.047	0.0064	0.0051	-	0.005	0.0058	0.0056	0.006	0.0047	0.0019	0.0021	-
Total Phosphorus (mg/L)	0.33	0.3	0.2	0.184	0.174	0.195	0.163	0.23	0.34	0.22	0.182	-
pH	7.52	7.19	8.16	8.53	7.69	7.95	7.79	8.4	7.76	8.22	8.16	-
Temperature (DegC)	7.3	5.7	11.6	17.9	15.5	20.6	21.8	21.1	14	14.3	9.4	-
Turbidity (NTU)	55	153	43	48	56	57	75	58	116	75	41	-

No monitoring was carried out in June 2021.

Off Selwyn River Mouth	24-Jul-20	26-Aug-20	21-Sep-20	19-Oct-20	11-Nov-20	15-Dec-20	14-Jan-21	15-Feb-21	19-Mar-21	20-Apr-21	25-May-21	Jun-21
Ammoniacal-N (mg/L)	0.005	0.006	0.01	0.019	0.017	0.011	0.007	0.015	<0.005	<0.005	<0.005	-
Nitrate + Nitrite-N (mg/L)	<0.001	<0.001	<0.001	0.002	0.157	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	-
Total Nitrogen (mg/L)	2.70	2.70	2.80	2.70	2.90	3.10	2.50	3.50	3.10	2.70	2.50	-
Chlorophyll A (μg/L)	120	140	140	140	85	120	110	140	160	120	122	-
Dissolved Oxygen	103.7	95.6	125.9	130.8	121.6	116.8	132.0	120.1	103.1	156.1	116.3	-
Electrical Conductivity (mS/m)	1133.8	1740.0	-	1420.9	1440.9	1563.3	1524.2	1651.1	1661.5	1610.8	1437.0	-
E coli (MPN/100ml)	10	40	<10	10	282	<10	<10	<10	20	31	<10	-
Dissolved Reactive Phosphorus (mg/L)	0.0053	0.0051	0.0054	-	0.0064	0.0051	0.0059	0.0052	0.0066	0.0020	0.0029	-
Total Phosphorus (mg/L)	0.177	0.200	0.153	0.189	0.166	0.300	0.163	0.260	0.240	0.183	0.178	-
pH	8.37	8.73	8.70	8.77	8.60	9.17	8.68	8.75	8.42	9.48	8.42	-
Temperature (DegC)	6.5	9.4	12.9	14.7	15.0	18.3	22.4	19.1	15.2	15.0	9.0	-
Turbidity (NTU)	56.0	113.0	38.0	53.0	49.0	157.0	61.0	103.0	104.0	55.0	58.0	-

No monitoring was carried out in June 2021.

Mid Lake	24-Jul-20	26-Aug-20	21-Sep-20	19-Oct-20	11-Nov-20	15-Dec-20	14-Jan-21	15-Feb-21	19-Mar-21	20-Apr-21	25-May-21	Jun-21
Ammoniacal-N (mg/L)	0.006	0.013	0.009	0.028	<0.005	0.01	0.011	0.015	<0.005	<0.005	<0.005	-
Nitrate + Nitrite-N (mg/L)	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Total Nitrogen (mg/L)	2.40	2.60	2.70	2.30	2.80	2.90	2.70	3.10	3.00	2.80	2.30	-
Chlorophyll A (μg/L)	110	130	150	110	82	100	120	150	150	130	110	-
Dissolved Oxygen	94.3	88.2	108.2	108.4	116.6	102.9	106.0	99.1	92.5	110.6	114.1	-
Electrical Conductivity (mS/m)	1210.0	1650.0	1658.0	1619.4	1549.4	1575.2	1639.9	1702.3	1694.0	1688.5	1602.9	-
E coli (MPN/100ml)	<10	10	<10	<10	10	<10	<10	<10	<10	<10	<10	-
Dissolved Reactive Phosphorus (mg/L)	0.0047	0.0051	0.0049	-	0.0058	0.0043	0.0046	0.0048	0.0059	0.0015	0.0021	-
Total Phosphorus (mg/L)	0.179	0.240	0.179	0.194	0.178	0.250	0.156	0.250	0.330	0.210	0.195	-
pH	8.16	8.53	8.41	8.35	8.45	8.34	8.52	8.50	8.18	8.38	8.38	-
Temperature (DegC)	6.7	8.7	12.2	13.2	14.8	17.3	21.0	18.2	15.2	13.4	9.2	-
Turbidity (NTU)	68.0	155.0	70.0	63.0	65.0	163.0	66.0	89.0	154.0	66.0	63.0	-

No monitoring was carried out in June 2021.

South of Timber Yard	24-Jul-20	26-Aug-20	21-Sep-20	19-Oct-20	11-Nov-20	15-Dec-20	14-Jan-21	15-Feb-21	19-Mar-21	20-Apr-21	25-May-21	Jun-21
Ammoniacal-N (mg/L)	0.081	0.008	0.017	0.026	<0.005	0.01	0.006	0.015	<0.005	<0.005	<0.005	-
Nitrate + Nitrite-N (mg/L)	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.082	-
Total Nitrogen (mg/L)	2.3	2.6	2.9	2.5	2.8	3	2.5	3.1	2.5	2.6	2.6	-
Chlorophyll A (µg/L)	110	160	190	120	80	100	120	130	150	130	120	-
Dissolved Oxygen	104	94.3	120.3	126.5	122.5	106.7	127.2	117.4	100	133.5	125.2	-
Electrical Conductivity (mS/m)	1202.6	1720	1450	1590.3	1474.4	1542.2	1429.8	1652.4	1716.3	1601.2	1371.9	-
E coli (MPN/100ml)	<10	<10	10	<10	10	<10	<10	<10	10	<10	20	-
Dissolved Reactive Phosphorus (mg/L)	0.0053	0.0051	0.0055	-	0.0059	0.0049	0.0057	0.0054	0.0063	0.0018	0.0027	-
Total Phosphorus (mg/L)	0.177	0.198	0.16	0.193	0.165	0.3	0.137	0.24	0.24	0.193	0.183	-
pH	8.41	8.67	8.8	8.66	8.67	8.56	8.68	8.8	8.39	8.58	8.54	-
Temperature (DegC)	7.1	9	12.6	14.4	14.8	18.1	21.4	18.7	15.3	14.9	9.5	-
Turbidity (NTU)	56	112	47	64	57	168	65	77	114	71	53	-

No monitoring was carried out in June 2021.

Taumutu	24-Jul-20	26-Aug-20	21-Sep-20	19-Oct-20	11-Nov-20	15-Dec-20	14-Jan-21	15-Feb-21	19-Mar-21	20-Apr-21	25-May-21	Jun-21
Ammoniacal-N (mg/L)	0.009	0.005	<0.005	0.011	0.015	<0.005	0.007	0.013	<0.005	<0.005	0.006	-
Nitrate + Nitrite-N (mg/L)	<0.001	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	0.001	0.001	-
Total Nitrogen (mg/L)	2.3	2.6	2.7	2.3	2.8	4.1	2.5	3.6	2.9	3	2.4	-
Chlorophyll A (μg/L)	140	160	150	120	76	100	120	130	160	130	120	-
Dissolved Oxygen	108.2	99.8	120.3	123.3	120.1	104.9	115.2	108.2	87.2	142	111.6	-
Electrical Conductivity (mS/m)	1426.6	1640	1400	1601.7	1517.3	1566.6	1525.3	1612.3	1647.9	1630	1522.1	-
E coli (MPN/100ml)	<10	31	<10	10	<10	<10	<10	<10	<10	10	<10	-
Dissolved Reactive Phosphorus (mg/L)	0.0152	0.0049	0.005	-	0.0062	0.0045	0.0044	0.0056	0.0068	0.002	0.0029	-
Total Phosphorus (mg/L)	0.148	0.21	0.146	0.192	0.171	0.32	0.149	0.23	0.28	0.21	0.182	-
pH	8.46	8.71	8.8	8.62	8.59	9.19	8.62	8.7	8.31	8.57	8.37	-
Temperature (DegC)	6.6	8.2	12.5	14.2	15	17.9	21.1	18.6	14.7	15.4	9	-
Turbidity (NTU)	46	124	49	53	58	183	66	89	159	92	53	-

No monitoring was carried out in June 2021.

