3. Baseline Surface Water Quality

3.1. Introduction

The Selwyn River and main tributaries (Hororata River, Waianiwaniwa River and Hawkins River) traverse the Central Plains from headwaters in the foothills west of Glentunnel to Lake Ellesmere and are the primary surface water features within the CPWL scheme area. Numerous spring-fed streams originate in lowland areas around the margins of Te Waihora/Lake Ellesmere. These streams (including the lower reaches of the Selwyn River) gain baseflow from the alluvial aquifer system underlying the Central Plains. This groundwater is interpreted to comprise a mix of land surface recharge from the mid to upper plains with an increasing proportion of alpine river recharge toward the lake margin (Hanson and Abraham, 2009). Due to the hydraulic connection via the Central Plains groundwater system, increased nutrient losses (primarily in the form of elevated Nitrate-N) associated with changes in land use on the upper plains have the potential to impact on water quality in these lowland streams.

The following section outlines a range of data to provide an assessment of baseline surface water quality in the Selwyn Waihora zone. This data is primarily derived from reports prepared by Environment Canterbury for the Canterbury Water Management Strategy (CWMS) limit setting process, augmented by an ad-hoc data set compiled by Lincoln University.

3.1.1. Water quality data

Environment Canterbury

Environment Canterbury maintains a network of water quality monitoring sites on tributary streams to Te Waihora/Lake Ellesmere. These sites are distributed across the Selwyn River catchment and the lowland streams that originate around the margins of Te Waihora/Lake Ellesmere. A detailed outline of current monitoring sites, parameters and sampling methods is outlined in Stevenson *et al.* (2010). The location of current surface water quality sampling sites in the Selwyn Waihora zone is shown in **Figure 36** below.

Lincoln University

Lincoln University hold a database of water chemical and microbial water quality sample results collected from a large number of sites distributed across the wider Te Waihora/Lake Ellesmere catchment (Markham-Short, 2012). This data set is compiled from a large number of ad-hoc samples collected over the period 1993 to 2012. While this data is not sampled continuously, or subject to the same quality assurance procedures as data collected by Environment Canterbury, it provides a useful reference to characterise water quality in at number of sites (particularly those located on smaller streams) where no other water quality information exists.

Figure 37 shows the locations of sites included in the Lincoln University water quality data set.

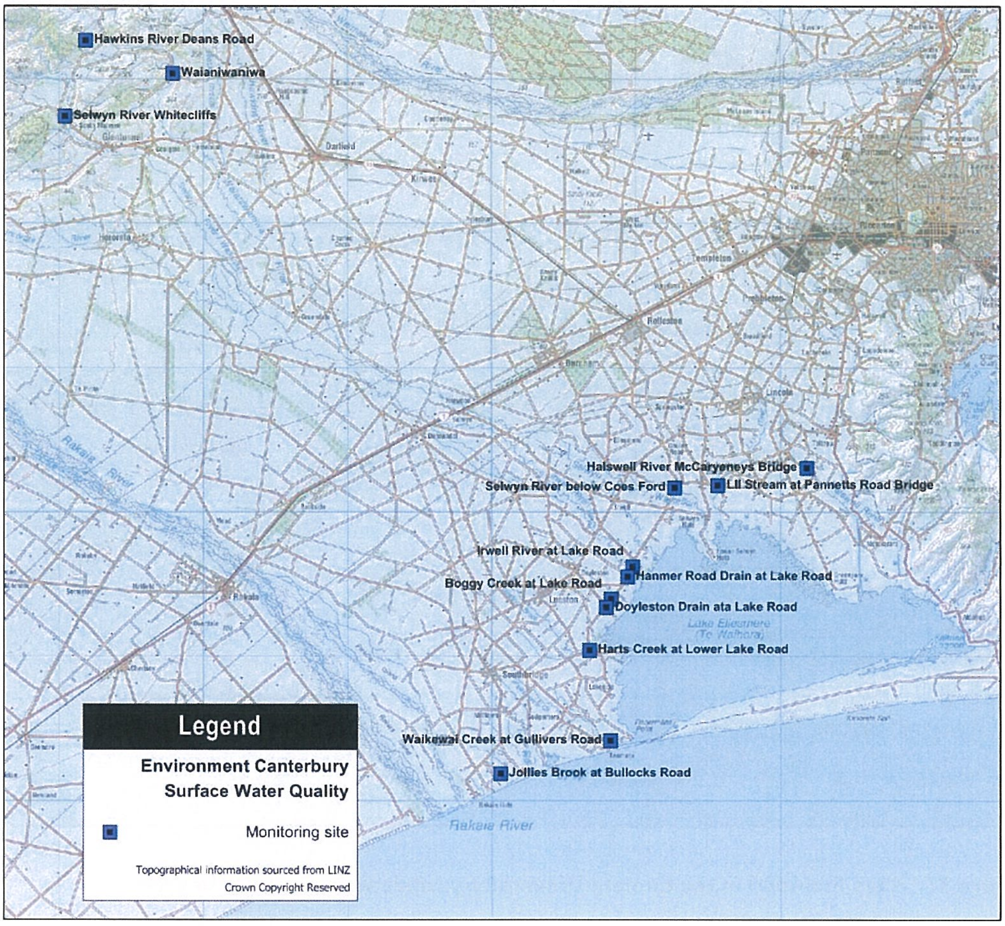

Figure 36. Location of Environment Canterbury surface water quality monitoring sites in the Te Waihora/Lake Ellesmere catchment

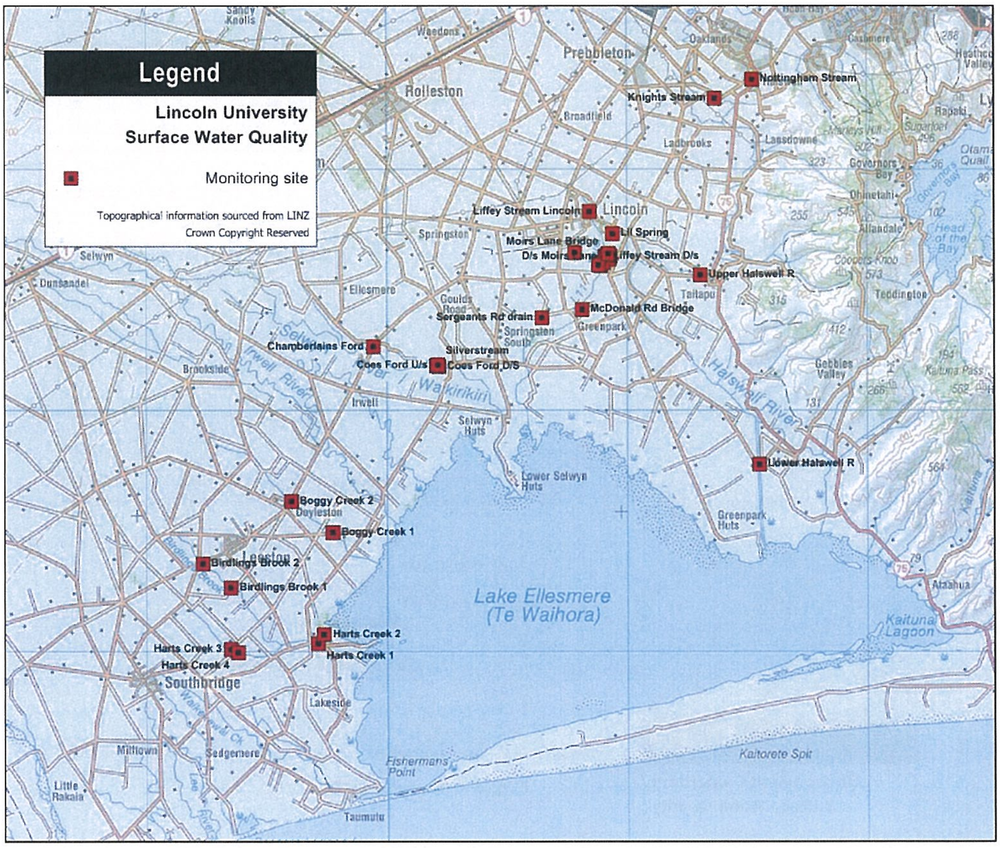

Figure 37. Sites included in the Lincoln University surface water quality data set

3.2. Current Surface Water Quality

The following section provides an assessment of current state and longer-term trends in water quality in the Selwyn Waihora zone. This assessment is largely drawn from analysis of Environment Canterbury regional surface water monitoring programme undertaken by Kelly (2012). This assessment provides information to quantify nutrient concentrations and loads, microbial indicators (*E.coli*) and plant indicators for sites in the CWMS Selwyn Waihora zone. Data from the Environment Canterbury monitoring programme is supplemented by a brief summary of data contained in the Lincoln University surface water quality data set.

