BEFORE THE HEARING COMMISSIONER
FOR SELWYN DISTRICT COUNCIL

UNDER	the Resource Management Act 1991
IN THE MATTER	of Private Plan Change 69 (Lincoln) by Rolleston Industrial Developments Limited

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STATEMENT OF EVIDENCE OF PHILIPPA AITCHISON-EARL ON BEHALF OF THE CANTERBURY REGIONAL COUNCIL AND CHRISTCHURCH CITY COUNCIL

11 NOVEMBER 2021

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INTRODUCTION

1. My full name is Philippa Lauren Aitchison-Earl.

2. I hold a Bachelor of Science (Honours) in Geology from the University of Canterbury. My post-graduate Honours year and dissertation focussed on groundwater science.

3. I am a Senior Groundwater Scientist and have worked at Canterbury Regional Council (**CRC**) since 1997.

4. My work at CRC includes investigating, monitoring, and reporting on quantity and quality of groundwater in the region. I also provide technical advice for plan changes and consent applications in relation to a number of topics, including water abstraction and dewatering, stream and spring depletion, wastewater and stormwater management. I developed the Springs Database and mapped many springs in the Canterbury region.

5. I am reviewed the submissions lodged by CRC and Christchurch City Council (CCC) dated 3 May 2021 in relation to this private plan change request (**PC69**), and the groundwater science issues raised by those submissions. I have been authorised by both CRC and CCC to provide evidence on their behalf.

Code of Conduct

6. While this evidence is not being prepared for an Environment Court hearing, I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I agree to comply with it, including when giving any oral evidence during this hearing, and have prepared my evidence on that basis. Except where I state that I am relying on the evidence of another person, I confirm that the matters addressed in my evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

7. As noted above, my evidence is on behalf of CRC and CCC in relation to PC69 to the Selwyn District Plan (**SDP**).

8. My evidence describes the groundwater and springs at the subject site, and addresses:

(a) the potential impact of excavation and construction associated with PC69 on local groundwater and springs; and

(b) the potential impact of reduced recharge and increased stormwater discharges associated with PC69 on local groundwater and springs.

9. I have reviewed the following documents and evidence in preparing my evidence:

(a) Request for Change to the Selwyn District Plan prepared for Rolleston Industrial Developments Limited (**RIDL**) Springs Road, Lincoln (April 2021) (**PC69**) including:

(i) Appendix B Updated Geotechnical Assessment (January 2021); and

(ii) Appendix F1 Ecological Assessment (October 2020); and

(b) PC69 by RIDL: 'Lincoln South' Section 42A Report (October 2021) including:

(i) Appendix E Ecology Report (October 2021).

Description of groundwater and springs

10. The subject site proposed for rezoning is at the western edge of the coastal confined aquifer system, a succession of artesian gravel aquifer and semi-confining[1] layers that occurs between Leithfield Beach and the Rakaia River mouth (Weeber, 2002).

[1] They are not true 'confining' layers, as water can flow through the fine sediments, just at slower rates.

11. The uppermost semi-confining layer is the Springston Formation which includes silts, fine sands, peat and organic material as well as lobes of gravels. Beneath this is a gravel aquifer (Riccarton Gravels) with artesian pressure. To the west the semi-confining layers thin and become discontinous so their ability to act as a semi-confining layer diminishes. Deposits become dominated by gravel, sand and silts and groundwater is generally unconfined (a water table). Figure 1 shows the thickness of the semi-confining layer in the vicinity of the PC69 site. The western block of the proposed PC69 site is likely to be over an unconfined water table (confining layer thickness is thin, mapped at less than 1 m west of Springs Road).

12. Regional groundwater flow direction in the area is from North-West to South-East (perpendicular to the blue piezometric contours[2] shown in Figure 1). However, measured groundwater levels across the PC69 site do not always show this gradient. Groundwater levels become deeper towards the west because the wells in the east of the site are under some artesian pressure rising from the confining pressure in the Riccarton Gravel aquifer.

13. The applicant provided information from well details in the area, informing us that the highest groundwater levels may be 0.2 to 0.42 m below ground level.[3] Mr Thompson also details groundwater levels in Cone Penetration Testing (**CPT**) and test pits ranging from 0.5 to 2.4 m below ground, becoming shallower to the east. In January 2021 regional groundwater levels were low and as a result I consider the levels measured then will be lower than occurs over the longer term.

14. The nearest CRC monitoring bore (M36/4804) currently monitoring shallow groundwater (12 m deep located around 2km NW of the site see Figure 1) was at the 12th percentile for its range between 2001-2021. I would expect groundwater levels at the site to vary and to usually be higher than those measured in January 2021. Past groundwater monitoring at Lincoln University at shallow well (M36/0509) (4 m deep) ranged from 0.35 to 3.32 m below ground between 1947 and 1997.

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[2] Piezometric contour from 1993 survey. Other surveys show very similar patterns.

[3] Updated Geotechnical Assessment in support of plan change application, Chris Thompson, 28 January 2021.

15. Artesian conditions with higher groundwater levels occur in deeper wells and in wells further to the east. Well M36/0512 (87.5 m deep) just north of the PC69 site was measured from 1950-2007 with pressures ranging from 4.58 m above ground to 0.59 m below ground.