6.5. Groundwater Quality Monitoring Data

BW22/0041	9/09/2020	10/12/2020	3/03/2021	24/06/2021
Groundwater Level (mbgl)	6.765	6.600	6.790	4.340
Alkalinity (mg L^{-1})	29	29	31	14
Bromide(mg L^{-1})	0.02	0.03	0.03	0.04
Chloride (mg L^{-1})	6.93	6.92	6.73	12.10
Dissolved Oxygen (% Sat.)	87.3	90.2	87.2	95.8
Dissolved Reactive Phosphorus (mg L^{-1})	0.010	0.009	0.007	0.011
Electrical Conductivity (mS/m)	15.2	15.3	14.9	17.2
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg L^{-1})	4.95	4.41	3.96	7.32
Total Nitrogen (mg L^{-1})	4.95	4.54	4.13	7.23
pH	6.4	6.6	6.5	6.3
Sulphate (mg L^{-1})	10.5	9.8	9.6	13.0
Temperature (DegC)	11.6	11.9	12.2	11.7
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BW22/0042	16/09/2020	3/12/2020	2/03/2021	17/06/2021
Groundwater Level (mbgl)	19.590	18.995	20.720	12.160
Alkalinity (mg L^{-1})	47	38	39	42
Bromide(mg L^{-1})	0.05	0.05	0.04	0.04
Chloride (mg L^{-1})	18.90	5.69	11.10	11.20
Dissolved Oxygen (% Sat.)	74.3	73.5	73.7	70.4
Dissolved Reactive Phosphorus (mg L^{-1})	0.007	0.008	0.008	0.010
Electrical Conductivity (mS/m)	nt	17.3	25.9	25.4
E. coli (MPN/100ml)	<1	<1	<1	5.3
Nitrate-N (mg L^{-1})	12.40	3.66	6.52	5.69
Total Nitrogen (mg L^{-1})	11.70	3.62	6.16	6.14
pH	6.8	6.5	6.3	6.1
Sulphate (mg L^{-1})	35.0	12.5	34.8	28.1
Temperature (DegC)	11.5	12.5	12.8	11.9
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX21/0017	14/09/2020	7/12/2020	3/03/2021	24/06/2021
Groundwater Level (mbgl)	9.470	9.395	9.370	7.915
Alkalinity (mg L^{-1})	29	26	29	32
Bromide(mg L^{-1})	0.04	0.04	0.05	0.05
Chloride (mg L^{-1})	12.30	12.90	13.20	15.50
Dissolved Oxygen (% Sat.)	77.6	75.6	78.2	83.7
Dissolved Reactive Phosphorus (mg L^{-1})	0.012	0.014	0.012	0.017
Electrical Conductivity (mS/m)	22.9	23.7	24.4	27.6
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg L^{-1})	10.90	11.50	12.50	15.00
Total Nitrogen (mg L^{-1})	10.40	11.70	11.90	14.90
pH	6.4	6.3	6.2	6.5
Sulphate (mg L^{-1})	12.2	12.3	13.5	12.0
Temperature (DegC)	12.1	12.4	12.3	11.9
Ammonia-N (mg L^{-1})	<0.01	0.02	<0.01	<0.01

BX21/0018	14/09/2020	4/12/2020	2/03/2021	16/06/2021
Groundwater Level (mbgl)	80.900	84.320	88.120	86.610
Alkalinity (mg L^{-1})	60	68	62	67
Bromide(mg L^{-1})	<0.02	<0.02	0.02	<0.02
Chloride (mg L^{-1})	6.87	5.67	6.51	5.25
Dissolved Oxygen (% Sat.)	97.1	97.8	101.1	94.8
Dissolved Reactive Phosphorus (mg L^{-1})	<0.005	0.014	0.013	0.015
Electrical Conductivity (mS/m)	19.6	19.2	19.1	18.9
E. coli (MPN/100ml)	<1	<1	>200.5	<1
Nitrate-N (mg L^{-1})	2.67	2.22	2.58	2.11
Total Nitrogen (mg L^{-1})	2.70	2.24	2.75	2.13
pH	7.9	8.0	8.0	7.9
Sulphate (mg L^{-1})	8.3	8.1	9.1	8.2
Temperature (DegC)	11.9	12.3	12.8	11.5
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0041	15/09/2020	7/12/2020	3/03/2021	22/06/2021
Groundwater Level (mbgl)	21.115	20.720	20.935	20.150
Alkalinity (mg L^{-1})	47	51	51	59
Bromide(mg L^{-1})	0.05	0.04	0.04	0.04
Chloride (mg L^{-1})	9.71	14.70	11.70	11.60
Dissolved Oxygen (% Sat.)	56.4	65.5	64.2	69.9
Dissolved Reactive Phosphorus (mg L^{-1})	<0.005	0.005	<0.005	0.007
Electrical Conductivity (mS/m)	19.1	25.8	22.7	23.8
E. coli (MPN/100ml)	<1	2	<1	<1
Nitrate-N (mg L^{-1})	4.25	8.57	6.32	6.23
Total Nitrogen (mg L^{-1})	4.31	8.51	5.76	6.18
pH	6.9	7.1	6.9	7.2
Sulphate (mg L^{-1})	7.6	11.8	9.7	9.3
Temperature (DegC)	11.8	13.7	12.8	11.4
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0042	14/09/2020	7/12/2020	2/03/2021	22/06/2021
Groundwater Level (mbgl)	43.655	44.760	45.325	45.150
Alkalinity (mg L^{-1})	45	48	50	44
Bromide(mg L^{-1})	0.05	0.04	0.04	0.04
Chloride (mg L^{-1})	13.70	11.00	9.57	9.44
Dissolved Oxygen (% Sat.)	88.5	86.0	92.6	91.4
Dissolved Reactive Phosphorus (mg L^{-1})	0.006	0.005	0.005	0.007
Electrical Conductivity (mS/m)	23.4	21.0	19.7	17.5
E. coli (MPN/100ml)	<1	<1	<1	88.5
Nitrate-N (mg L^{-1})	8.20	5.98	4.94	3.90
Total Nitrogen (mg L^{-1})	7.68	6.08	4.59	4.01
pH	7.2	7.4	7.5	7.6
Sulphate (mg L^{-1})	7.6	8.1	9.6	8.5
Temperature (DegC)	12.5	13.3	13.5	11.5
Ammonia-N (mg L^{-1})	<0.01	0.01	<0.01	<0.01

BX22/0043	14/09/2020	9/12/2020	4/03/2021	22/06/2021
Groundwater Level (mbgl)	56.040	58.870	61.660	57.290
Alkalinity (mg L^{-1})	53	80	80	84
Bromide(mg L^{-1})	0.06	0.07	0.04	0.04
Chloride (mg L^{-1})	21.60	23.70	12.40	11.40
Dissolved Oxygen (% Sat.)	111.8	88.3	88.8	87.5
Dissolved Reactive Phosphorus (mg L^{-1})	0.008	0.007	<0.005	0.008
Electrical Conductivity (mS/m)	32.8	41.0	31.3	31.6
E. coli (MPN/100ml)	<1	<1	<1	3.1
Nitrate-N (mg L^{-1})	13.20	14.90	8.73	8.57
Total Nitrogen (mg L^{-1})	12.60	15.10	8.78	8.55
pH	7.7	7.8	7.4	7.7
Sulphate (mg L^{-1})	13.0	18.0	13.5	15.0
Temperature (DegC)	12.4	13.1	12.4	11.2
Ammonia-N (mg L^{-1})	0.01	<0.01	<0.01	<0.01