3.2.1. Nutrient Status and Trends

Analysis of water quality state in Te Waihora/Lake Ellesmere tributary catchments by Kelly (2012) utilised box plots to provide a statistical representation of data recorded at individual monitoring sites generated from data collected between July 2006 and September 2011. Temporal trends in nutrient concentrations were analysed using Time Trends software developed by NIWA[8]. Trends were analysed using the longest continuous time series of data available for each site. Mean daily flow (either measured or synthetic) for each sampling site on the day of sampling was used as a covariate

[8] http://www.niwa.co.nz/our-science/freshwater/tools/time-trends

in the analysis. The direction and magnitude of any trends identified were assessed using the Seasonal Kendall test and Lowess smoothing of 30% for the covariate adjustment. Any significant change was interpreted using the Relative Seasonal Kendall Slope Estimator (RSKSE), which allows identification of percentage change per annum for individual sites.

Dissolved Reactive Phosphorus

Figure 38 shows a box plot of dissolved reactive phosphorus (DRP) concentrations in the Selwyn Waihora zone. Results indicate that, of the spring-fed streams, DRP concentrations were highest in the Irwell River, Hamner Road Drain, Boggy Creek, Doyleston Drain and the Halswell River. DRP concentrations were low in the spring-fed Jollies Brook, Lee River and Harts Creek and the hill-fed Hawkins River and Upper Selwyn River at Whitecliffs.

As illustrated in **Figure 39**, analysis of temporal trends indicated a significant increase in DRP concentrations (1.7% per year after flow adjustment) in the Halswell River over the period 1992-2011. However, DRP declined significantly in the L2 (6.8% per year), Boggy Creek (8.2% per year), Selwyn at Coes Ford (1.6% per year) and Hawkins (10% per year). There were no significant trends in DRP at any of the other monitoring sites.

Overall the data suggest that DRP concentrations in a majority of the Selwyn Waihora zone are stable or declining slightly (with the exception of the Halswell River).

Dissolved Inorganic Nitrogen

The box plot shown in **Figure 40** shows that, with the exception of the Irwell River and Jollies Brook, median DIN concentrations in all spring-fed rivers exceeded the threshold guideline expected to protect 95% of test biota from the effects of chronic nitrate toxicity (as per Hickey and Martin, 2009). Highest Nitrate-N concentrations were recorded in Boggy Creek, Harts Creek and the Selwyn River at Coes Ford. Of the three hill-fed rivers, only the Hawkins breached the Nitrate-N chronic toxicity threshold for protection of 95% of test biota.

All of the spring-fed streams analysed breached the MfE (Biggs, 2000) and ANZECC guidelines values for DIN for the protection of recreational and aesthetic values and nuisance weed growth (respectively 0.026 mg/L for a 20 day accrual period and 0.444 mg/L), with the magnitude of exceedance significantly higher than for the chronic nitrate toxicity threshold. However, it was noted that as the MfE guideline concentrations were developed from data representing mainly Hill-fed rivers, they may have limited relevance when interpreting potential effects of nutrients on plant and periphyton growth in spring-fed streams.

Analysis of temporal trends shown in **Figure 41** indicates a significant increase in DIN in the Hanmer Road Drain (4% per year), Harts Creek (2% per year), Selwyn River at Coes Ford (1.5% per year), the Lee River (3.9% per year) and LII. Although the Halswell River was the only spring-fed river where a significant decrease in DIN was detected (1.7% per year; Fig. 4f), DIN concentrations in this stream still remain high. There were no other significant trends in DIN at the remaining monitoring sites.

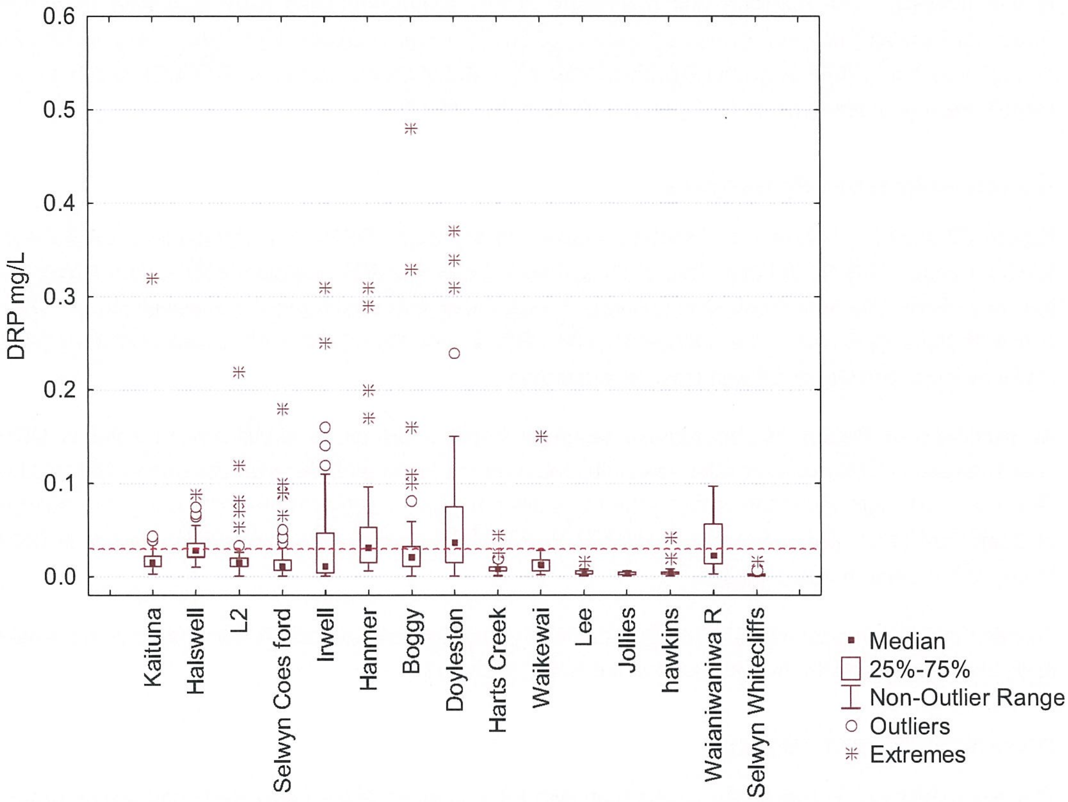

Figure 38. Dissolved Reactive Phosphorus (DRP) concentrations in Te Waihora/Lake Ellesmere tributaries, July 2006 to October 2011. Red line depicts guideline concentration expected to protect recreational/aesthetic values from plant growth (20 day accrual periods, Biggs 2000). Reproduced from Kelly (2012).