BX22/0044	15/09/2020	4/12/2020	4/03/2021	24/06/2021
Groundwater Level (mbgl)	5.330	5.070	5.230	4.800
Alkalinity (mg L^{-1})	41	40	40	41
Bromide(mg L^{-1})	0.03	0.03	0.03	0.05
Chloride (mg L^{-1})	8.57	8.92	7.76	12.90
Dissolved Oxygen (% Sat.)	79.9	80.4	78.9	80.0
Dissolved Reactive Phosphorus (mg L^{-1})	0.008	0.010	0.010	0.011
Electrical Conductivity (mS/m)	19.0	19.7	18.5	24.5
E. coli (MPN/100ml)	<1	<1	<1	32.4
Nitrate-N (mg L^{-1})	5.05	5.43	4.22	8.41
Total Nitrogen (mg L^{-1})	4.65	5.58	4.40	8.05
pH	6.6	6.5	6.4	6.4
Sulphate (mg L^{-1})	10.7	12.5	11.7	17.5
Temperature (DegC)	12.0	12.1	13.2	12.5
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0046	15/09/2020	4/12/2020	4/03/2021	24/06/2021
Groundwater Level (mbgl)	8.810	9.545	9.750	8.865
Alkalinity (mg L^{-1})	65	61	58	68
Bromide(mg L^{-1})	0.06	0.05	0.06	0.06
Chloride (mg L^{-1})	12.60	12.50	12.40	13.60
Dissolved Oxygen (% Sat.)	80.3	74.5	75.2	75.3
Dissolved Reactive Phosphorus (mg L^{-1})	0.006	0.007	0.006	0.009
Electrical Conductivity (mS/m)	34.4	33.3	33.7	34.4
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg L^{-1})	14.30	14.30	14.10	14.10
Total Nitrogen (mg L^{-1})	14.10	14.00	4.60	14.10
pH	6.9	6.9	6.6	6.7
Sulphate (mg L^{-1})	19.2	18.6	18.1	18.6
Temperature (DegC)	12.2	13.0	12.7	12.5
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0053	15/09/2020	9/12/2020	4/03/2021	16/06/2021
Groundwater Level (mbgl)	37.710	40.740	43.300	42.280
Alkalinity (mg L^{-1})	54	52	54	59
Bromide(mg L^{-1})	0.06	0.05	0.04	0.05
Chloride (mg L^{-1})	16.00	14.20	11.00	12.30
Dissolved Oxygen (% Sat.)	93.1	85.0	89.2	83.5
Dissolved Reactive Phosphorus (mg L^{-1})	0.006	0.005	0.005	0.008
Electrical Conductivity (mS/m)	28.7	27.3	24.0	25.9
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg L^{-1})	10.60	10.70	7.59	8.11
Total Nitrogen (mg L^{-1})	10.20	10.60	7.47	8.08
pH	7.7	7.6	7.4	7.6
Sulphate (mg L^{-1})	11.5	11.0	10.4	11.3
Temperature (DegC)	11.8	12.9	12.9	12.1
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0065	8/09/2020	10/12/2020	8/03/2021	23/06/2021
Groundwater Level (mbgl)	9.660	12.020	14.000	6.545
Alkalinity (mg L^{-1})	42	51	33	27
Bromide(mg L^{-1})	0.06	0.08	0.07	0.08
Chloride (mg L^{-1})	21.50	24.80	23.10	27.50
Dissolved Oxygen (% Sat.)	82.8	72.4	84.9	86.0
Dissolved Reactive Phosphorus (mg L^{-1})	0.012	0.008	0.007	0.011
Electrical Conductivity (mS/m)	31.6	35.7	31.6	34.3
E. coli (MPN/100ml)	<1	<1	15	50.4
Nitrate-N (mg L^{-1})	13.80	13.60	12.90	15.70
Total Nitrogen (mg L^{-1})	12.90	13.70	13.20	15.90
pH	6.7	6.7	6.8	6.1
Sulphate (mg L^{-1})	20.6	23.0	22.2	24.1
Temperature (DegC)	12.6	13.8	12.7	13.2
Ammonia-N (mg L^{-1})	0.05	<0.01	<0.01	<0.01

BX22/0066	8/09/2020	3/12/2020	5/03/2021	17/06/2021
Groundwater Level (mbgl)	21.220	21.760	26.320	21.905
Alkalinity (mg L^{-1})	41	39	43	42
Bromide(mg L^{-1})	0.05	0.04	0.04	0.05
Chloride (mg L^{-1})	12.80	13.20	11.50	15.30
Dissolved Oxygen (% Sat.)	69.9	71.0	61.8	78.0
Dissolved Reactive Phosphorus (mg L^{-1})	0.009	0.007	0.006	0.008
Electrical Conductivity (mS/m)	22.7	21.9	21.3	25.5
E. coli (MPN/100ml)	<1	<1	<1	5.3
Nitrate-N (mg L^{-1})	6.61	5.62	5.06	7.20
Total Nitrogen (mg L^{-1})	6.21	5.54	4.97	7.59
pH	6.6	6.7	6.7	6.5
Sulphate (mg L^{-1})	16.8	14.9	13.8	17.5
Temperature (DegC)	12.6	13.4	12.6	12.0
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0067	9/09/2020	8/12/2020	5/03/2021	23/06/2021
Groundwater Level (mbgl)	29.490	33.330	35.570	31.260
Alkalinity (mg L^{-1})	51	38	41	40
Bromide(mg L^{-1})	0.11	0.11	0.11	0.11
Chloride (mg L^{-1})	29.10	33.10	32.50	35.10
Dissolved Oxygen (% Sat.)	69.2	61.3	75.8	65.5
Dissolved Reactive Phosphorus (mg L^{-1})	0.011	0.016	0.016	0.019
Electrical Conductivity (mS/m)	37.4	41.0	39.6	41.8
E. coli (MPN/100ml)	<1	>200.5	34.4	12.4
Nitrate-N (mg L^{-1})	15.40	19.60	17.20	18.10
Total Nitrogen (mg L^{-1})	15.10	19.90	1.45	18.30
pH	6.6	6.5	7.1	6.3
Sulphate (mg L^{-1})	19.7	25.0	23.0	25.7
Temperature (DegC)	12.5	14.0	12.7	12.6
Ammonia-N (mg L^{-1})	<0.01	0.02	<0.01	<0.01

BX22/0068	9/09/2020	27/01/2021	8/03/2021	21/06/2021
Groundwater Level (mbgl)	60.735	65.545	66.870	62.510
Alkalinity (mg L^{-1})	41	45	45	22
Bromide(mg L^{-1})	0.04	0.05	0.04	0.14
Chloride (mg L^{-1})	10.70	13.80	13.40	69.60
Dissolved Oxygen (% Sat.)	82.4	89.0	86.3	87.2
Dissolved Reactive Phosphorus (mg L^{-1})	0.018	0.013	0.011	0.007
Electrical Conductivity (mS/m)	16.7	20.0	20.0	58.9
E. coli (MPN/100ml)	<1	<1	<1	40.6
Nitrate-N (mg L^{-1})	3.74	6.31	5.70	29.90
Total Nitrogen (mg L^{-1})	3.75	5.98	5.12	29.60
pH	7.7	7.4	7.7	7.1
Sulphate (mg L^{-1})	3.9	4.4	4.9	25.3
Temperature (DegC)	12.1	13.3	12.0	11.5
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0069	8/09/2020	3/12/2020	1/03/2021	21/06/2021
Groundwater Level (mbgl)	51.850	54.260	57.090	57.070
Alkalinity (mg L^{-1})	30	31	30	37
Bromide(mg L^{-1})	0.06	0.06	0.05	0.08
Chloride (mg L^{-1})	14.10	13.90	13.20	22.90
Dissolved Oxygen (% Sat.)	104.6	97.6	93.6	79.0
Dissolved Reactive Phosphorus (mg L^{-1})	0.009	0.011	0.009	0.007
Electrical Conductivity (mS/m)	22.3	22.0	22.1	34.2
E. coli (MPN/100ml)	<1	<1	<1	<1
Nitrate-N (mg L^{-1})	11.20	11.30	11.00	16.80
Total Nitrogen (mg L^{-1})	11.00	11.00	11.70	16.80
pH	7.0	7.1	7.1	7.3
Sulphate (mg L^{-1})	5.1	5.1	4.8	21.4
Temperature (DegC)	11.7	12.7	12.7	11.3
Ammonia-N (mg L^{-1})	<0.01	0.01	<0.01	<0.01

BX22/0070	9/09/2020	10/12/2020	1/03/2021	21/06/2021
Groundwater Level (mbgl)	83.220	87.840	90.835	92.590
Alkalinity (mg L^{-1})	32	32	31	46
Bromide(mg L^{-1})	0.05	0.04	0.05	0.06
Chloride (mg L^{-1})	9.58	9.87	10.00	20.20
Dissolved Oxygen (% Sat.)	84.9	84.0	84.9	83.9
Dissolved Reactive Phosphorus (mg L^{-1})	0.009	0.008	0.010	0.009
Electrical Conductivity (mS/m)	17.7	18.0	18.1	32.5
E. coli (MPN/100ml)	<1	<1	<1	2
Nitrate-N (mg L^{-1})	6.96	7.04	7.39	15.90
Total Nitrogen (mg L^{-1})	6.70	6.88	7.37	15.80
pH	6.9	6.9	6.9	7.2
Sulphate (mg L^{-1})	6.2	6.0	6.0	15.8
Temperature (DegC)	11.5	12.0	11.9	10.5
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX22/0071	8/09/2020	3/12/2020	2/03/2021	16/06/2021
Groundwater Level (mbgl)	61.540	61.290	63.050	66.770
Alkalinity (mg L^{-1})	31	32	32	33
Bromide(mg L^{-1})	0.03	0.02	0.02	0.03
Chloride (mg L^{-1})	7.28	6.78	7.02	7.01
Dissolved Oxygen (% Sat.)	87.0	77.3	77.3	82.2
Dissolved Reactive Phosphorus (mg L^{-1})	0.010	0.007	0.005	0.007
Electrical Conductivity (mS/m)	14.1	13.8	14.0	14.5
E. coli (MPN/100ml)	<1	<1	<1	11.1
Nitrate-N (mg L^{-1})	3.46	3.28	2.90	3.86
Total Nitrogen (mg L^{-1})	3.51	3.42	3.10	3.96
pH	6.9	6.7	6.7	6.9
Sulphate (mg L^{-1})	7.9	7.4	7.5	7.2
Temperature (DegC)	10.5	11.7	12.1	10.8
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	0.01

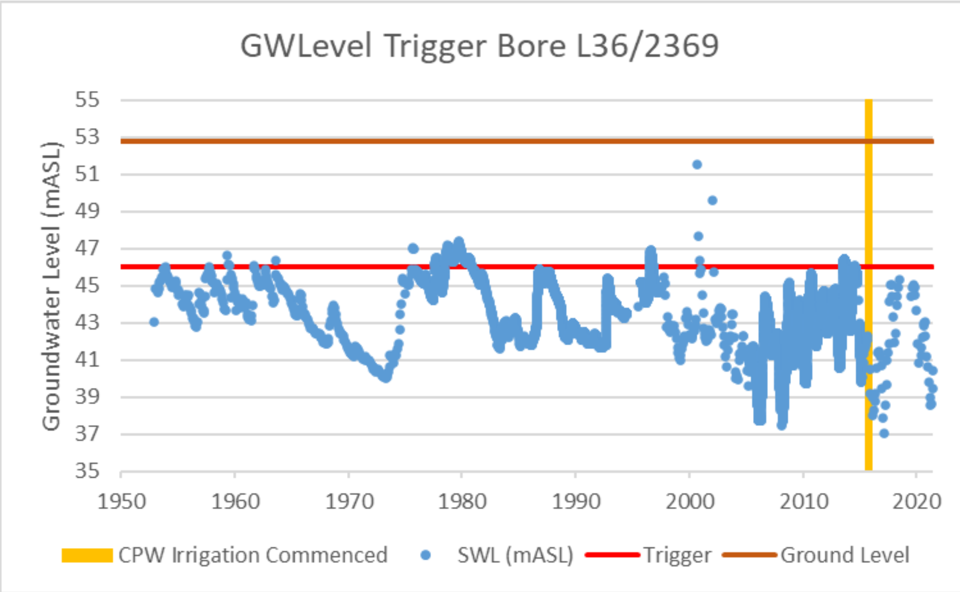
BX22/0072	16/09/2020	7/12/2020	3/03/2021	17/06/2021
Groundwater Level (mbgl)	11.295	10.010	13.575	10.710
Alkalinity (mg L^{-1})	31	35	39	38
Bromide(mg L^{-1})	<0.02	0.05	0.04	0.04
Chloride (mg L^{-1})	4.47	12.00	11.70	13.10
Dissolved Oxygen (% Sat.)	85.9	76.8	72.1	92.0
Dissolved Reactive Phosphorus (mg L^{-1})	0.007	0.007	0.006	0.007
Electrical Conductivity (mS/m)	nt	25.1	23.6	24.9
E. coli (MPN/100ml)	<1	<1	<1	1
Nitrate-N (mg L^{-1})	3.77	11.90	9.85	10.40
Total Nitrogen (mg L^{-1})	3.76	12.00	9.38	11.60
pH	6.7	6.7	6.7	6.6
Sulphate (mg L^{-1})	6.7	11.2	11.7	10.4
Temperature (DegC)	12.2	13.7	12.9	11.6
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

BX23/0423	16/09/2020	10/12/2020	5/03/2021	23/06/2021
Groundwater Level (mbgl)	31.760	35.640	35.840	26.390
Alkalinity (mg L^{-1})	33	26	29	40
Bromide(mg L^{-1})	0.06	0.08	0.07	0.08
Chloride (mg L^{-1})	15.00	18.70	14.00	17.40
Dissolved Oxygen (% Sat.)	90.3	89.4	86.5	91.3
Dissolved Reactive Phosphorus (mg L^{-1})	0.009	0.008	<0.005	0.009
Electrical Conductivity (mS/m)	nt	31.8	27.9	29.2
E. coli (MPN/100ml)	<1	<1	<1	4.2
Nitrate-N (mg L^{-1})	12.20	17.70	14.20	13.80
Total Nitrogen (mg L^{-1})	11.90	17.80	14.90	13.60
pH	6.7	7.0	6.7	6.9
Sulphate (mg L^{-1})	15.0	21.4	16.3	15.8
Temperature (DegC)	12.7	13.2	12.8	12.2
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

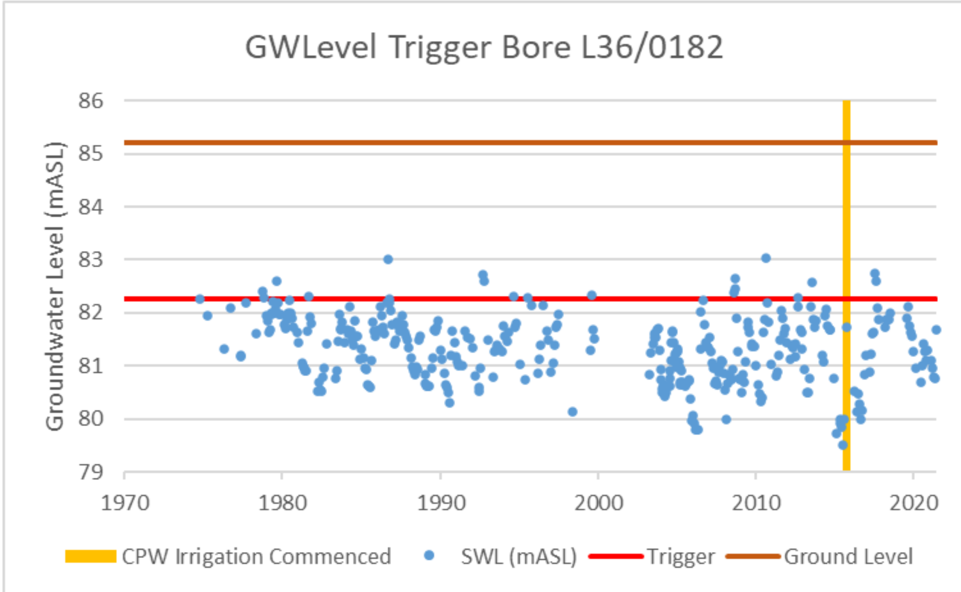
BX23/0424	16/09/2020	8/12/2020	5/03/2021	23/06/2021
Groundwater Level (mbgl)	45.740	47.780	50.425	50.230
Alkalinity (mg L^{-1})	36	40	41	55
Bromide(mg L^{-1})	0.07	0.06	0.06	0.08
Chloride (mg L^{-1})	19.90	14.70	14.40	26.50
Dissolved Oxygen (% Sat.)	78.3	75.0	76.6	80.7
Dissolved Reactive Phosphorus (mg L^{-1})	0.007	<0.005	<0.005	0.007
Electrical Conductivity (mS/m)	nt	22.5	22.1	34.7
E. coli (MPN/100ml)	<1	<1	<1	13.7
Nitrate-N (mg L^{-1})	13.20	8.98	8.69	12.50
Total Nitrogen (mg L^{-1})	12.80	9.24	8.37	12.40
pH	7.1	7.3	7.4	7.0
Sulphate (mg L^{-1})	9.2	6.4	6.2	21.2
Temperature (DegC)	12.3	13.1	12.4	12.2
Ammonia-N (mg L^{-1})	<0.01	<0.01	<0.01	<0.01