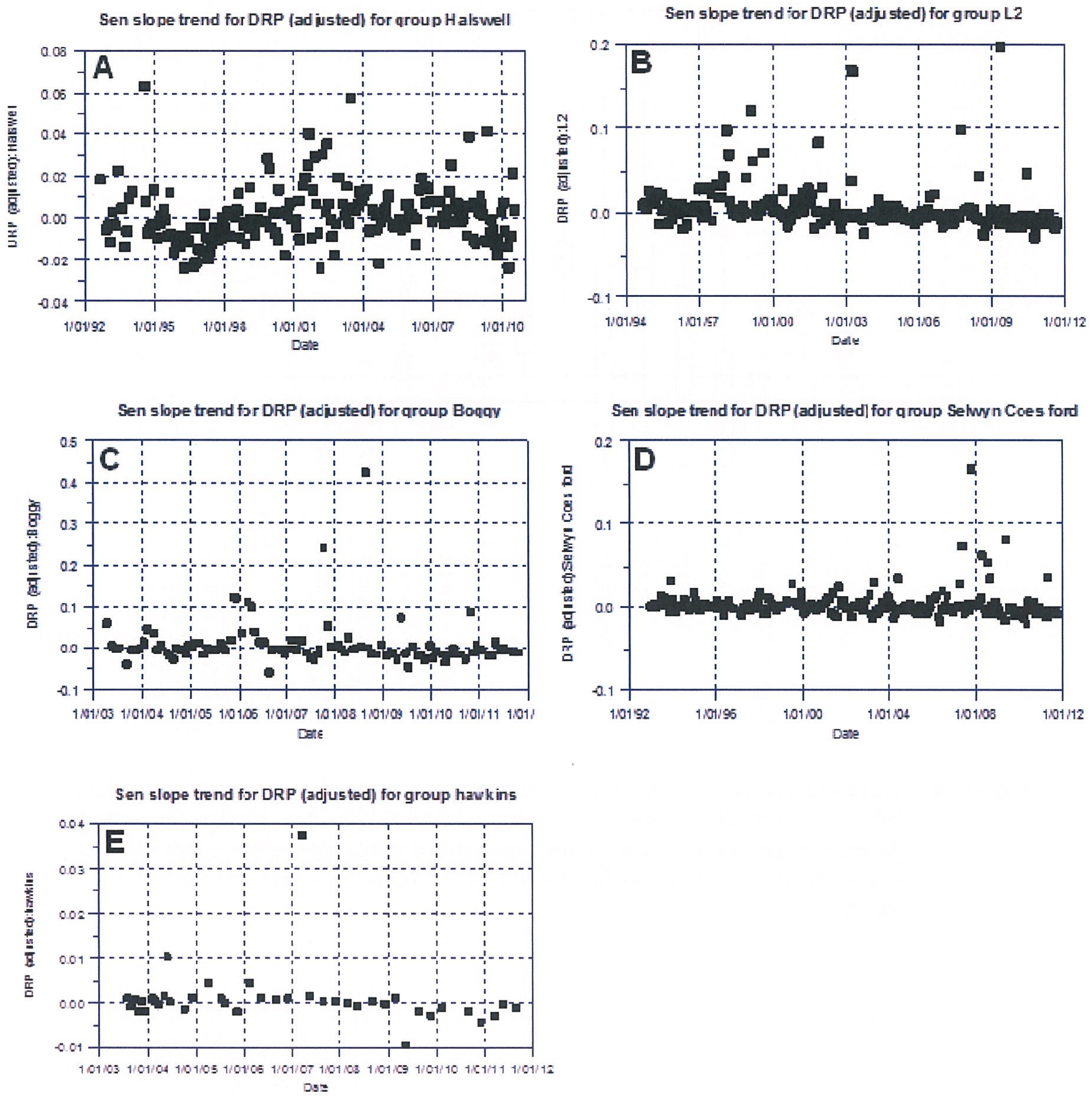

Figure 39. Analysis of flow adjusted temporal trends in DRP concentrations in Te Waihora/Lake Ellesmere tributaries (Halswell River (Panel A), LII (Panel B), Boggy Creek (Panel C), Selwyn River at Coes Ford (Panel D) and Hawkins River (Panel E)). Reproduced from Kelly (2012).

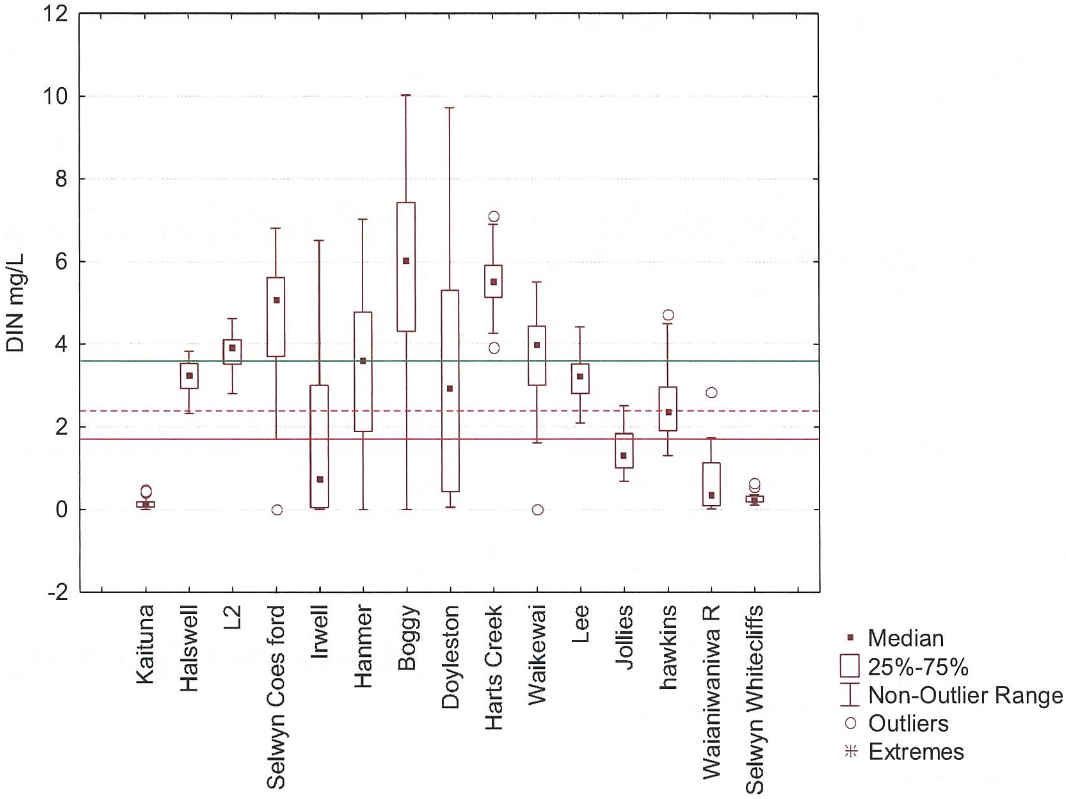

Figure 40. Dissolved Inorganic Nitrogen (DIM) in Te Waihora/Lake Ellesmere tributaries July 2006 to October 2011. ***Solid Red line depicts the threshold guideline concentration deemed protective of 95% biota from chronic nitrate toxicity effects; dashed 90% and green 80% biota (as per Hickey and Martin 2009).*** **Reproduced from Kelly, (2012).**