6.6. Lowland Groundwater Level Results (ECan Data)

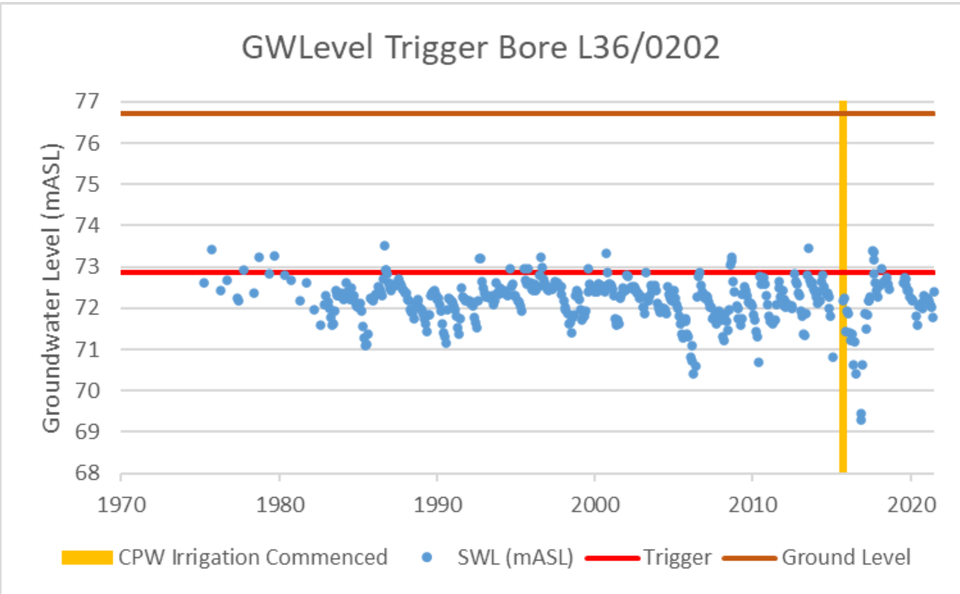
L36/2369	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	14-Oct-20	11-Nov-20	10-Dec-20	26-Jan-21	24-Feb-21	23-Mar-21	21-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>46.01	42.23	42.85	43.06	42.28	41.2	40.66	39.78	38.95	38.57	38.59	39.45	40.41
L36/0182	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	15-Oct-20	12-Nov-20	-	26-Jan-21	24-Feb-21	-	21-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>82.26	81.01	81.41	81.28	81.11	81.3	-	81.1	80.97	-	80.79	80.76	81.68
L36/0202	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	14-Oct-20	11-Nov-20	10-Dec-20	26-Jan-21	24-Feb-21	23-Mar-21	21-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>72.88	72.06	72.06	72.13	72	72.31	72.23	72.23	72.17	72.1	72.02	71.78	72.4
L37/0451	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	14-Oct-20	11-Nov-20	10-Dec-20	25-Jan-21	23-Feb-21	22-Mar-21	20-Apr-21	17-May-21	15-Jun-21
SWL (mASL)	>23.5	20.32	20.42	20.25	19.58	19.63	19.64	19.52	19.39	19.5	19.54	19.4	19.4
M36/0250	Trigger	21-Jul-20	19-Aug-20	15-Sep-20	14-Oct-20	11-Nov-20	9-Dec-20	26-Jan-21	23-Feb-21	22-Mar-21	20-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>16.1	14.08	14.22	14.3	14.1	13.8	13.57	13.22	12.92	12.69	12.64	12.85	13.28
M36/0183	Trigger	21-Jul-20	19-Aug-20	15-Sep-20	14-Oct-20	11-Nov-20	9-Dec-20	26-Jan-21	24-Feb-21	23-Mar-21	21-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>23.82	21.44	21.67	21.64	20.86	20.4	20.32	20.1	19.83	19.76	19.78	20.03	20.5
M36/0419	Trigger	21-Jul-20	15-Sep-20	14-Oct-20	-	10-Nov-20	9-Dec-20	26-Jan-21	24-Feb-21	22-Mar-21	20-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>33.5	32.83	32.75	32.27	-	32.15	32.04	31.69	31.39	31.13	30.87	31.03	32.46
M36/0424	Trigger	21-Jul-20	18-Aug-20	15-Sep-20	13-Oct-20	10-Nov-20	9-Dec-20	26-Jan-21	23-Feb-21	22-Mar-21	20-Apr-21	17-May-21	15-Jun-21
SWL (mASL)	>21.02	20.84	20.63	20.64	20.26	20.24	19.98	19.46	18.86	18.55	18.51	18.94	20.24
M36/0599	Trigger	21-Jul-20	18-Aug-20	15-Sep-20	13-Oct-20	10-Nov-20	-	-	-	-	20-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>13.63	13.04	13.27	13.27	13.01	12.99	-	-	-	-	11.15	11.11	11.52
M36/0693	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	14-Oct-20	11-Nov-20	10-Dec-20	-	23-Feb-21	22-Mar-21	20-Apr-21	17-May-21	15-Jun-21
SWL (mASL)	>21.53	18.48	18.72	18.81	18.41	17.94	-976.26	-	-976.26	-976.26	-976.26	-976.26	-976.26
M36/7880	Trigger	21-Jul-20	18-Aug-20	15-Sep-20	14-Oct-20	11-Nov-20	9-Dec-20	26-Jan-21	24-Feb-21	22-Mar-21	20-Apr-21	18-May-21	16-Jun-21
SWL (mASL)	>35.14	34.67	34.63	34.63	34.46	34.35	34.09	33.62	33.21	32.92	32.65	32.82	35.11
M37/0010	Trigger	22-Jul-20	19-Aug-20	16-Sep-20	14-Oct-20	11-Nov-20	10-Dec-20	25-Jan-21	23-Feb-21	22-Mar-21	20-Apr-21	17-May-21	15-Jun-21
SWL (mASL)	>6.21	5.74	5.7	5.72	5.47	5.53	5.28	5.36	5.19	5.18	5.32	5.44	5.55



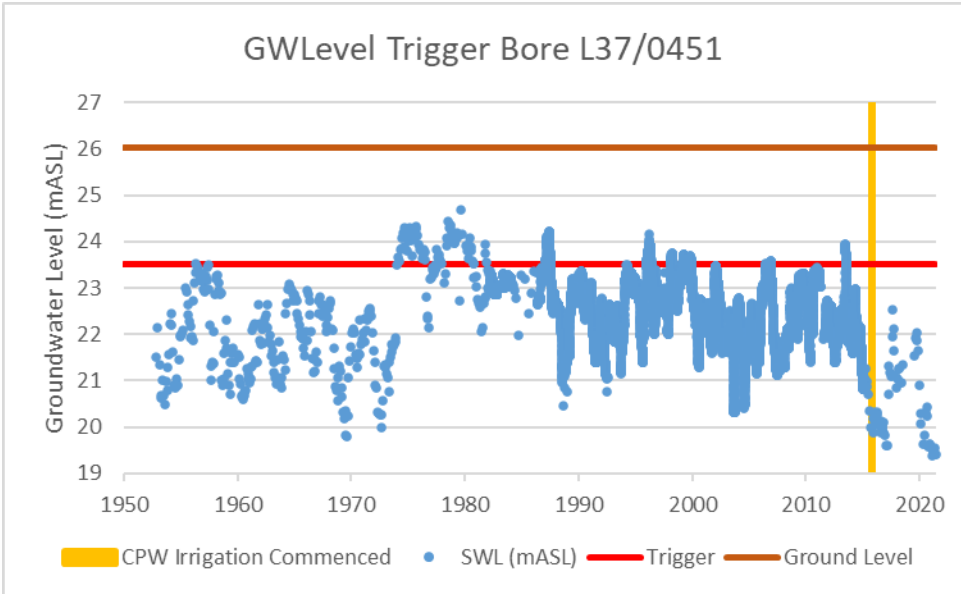
GWLevel Trigger Bore L36/2369
Groundwater Level (mASL)
55
53
51
49
47
45
43
41
39
37
35
1950
1960
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level



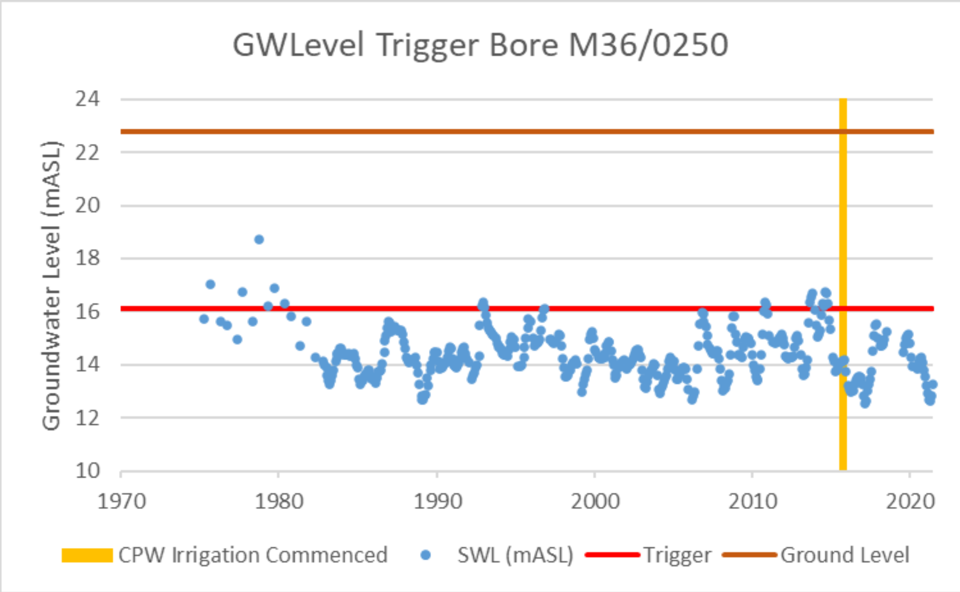
GWLevel Trigger Bore L36/0182
Groundwater Level (mASL)
86
85
84
83
82
81
80
79
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

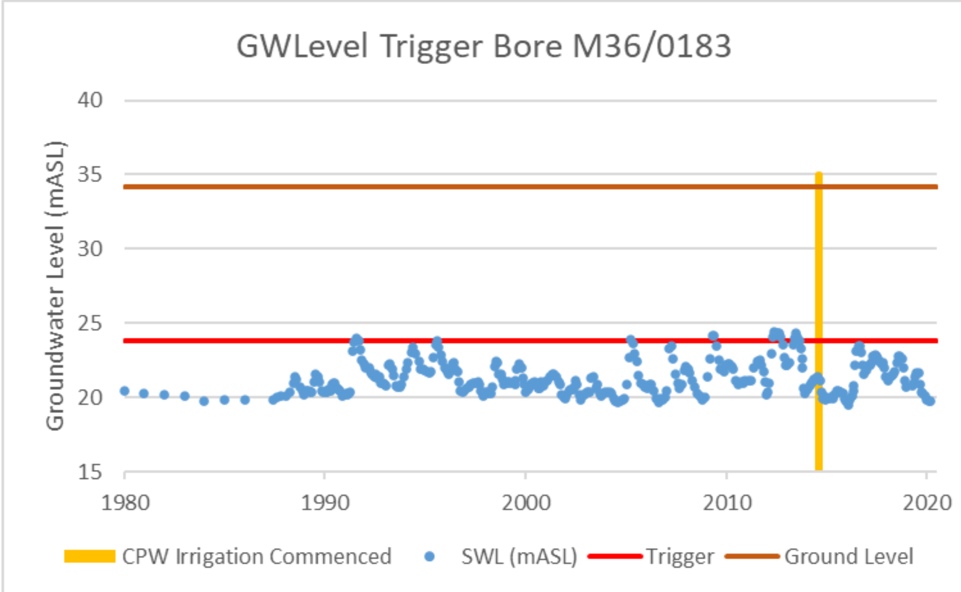


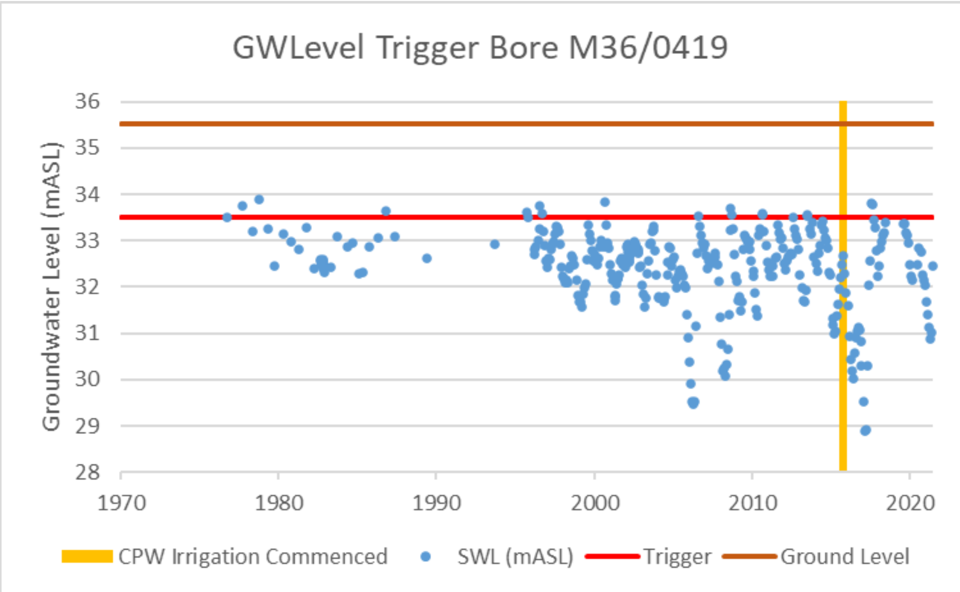
GWLevel Trigger Bore L36/0202
Groundwater Level (mASL)
77
76
75
74
73
72
71
70
69
68
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

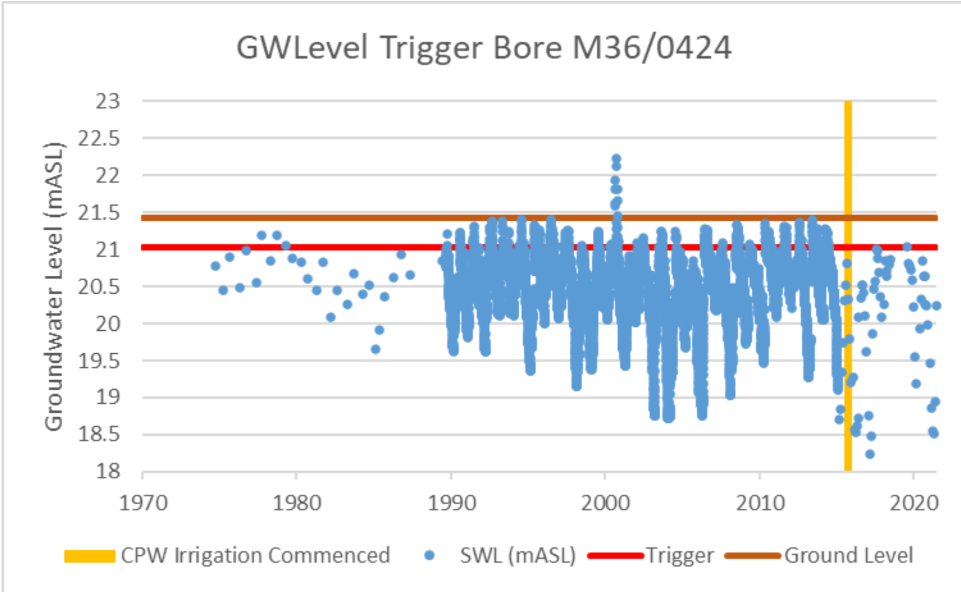


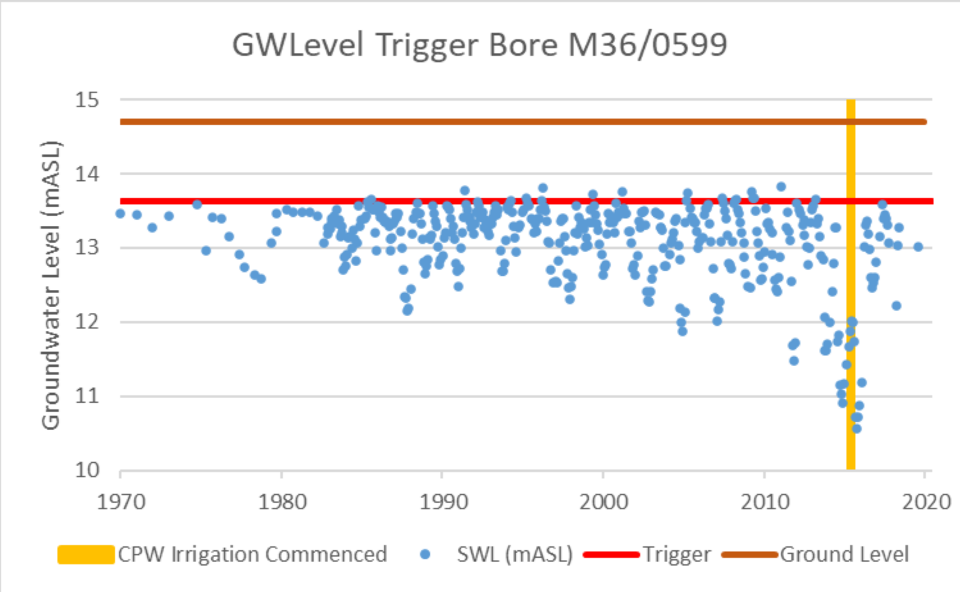
GWLevel Trigger Bore L37/0451
Groundwater Level (mASL)
27
26
25
24
23
22
21
20
19
1950
1960
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