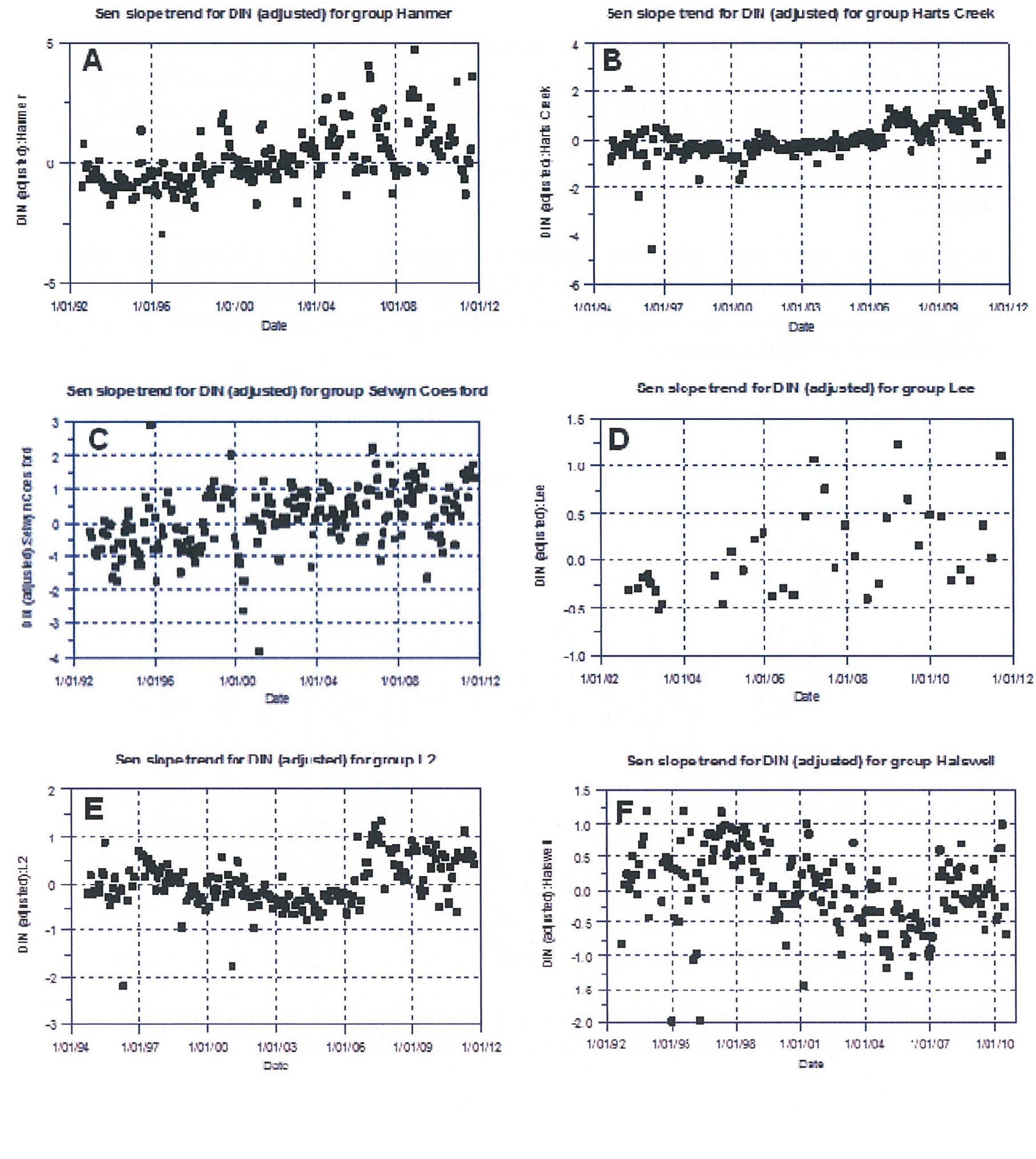

Figure 41. Analysis of flow adjusted temporal trends in DIN concentrations in Te Waihora/Lake Ellesmere tributaries (Hammer Road Drain (Panel A), Harts Creek (Panel B), Selwyn River at Coes Ford (Panel C), Lee River (Panel D), LII (Panel E) and the Halswell River (Panel F). Reproduced from Kelly (2012)

Lincoln University data

Nitrate-N and soluble phosphorus results from the Lincoln University data set are summarised in the box plots shown in **Figure 42** and **Figure 43** below. Overall, the data set show that median Nitrate-N concentrations are lowest (<2 mg/L) in the Selwyn River at Coalgate and the LII catchment and highest (>3.5 mg/l) in Harts Creek and the Lower Selwyn River. Median soluble phosphorus concentrations are lowest (<0.25 mg/L) in Harts Creek and the LII catchment and highest in the Lower Selwyn.

However, it is noted that significantly elevated concentrations of both Nitrate-N and soluble phosphorus are measured in small farm drains (not illustrated). This observation suggests that local land management practices may exert a significant influence on nutrient concentrations in some parts of the Selwyn-Te Waihora catchment.

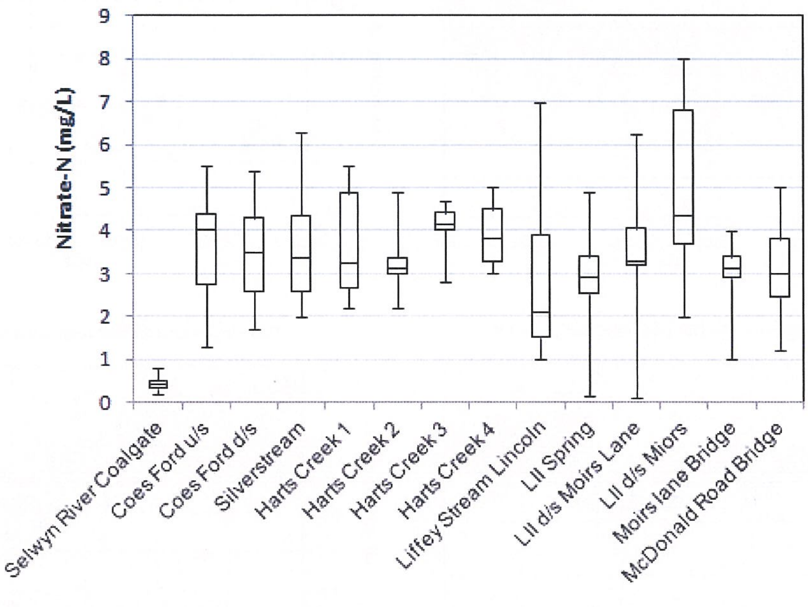

Figure 42. Box plot of Nitrate-N concentrations recorded in Te Waihora/Lake Ellesmere tributaries. Lincoln University water quality data, 1994 to 2013

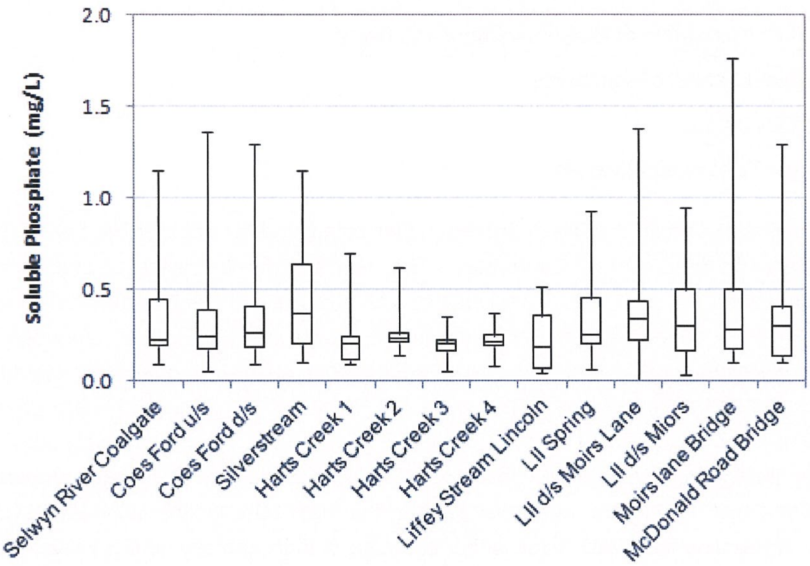

Figure 43. Box plot of soluble Phosphate (PO_4) concentrations recorded in Te Waihora/Lake Ellesmere tributaries. Lincoln University water quality data, 1994 to 2013.