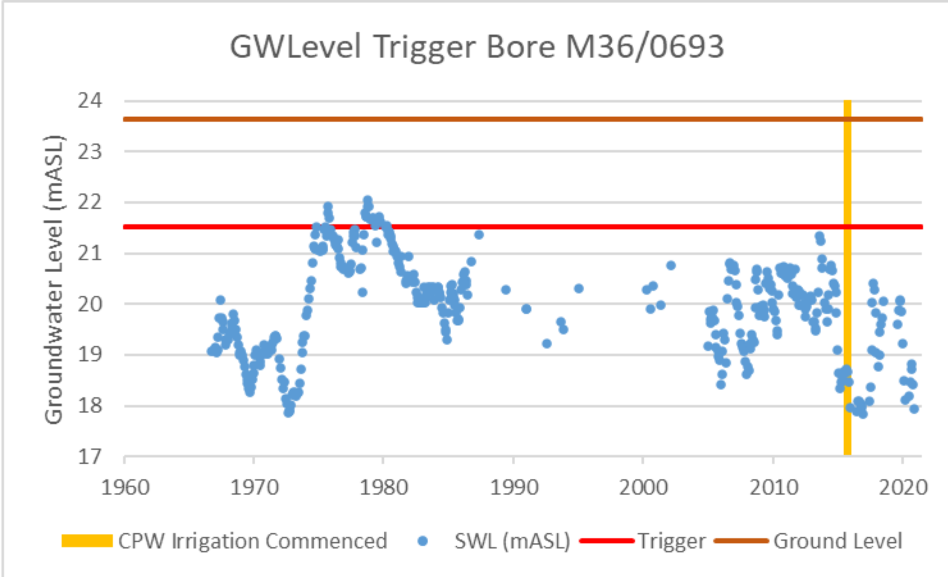

GWLevel Trigger Bore M36/0250
Groundwater Level (mASL)
24
22
20
18
16
14
12
10
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

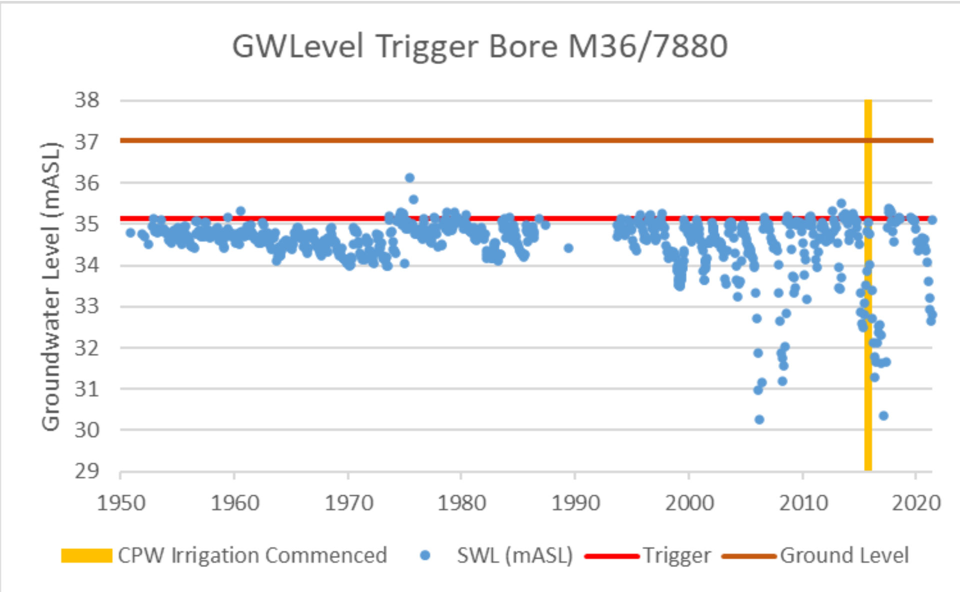

GWLevel Trigger Bore M36/0183
Groundwater Level (mASL)
40
35
30
25
20
15
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

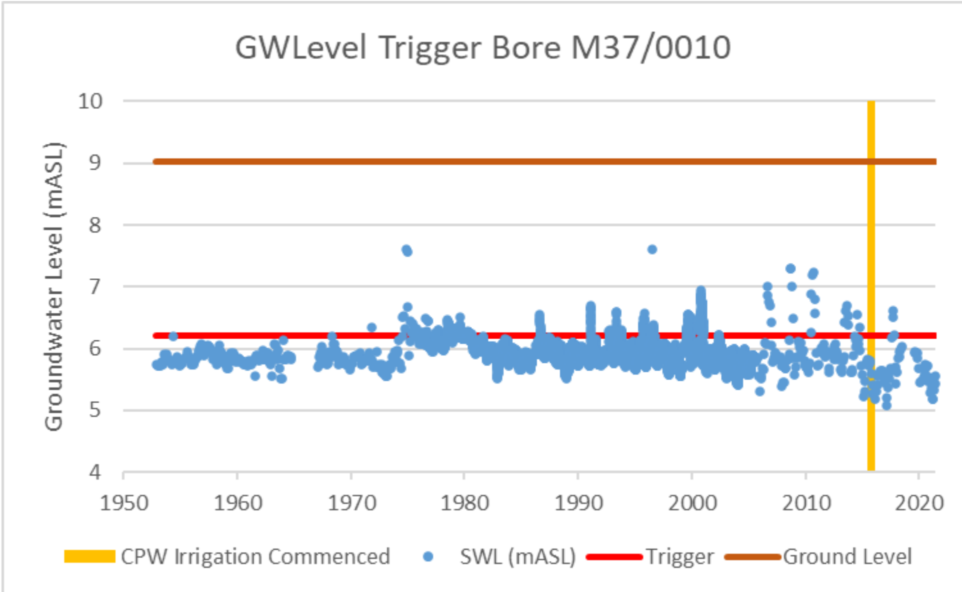

GWLevel Trigger Bore M36/0419
Groundwater Level (mASL)
36
35
34
33
32
31
30
29
28
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0424
Groundwater Level (mASL)
23
22.5
22
21.5
21
20.5
20
19.5
19
18.5
18
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0599
Groundwater Level (mASL)
15
14
13
12
11
10
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/0693
Groundwater Level (mASL)
24
23
22
21
20
19
18
17
1960
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M36/7880
Groundwater Level (mASL)
38
37
36
35
34
33
32
31
30
29
1950
1960
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level


GWLevel Trigger Bore M37/0010
Groundwater Level (mASL)
10
9
8
7
6
5
4
1950
1960
1970
1980
1990
2000
2010
2020
CPW Irrigation Commenced
SWL (mASL)
Trigger
Ground Level

6.7. Assessment of Compliance

During 2020-21, 33 Farm Environment Plans were audited. 21 received an A-grade, 10 a B-grade and there were no C-grades. Two plans received a D-grade during 2020-21. These D-graded farms have had a recent change in management and the existing FEPs no longer represent current farm practices. [One D-grade plan has been improved to a B-grade and a new nutrient budget was calculated for the other D-grade FEP, which when reaudited was given an A-grade].