3.2.2. Indicator plant growth

While plants are an important component of the natural structure and functioning of rivers, they can impact on a number of values when growth and biomass becomes high. For example, plant growth can impact on angling and boating as well as reducing the efficiency of land drainage. Excessive plant growth may also reduce the availability of physical substrate as habitat for fish spawning and invertebrates. When plants impede flow, an increased amount of suspended sediment may be deposited on the river bed resulting in siltation of substratum. Aquatic plant photosynthesis and respiration can also modify the suitability of the physio-chemical environment for animals by causing extreme diurnal fluctuations in dissolved oxygen and pH.

Vascular plants (or macrophytes) are the main plant growth form in the groundwater sourced tributaries of the Te Waihora/Lake Ellesmere catchment. Macrophyte growth is influenced by a wide range of factors including substrate suitability (for root system establishment), temperature, shade, flow, as well as nutrient availability both in the water column and sediment (Matheson *et al*. 2012 and Booker and Snelder, 2012). This complexity of possible causal factors makes it difficult to directly relate macrophyte abundance to water column dissolved nutrients concentrations.

Because macrophytes are the dominant plant growth form in lowland spring-fed streams in Canterbury, the NRRP (and the recently proposed Land And Water Regional Plan (LWRP)) sets specific macrophyte numeric objectives for each of the different river types in the region; a maximum percent bed cover of 50 for total macrophytes has been set for spring-fed plains rivers, and in springs where periphyton is a problem, a corresponding maxima for filamentous algae of 30% has been set.

These thresholds are expected to provide for the following purposes for management (see Hayward *et al.* 2009):

- Maintain aquatic ecosystem of indigenous flora and fauna
- Protect significant habitat of salmonids
- Maintain amenity values
- Safeguard Ngai Tahu cultural values

Table 6 lists the average annual maximum percent cover calculated for each of the Lake Ellesmere catchments monitored by Environment Canterbury. The maxima figures provide an indication of the highest possible abundance in any year for periods in which observations were conducted. Each year of data was summarised by water year (July in year *X* to June in year *X + 1*). Average annual maximum values were then compared with the corresponding numerical objectives stated in the NRRP. It is possible that because some of the rivers are mechanically cleared of weed growth that abundance could be underestimated. However, because the data are based on monthly observations there is a greater likelihood that any one observation will capture a period of high abundance. It should also be noted that there were numerous gaps in the plant data for the Halswell River, Harts Creek, LII, Jollies Brook and the Irwell River, either because of high turbidity, which prevented visual estimation, or because the river was dry (Irwell). These gaps may also lead to underestimation of observed average annual maxima.

Apart from the Selwyn River at Coes Ford, all springs exceeded the NRRP threshold for total macrophyte cover, with most springs also exceeding the threshold for filamentous algal cover. While macrophytes are expected to be the dominant plant growth form in spring-fed streams, filamentous algae can also grow attached to macrophytes or on available substratum, and is an indicator of nutrient enrichment. The Selwyn River at Coes Ford is shallow and riffle-like in comparison to the other spring-fed systems that are narrower and deeper, and has predominantly periphyton as opposed to macrophyte growth. In the Selwyn River at Coes ford, filamentous periphyton growth exceeds the NRRP objective. The Hawkins and Waianiwaniwa river sites also exceed the relevant NRRP numerical objective for filamentous algae, whereas in the Upper Selwyn River at Whitecliffs, observed data barely exceeded the NRRP objective. In the Little Rakaia groundwater zone, the Jollies Brook and Lee River sites exceeded the numerical objective for total macrophyte cover.

In summary, current monitoring data for stream sites in the Selwyn Waihora catchment and Little Rakaia zone indicate that plant growth is generally excessive, with the potential to impact on a number of values. For those sites in which the NRRP objective for filamentous algae was breached, it is likely that the elevated nutrient concentrations are mainly responsible since these types of algae prevail in more enriched conditions (Biggs, 2000). However, other factors such as substrate particle size may also influence macrophyte abundance.

Table 6. Comparison of current plant indicator state with NRRP numerical objectives in Ellesmere Streams. Values exceeding NRRP numerical objectives in bold. Reproduced from Kelly (2012)

Site name	River type	Total Macrophyte percent cover		Filamentous algae percent cover	
		Observed Average annual maximum	NRRP maximum cover	Observed Average annual maximum	NRRP maximum cover
Hawkins Deans Rd Bridge	Hill-fed lower	46	No value set	**35**	30
Waianiwaniwa Auchenflower Rd	Hill-fed lower	16	No value set	**47**	30
Selwyn River Whitecliffs	Hill-fed upper	-	No value set	**13**	10
Halswell River McCartneys Bridge	Spring fed plains	**80**	50	1	30
Lii Stream @ Pannetts Rd Bridge	Spring fed plains	**91**	50	**41**	30
Irwell R At Lake Rd	Spring fed plains	**64**	50	**79**	30
Hanmer Rd Drain At Lake Rd	Spring fed plains	**64**	50	21	30
Boggy Creek At Lake Rd	Spring fed plains	**58**	50	**35**	30
Doyleston Drain At Lake Rd	Spring fed plains	**65**	50	**45**	30
Harts Ck At Lower Lake Rd	Spring fed plains	**79**	50	3.5	30
Waikewai Creek Gullivers Rd	Spring fed plains	**85**	50	**58**	30
Selwyn R Below Coes Ford	Spring fed plains	24	50	**45**	30
Little Rakaia Zone					
Lee River Bridge Brooklands	Spring fed plains	**93**	50	15	30
Jollies Brook Bullocks Rd	Spring fed plains	**57**	50	3	30

3.2.3. Nutrient Load Estimates

Current nutrient loads for DRP and DIN were estimated using data from the last 5 water years (July 2006-June 2011) by Kelly (2012) using the "averaging approach". This method was utilised as it provides a broad indication of the relative load contribution of each stream. For monthly monitored sites, annual loads were calculated as in Norton and Kelly (2010). However, for quarterly monitored sites, annual loads were calculated based on the average concentration for that water year.

Flow data used to estimate nutrient loads were derived either from continuous flow recorders (aligned with water quality sites) or from a synthetic record generated by Environment Canterbury (aligned with spot gauging sites). Confidence in load estimates is greater for sites that are monitored more frequently for nutrients (monthly as compared to quarterly), and for sites with a continuous flow record as opposed to sites with a synthetic record.

Nutrient load estimates for individual monitoring sites in the Lake Ellesmere catchment are summarised in **Table 7**.

DIN load estimates

The lower Selwyn River at Coes Ford is the largest contributor to DIN load estimates in the Lake Ellesmere catchment, based on measured data, accounting for approximately 31% of the total estimated load. Significant contributions to the cumulative DIN load were also calculated for Harts Creek, the LII and Halswell River (21%, 20%, and 11.9%, respectively). Collectively, the Irwell River, Hanmer Road Drain, Boggy Creek, Doyleston Drain and Waikekewai Creek catchments were calculated to contribute approximately 15% to the estimated load, with the Banks Peninsula-sourced Kaituna making a relatively minor contribution (0.5%).

Of the monitored Selwyn tributaries, the Hawkins River is the largest contributor with the Waianiwaniwa River making a lesser contribution largely because of frequently low or zero flows. It is noted that the Hororata River, another major tributary of the Selwyn, is not monitored by Environment Canterbury and so its contribution is unknown. Nonetheless, these data re-enforce the difference in loads contributed by the upper Selwyn catchment (79 tonnes DIN) compared that arising from the mid to lower plains (1091 tonnes DIN; not including Kaituna). This indicates the mid to lower plains contribute in excess of 10 times the DIN loading derived from the headwaters of the Selwyn catchment.

Figure 44 shows a plot of the relative contribution of individual catchments to the estimated cumulative DIN loading to Lake Ellesmere/Te Waihora.

Table 7. Nutrient load estimates in the Lake Ellesmere - Te Waihora catchment. Relative loads calculated as a percentage of the total load estimated for the lower tributaries.

Site name	River type	Average DIN load (T/yr)	Percent of total measured load lower Waihora catchment	Average DRP load (T/yr)	Percent of total measured load lower Waihora catchment
Lake Ellesmere Catchment					
Hawkins River at Deans Road	Hill-fed lower	49.8	n/a	0.107	n/a
Waianiwaniwa at Auchenflower Rd	Hill-fed lower	3.4	n/a	0.18	n/a
Selwyn River at Whitecliffs	Hill-fed Upper	26.2	n/a	0.35	n/a
Halswell River at McCartneys Bridge	Spring-fed Plains	139.1	11.9	1.45	13.3
L2 Stream at Pannetts Road Bridge	Spring-fed Plains	236.8	20	1.58	14.5
Irwell River at Lake Road	Spring-fed Plains	59.4	5.1	0.49	4.5
Hanmer Road Drain at Lake Rd	Spring-fed Plains	39.4	3.4	0.55	5.1
Boggy Creek at Lake Road	Spring-fed Plains	43.9	3.8	0.44	4
Doyleston Drain at Lake Road	Spring-fed Plains	29.5	2.5	0.35	3.3
Harts Creek at Lower Lake Road	Spring-fed Plains	246.3	21.1	2.46	22.6
Waikewai Creek at Gullivers Road	Spring-fed Plains	9.7	0.8	0.046	0.4
Selwyn River below Coes Ford	Spring-fed Plains	366.8	31	3.12	28.7
Little Rakaia Zone					
Lee River	Spring-fed Plains	161	n/a	0.235	n/a
Jollies Brook	Spring-fed Plains	31	n/a	0.075	n/a

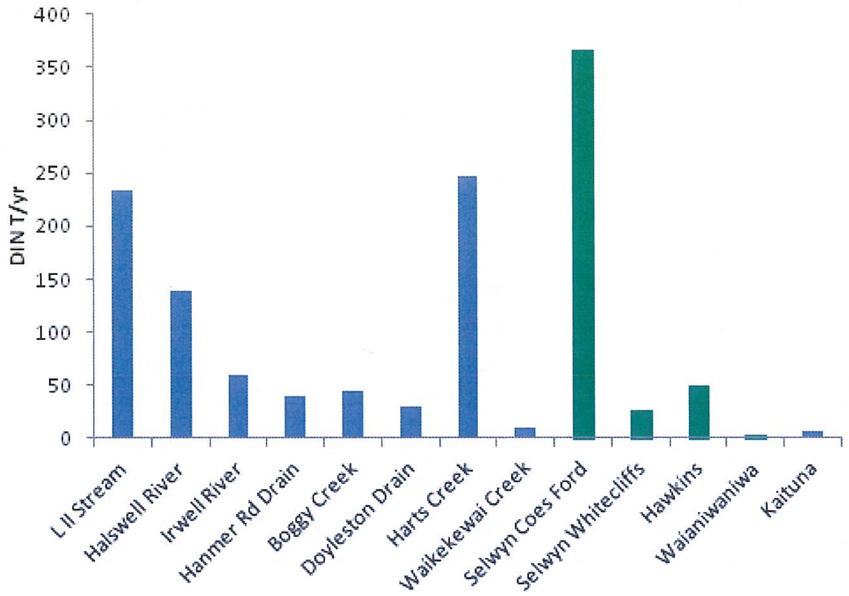

Figure 44. Estimated annual DIN loads in the rivers of the Te Waihora/Lake Ellesmere catchment (mean of 2006 - 2011). Reproduced from Kelly (2012)

DRP Load estimates

DRP load estimates in the lower catchment show a similar pattern to that for DIN. Again the Lower Selwyn River at Coes Ford is the largest contributor to DRP loads, accounting for approximately 29% of the total estimated load. Harts Creek, the L2 and Halswell River also contribute significantly (22.6%, 14.5%, and 13.3% of the cumulative loading respectively). Collectively, the Irwell River, Hanmer Road Drain, Boggy Creek, Doyleston Drain and Waikekewai Creek contribute approximately 17% of the estimated load, with the Kaituna, sourced from the phosphorus-rich Banks Peninsula catchment, contributing 3.5% of the total load. Relative DRP loadings for rivers of the Lake Ellesmere/Te Waihora catchment are illustrated in **Figure 45** below.

Of the monitored Selwyn tributaries, the Upper Selwyn is the largest DRP contributor with an estimated annual loading of 0.35 tonnes/year. These data re-enforce a marked difference in DRP load in the upper Selwyn catchment (637 kg/yr) as compared to the plains (9.85 tonnes/yr; not including Kaituna), with the plains contributing 15 times greater load than the upper catchment.

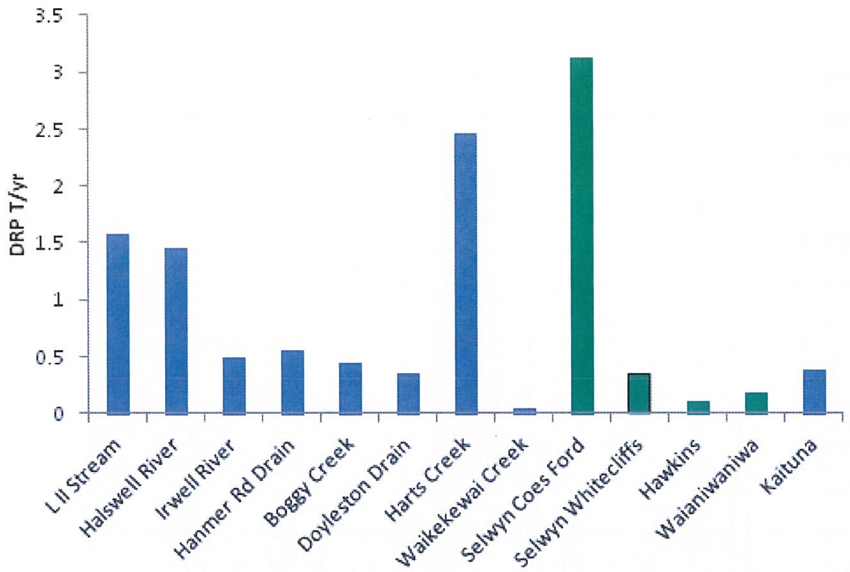

Figure 45. Estimated annual DRP loads in the rivers of the Te Waihora/Lake Ellesmere catchment (mean of 2006 - 2011). Reproduced from Kelly (2012)

3.2.4. Escherichia coli

Escherichia coli (*E.coli*) are the bacteria commonly used in freshwater as an indicator of the likely presence of pathogenic (diseasing-causing) faecal contaminants originating from warm-blooded animals (birds, mammals, humans). The presence of faecal contamination primarily affects the suitability of water for human uses such as potable supply, contact recreation, and stock water supply. Faecal contamination rarely directly affects aquatic ecosystems. There are national microbiological guidelines for human drinking water (<1 *E. coli* per 100mL; MoH 2005), contact recreation (<260 and <550 *E. coli* per 100 mL single sample Alert and Action level respectively; MfE/MoH 2003) and stock drinking water (100 faecal coliforms per 100 mL; ANZECC 2000).