Under the 2017 LWRP baseline CPW's allowance for the loss of Nitrogen is set at 3,644 tonnes/year. A 925 tonnes/year allocation was made for new irrigation (this includes the dryland baseline component), giving a total Nitrogen discharge allowance of 4,569 tonnes/year. CPW water users are required by ECan's Land and Water Regional Plan to reduce nitrogen losses by 14.2 percent (617 tonnes/year) of the original nitrogen loss allowance by 1 January 2022 (i.e., the new total discharge allowance from that date will be 3731 tonnes/year). The 2020-21 nitrogen Load for CPW water users is 3,064 tonnes/year which reflects a 30% reduction below the Schemes total nitrogen discharge allowance or a 14% reduction below the Baseline Load. Therefore during 2020-21 CPWL was currently within its consented total nitrogen allocation and appears to be on track for making the necessary reductions in losses to be compliant with the reduced allowance from 1 January 2022.

	Tonnes Nitrogen/yr	
	2019-20	2020-21
Baseline N Load	3644	3581
Allocation for New Irrigation	925	767
Total N Discharge Allowance	4569	4348
Current N Load	3276	3064
Reduction below Total N Discharge Allowance	28%	30%
Reduction below Baseline N	10%	14%
2022 N Discharge Allowance (14.2% decrease from Total N Discharge Allowance)	3920	3731
Reduction below 2022 Allowance	16%	18%

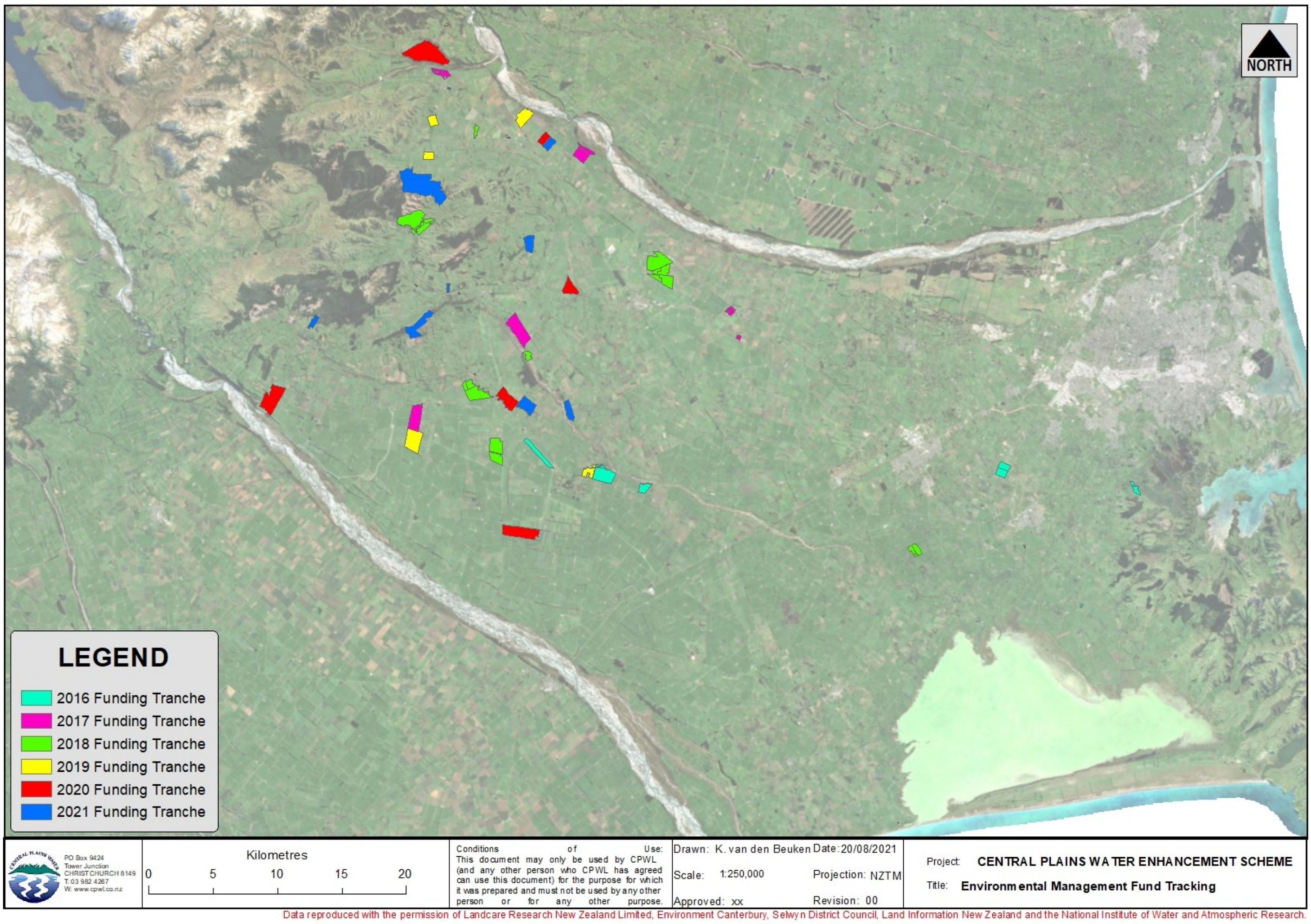
NB: Differences between 2019-20 and 2020-21 Baseline N Load, Allocation for New irrigation, and Total N Discharge Allowance values are due to different versions of Overseer being used in the calculations.

For 2020-21, the Nitrogen Loads for Stage 1, Stage 2 and Sheffield were 1385 tonnes, 1347 tonnes and 332 tonnes respectively [Total = 3064 tonnes]. This equates to being 34%, 27% and 19% below their individual Total N Discharge Allowances.

Overseer is stated within CPWL's consents and therefore CPWL are required to continue to use Overseer for managing the scheme's nutrient load. Environment Canterbury has informed CPWL that they are happy with CPWL's continued use of Overseer and the additional mitigation and tracking measures that we have in place to manage the schemes nutrient load going forward. It is business as usual, so it is important to CPWL that every shareholder contributes to a reduction in nutrient load within the catchment. Environment Canterbury are encouraging all stakeholders to be involved and provide feedback on the proposed new plan to be released in 2024.

The FEP audit grades detailed above show that the majority of CPW water users are applying Good Management Practices to their farming operations which in turn means the reduction in nutrient losses required by the Matrix of Good Management are being met.

The locations, and brief descriptions, of projects that have received funding from the Environmental Management Fund are shown in the following figure, and table, respectively.



Environmental Management Funded Projects Locations

Environmental Management Funded Projects and Categories

Year Funding Provided	Project	Category of Funding
2016-2017	Restoration and Community Planting	Native Planting
2017-2018	The Effect of Medium to Long-term Irrigation on Soil Water Holding Properties	Research
	Natives Under Pivots	Native Planting
	Restoration Planting on the Central Plains and Community Engagement	Native Planting
	Waikirikiri Farm Enhancement Project	Native Planting
2018-2019	Morchard Environment Enhancement Plantings	Native Planting
	Bishops Creek Planting	Native Planting
	Native planting enhancement and protection	Native Planting
	Darfield High School Environment Group	Native Planting
	Restoration planting on the Central Plains and community engagement	Native Planting
	Silverstream restoration project	Native Planting
	Native planting project	Native Planting
	The Effect of Medium to Long-term Irrigation on Soil Water Holding Properties	Research
	Waikirikiri Farm Enhancement Project	Native Planting
	Haldons wetland enhancement project	Wetland / SNA Protection
2019-2020	Natives on Canterbury Plains	Native Planting
	Wetland Restoration - Swamp Rd and Wyndale Rd	Wetland / SNA Protection
	Hororata River Enhancement and Protection	Native Planting
	Springfield Rd Native Wetland Planting	Wetland / SNA Protection
	Restoration Planting on the Central Plains and Community Engagement	Native Planting
	Wetland Restoration - Swamp Rd and Wyndale Rd	Wetland / SNA Protection
	Waikirikiri Farm Enhancement Project	Native Planting
	The Effect of Medium to Long-term Irrigation on Soil Water Holding Properties	Research
	Investigating the use of citizen science to develop a lake fly bio-indicator for Te Waihora/Lake Ellesmere	Research
2020-2021	Broadview Farm Native Planting	Native Planting
	Homestead Bush Weed Control	Native Planting
	Terraced Bank Enhancement and Protection - Windwhistle Pastoral Limited	Wetland / SNA Protection
	Native Planting Project - Tig Dalley	Native Planting
	Boundary Native Planting	Native Planting
	Te Ara Kakarirki Greenway Canterbury Trust	Native Planting
	MitiGator Risk Mapping - Central Plains Water Limited	Other
	Sharlands Road Native Planting - Abvan Farms Limited	Native Planting