Environment Canterbury conducts summer weekly monitoring at a number of popular swimming sites in the region including sites on the Selwyn River to determine their suitability for contact recreation. Environment Canterbury also monitors *E.coli* routinely as part of its annual water quality monitoring programme. **Figure 46** shows a box plot of results from this monitoring. These data show that in the lower catchment, only the Selwyn River at Coes Ford, the Irwell River, Waikekewai Creek, and Lee River had median *E.coli* levels considered less than high (i.e. < 126 MPN /100ml).

In the Upper catchment, the Selwyn at Whitecliffs and the Hawkins had median *E. coli* levels rated as less than high. However, there was wide variation in values at each of these sites indicating that on any occasion the water may be unsafe for contact recreation. All other lower catchment sites had median *E. coli* levels that were considered high or very high (i.e. > 400 MPN/ 100ml), with the highest values observed in Hamner Drain, Boggy Creek, and Doyleston Drain.

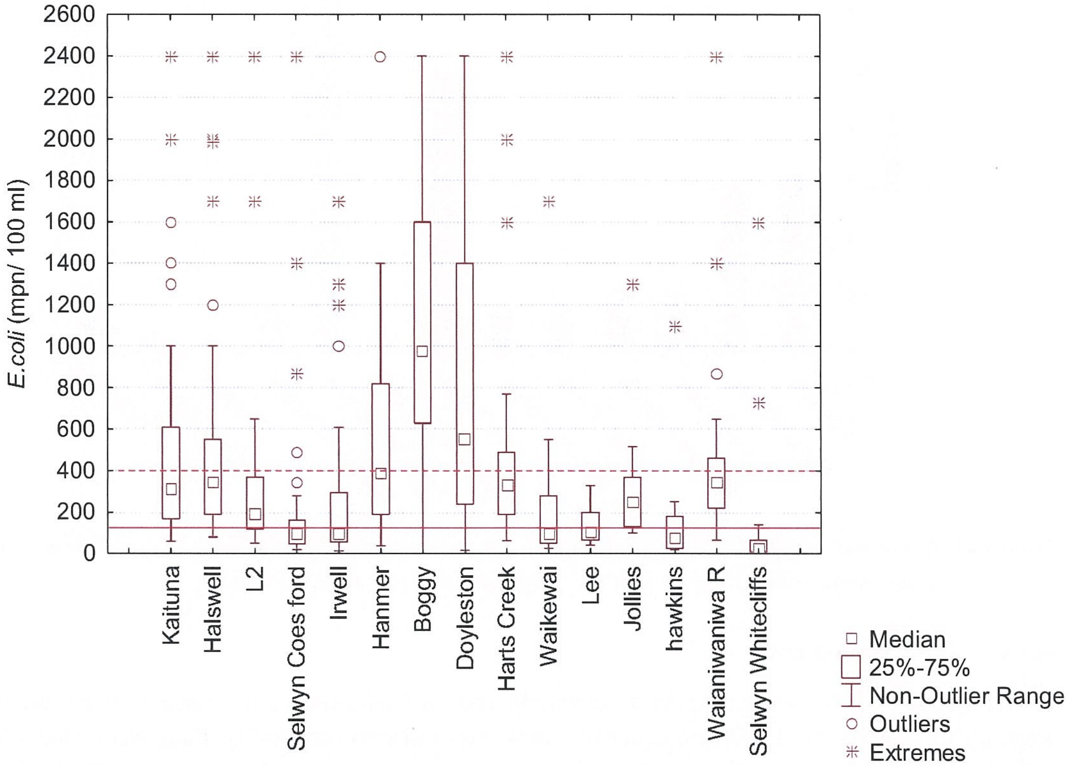

Figure 46. Box plot of *E.coli* levels in rivers of the Selwyn Waihora zone compared to the MfE/MOH Alert (126 cfu/ml) and Action levels (400 cfu/ml). Reproduced from Kelly (2012).

Figure 47 shows a box plot of *E.coli* levels in waterways in the Te Waihora/Lake Ellesmere catchment in samples included in the Lincoln University water quality data set. Again these data indicate elevated levels of indicator bacteria in all tributaries in the Lake Ellesmere-Te Waihora catchment. Of the sites illustrated, median *E.coli* levels are lowest in the Selwyn River at Coes Ford and highest in the Boggy Creek catchment. It is noted the database also includes a number of samples from small farm drains which exhibit extremely high *E.coli* values reflecting the impact of local drainage on levels of microbial contamination in some areas of the catchment.

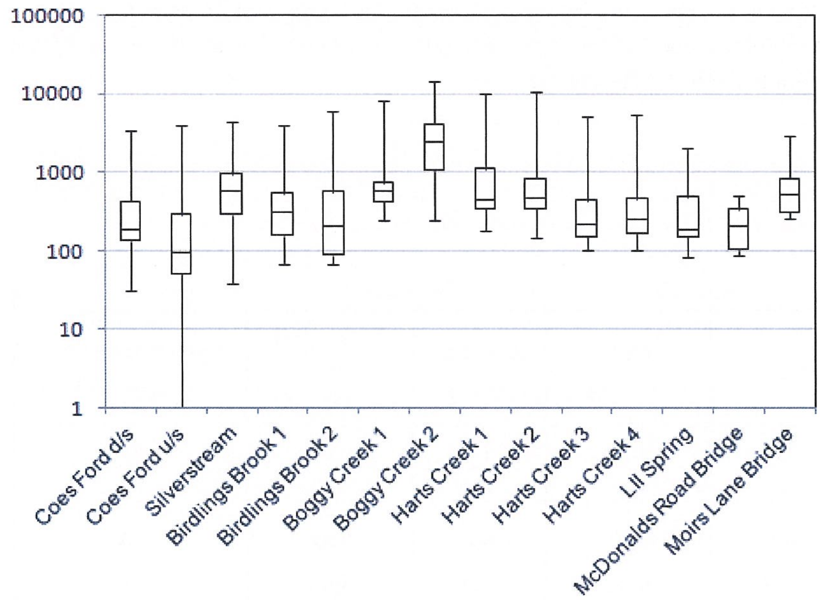

Figure 47. Box plot of E.coli levels in water quality samples recorded on the Lincoln University water quality database.

In summary, most lowland spring-fed rivers in Lake Ellesmere-Te Waihora catchments have water quality indicative of high to very high levels of faecal contamination and so are considered unsafe for contact recreational activity. This contamination is likely to reflect land use, drainage and riparian management across the wider Lake Ellesmere-Te Waihora catchment.

3.3. Future Baseline Water Quality

As noted in **Section 2.4.2**, recent work undertaken for the Environment Canterbury, Selwyn Waihora zone limit setting process involved modelling of the potential environmental, economic and social effects associated with a range of future land use scenarios (Robinson *et al.*, 2012). Of the future land use options considered Scenario 1, comprising continuation of 2011 land use with no additional water allocation or irrigation, essentially provides an assessment of future baseline water quality in the absence of CPW scheme development.

Kelly (2013 in prep) provides a summary of potential effects associated with the different land use scenarios modelled for the Selwyn Waihora zone limit setting process. Given that land use under Scenario 1 is assumed to remain static, the primary water quality effects associated with this option (in effect the Central Plains without the CPW scheme) are associated with increases in DIN which reflect the lag times associated with the groundwater system (as discussed in **Section 2.2**). In effect, this scenario provides sufficient time for groundwater quality across the Central Plains area to equilibrate with current land use.

Table 8 provides a comparison of current DIN concentrations in Lake Ellesmere tributaries against those calculated under Scenario 1. These data indicate an increase in median and 95th percentile

concentrations of between 24 percent in the Halswell River and a maximum of 44 percent in the Lee River. This provides an approximation of the likely change in baseline water quality in the Selwyn Waihora zone in the absence of the CPWL scheme.

Table 8. Comparison of measured mean dissolved inorganic nitrogen (DIN) concentrations (July 2006 to September 2011) against those calculated for Scenario 1 utilised for the Selwyn Waihora limit setting process. From Kelly (2012 *in prep.*)

	Current		Scenario 1		
Stream	Mean	95^{th} percentile	Modelled Mean	Estimated 95^{th} percentile	Percentage change relative to current (%)
Halswell	3.3	3.75	4.1	4.66	24
LII	3.8	4.50	4.9	5.76	28
Selwyn Coes Ford	4.9	6.51	6.2	8.32	28
Irwell	1.5	5.45	1.9	6.96	28
Hanmer	3.3	6.44	4.2	8.22	28
Boggy	5.9	9.71	8.2	13.62	40
Doyleston	3.3	8.46	4.6	11.90	41
Harts Creek	5.5	6.80	7.8	9.57	41
Waikekewai	3.9	5.10	5.4	7.14	40
Lee	3.2	4.11	4.6	5.91	44
Jollies	1.5	2.52	2.1	3.57	42

Table 9 provides an assessment of current and future (i.e. Scenario 1) baseline water quality against ecological and environmental outcomes for streams in the lower Selwyn Waihora catchment. This assessment indicates that risks to a wide range of recreational, cultural and ecological values associated with the catchment are likely to decline over time due to the lag between current land use and consequent effects (in terms of DIN) in lowland streams.

Table 9. Assessment of ecological and environmental outcomes for streams in the lower Te Waihora/Lake Ellesmere catchment in terms of current and future baseline water quality[9].

<table>
<tr><th>Metric</th><th colspan="2">Current Water Quality State</th><th colspan="3">Scenario1</th></tr>
<tr><td>NRRP plant objective (50%)</td><td colspan="2">No
(excl. Selwyn)</td><td colspan="3">No
(⇧ Risk Selwyn)</td></tr>
<tr><td>NRRP filamentous algae objective (<30%)</td><td>Yes
Halswell, Hanmer, Harts, Lee, Jollies, Kaituna</td><td>No
Selwyn, LII, Irwell, Boggy, Doyleston, Waikekewai</td><td>⇧Risk
Halswell, Hanmer, Harts, Lee, Jollies, Kaituna</td><td colspan="2">No
Selwyn, LII, Irwell, Boggy, Doyleston, Waikekewai</td></tr>
<tr><td>Visual aesthetics (<30% algae cover)</td><td>Yes
Halswell, Hanmer, Harts, Lee, Jollies, Kaituna</td><td>No
Selwyn, LII, Irwell, Boggy, Doyleston, Waikekewai</td><td>⇧Risk
Halswell, Hanmer, Harts, Lee, Jollies, Kaituna</td><td colspan="2">No
Selwyn, LII, Irwell, Boggy, Doyleston, Waikekewai</td></tr>
<tr><td>Recreation (due to plant/ algae growth)</td><td colspan="2">At Risk</td><td colspan="3">⇧Risk</td></tr>
<tr><td>Benthic biodiversity (response to algae/ plants//N toxicity)</td><td colspan="2">At Risk</td><td colspan="3">⇧Risk</td></tr>
<tr><td>Trout habitat & angling (response to algae/ plants/ N toxicity)</td><td colspan="2">At Risk</td><td colspan="3">⇧Risk</td></tr>
<tr><td>Nitrate toxicity: 95 % aquatic biodiversity protection (~1.7 mg/L)</td><td colspan="2">No
(excl. Kaituna)</td><td colspan="3">No
(excl. Kaituna)</td></tr>
<tr><td>Nitrate toxicity: 90 % aquatic biodiversity protection (~2.4 mg/L)</td><td colspan="2">No
(excl. Kaituna)</td><td colspan="3">No
(excl. Kaituna)</td></tr>
<tr><td>Nitrate toxicity: 80 % aquatic biodiversity protection (~3.6 mg/L)</td><td colspan="2">No
(excl. Kaituna/Jollies)</td><td colspan="3">No
(excl. Kaituna/Jollies)</td></tr>
<tr><td>Nitrate toxicity: drinking water ½ MAV (~5.65 mg/L)</td><td>Yes
(Halswell, LII, Irwell, Waikekewai, Kaituna, Jollies, Lee)</td><td>No
(Selwyn, Hanmer, Boggy, Doyleston, Harts)</td><td>Yes
(Halswell, Jollies, Kaituna)</td><td>No
(Selwyn, Hanmer, Boggy, Doyleston, Harts)</td><td>⇧Risk
(LII, Irwell, Lee, Waikekewai)</td></tr>
<tr><td>Nitrate toxicity: drinking water (~11.3 mg/L)</td><td colspan="2">Yes</td><td>Yes</td><td colspan="2">⇧Risk
(Boggy)</td></tr>
</table>

[9] From http://ecan.govt.nz/publications/Plans/selwyn-tewaihora-tech-overview-scenarios1-2.pdf

3.4. Summary

The assessment of baseline surface water quality in Te Waihora/Lake Ellesmere tributaries outlined in the preceding section indicates that:

- Highest dissolved reactive phosphorus (DRP) concentrations occur in the Hamner Road Drain and the Doyleston Drain where median concentrations exceed guideline concentrations for protecting recreational/aesthetic values for plant growth. DRP concentrations are also elevated in the Irwell River, Boggy Creek and the Halswell River. Analysis of monitoring data collected over the 1992 to 2011 period indicates significant declines in DRP concentrations in the LII, Boggy Creek, Lower Selwyn River and the Hawkins River. The only site exhibiting an increasing trend was the Halswell River;
- With the exception of the Irwell River and Jollies Brook, median dissolved inorganic nitrogen (DIN) concentrations in all spring-fed tributaries of Te Waihora/Lake Ellesmere exceed the threshold guideline for chronic nitrate toxicity. All spring-fed tributaries breach the MfE and ANZEEC guidelines for the protection of recreational and aesthetic values and nuisance weed growth. Significant increases in median DIN concentrations were observed in the Hamner Road Drain, Harts Creek, the Lower Selwyn River, the Lee River and the LII
- Apart for the Selwyn River at Coes Ford, all spring fed tributaries exceeded the NRRP (and proposed LWRP) threshold for total macrophyte cover, with most springs also exceeding the threshold for filamentous algal cover;
- Concentrations of indicator bacteria (E.coli) in Te Waihora/Lake Ellesmere are variable but typically exceed MfE/MOH guideline alert levels and are rates a high or very high risk for contact recreation (with the exception of the Selwyn River at Coes Ford, the Irwell River, Waikekewai Creek and the Lee River);
- Estimates of DRP and DIN loads to Te Waihora/Lake Ellesmere indicate streams originating on the lower plains contribute between 10 to 15 times the loads derived from headwater catchments. DRP loadings in these lowland catchments are interpreted to reflect (riparian) land management practices while the elevated DIN loadings in lowland streams reflects input of groundwater containing elevated Nitrate-N concentrations;
- Modelling of current land use indicates that future DIN concentrations in lowland streams may increase by 24 to 44% over current concentrations due to lags within the groundwater system. This increase in DIN concentrations is likely to result in a decline across a range of metrics used to assess water quality and ecological state in lowland streams.