16. Many artesian springs occur in and around the PC69 site feeding tributaries of the Arariri/LII River (locations shown in Figure 1). The springs are artesian, rising under pressure from the Riccarton Gravel aquifer in some cases to form sandy bubbly boil type springs (see Figure 2 photos of Spring Creek spring M36/5530). I visited and mapped these springs in 1998, although it is likely there have been changes since then. The springs are part of a wide band of springs that form at the edges of the coastal confining layer, where the water is either forced above the confining layer edges or flows up through weaknesses in the confining layer such as sandy or gravelly zones. The sandy boil like nature of the springs may indicate the presence of sandy weak spots in the confining layer allowing upward groundwater flow (Earl, 1998).

17. There is little information on the total discharge from the springs. Gauging in October 1983 of Spring Creek measured a flow of 196 L/s, compared to 139 L/s in the Aruriri/LII at the confluence of Lincoln Main Drain just upstream of the Spring Creek confluence. This would indicate that Spring Creek is a major contributor of flow to the Arariri/LII River.

18. The geochemistry of the headwater springs of the Aruriri/LII River was assessed by Scott and Hanson (2017), who concluded that the springs 'skimmed off' the local shallow groundwater which was more contaminated in nutrients compared to deeper groundwater, making the headwater springs a significant source of nitrate to the stream. The shallow groundwater and spring isotopic and chemical signature were similar and indicated recharge from a combination of local rainfall recharge with some contribution from Waimakariri River sourced groundwater.

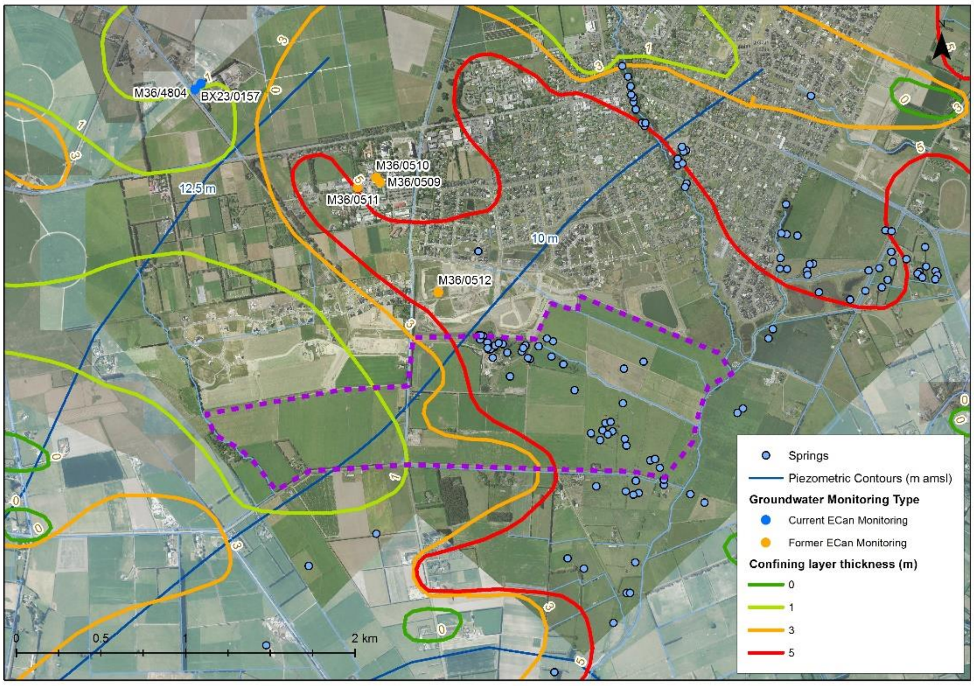

Figure 1: PC69 site (approx. outline in dashed purple line) and groundwater features.

Figure 2: Spring M36/5530 located at head of Spring Creek in main pond by Chudleigh Farmhouse showing ‘boiling’ sand vents (photo taken by author in 1998).

Impact of construction, excavation and dewatering on springs

19. In my experience, shallow groundwater and artesian conditions can pose challenges for construction, dewatering, future earthworks, stormwater discharges and wastewater infrastructure if an area is rezoned for development.

20. Of particular concern is whether any earthworks or construction penetrate the confining layer and create an 'artificial spring', or in other words a pathway for the groundwater under pressure to rise to the surface. This would lessen discharge to existing springs, which will have ecosystems and values associated with them. This has recently occurred in the Styx catchment, an area with similar bubbling artesian springs, where CPT near Main North Road, and bridge pilings penetrated the confining layer allowing groundwater to discharge to the surface. The CPT example was extremely hard to remediate, involving several attempts by various drilling compaines to redrill and grout the casing.

21. The confining layer could be impacted by earthworks removing peaty soils, cutting new drain courses or any geotechnical testing such as CPTs or test pits. With springs known to occur when tree stumps rot, there is a high risk that construction works could breach the confining layer, or buried tile drains draining now-forgotten springs.

22. Any excavations penetrating the confining layer could create a permanent discharge, and reduce artesian pressure in the aquifer. Reduced artesian pressures would have a detrimental effect on the spring flows and the flow in the Aruriri /LII stream below the confluence with Spring Creek. While total spring discharge may not change, flow to individual springs with existing ecological values could be diverted.

23. Dewatering is likely required as part of construction to lower the high groundwater levels at the site evidenced by the presence of springs and measured groundwater levels (see paragraphs 13-14). Dewatering may also be needed to lay pipes for reticulated water and wastewater services. Dewatering would temporarily reduce artesian pressure and hence flow to springs.

Impact of urban development on springs and groundwater

24. Local land surface recharge provides a source of flow to the springs (see paragraph 22). Increased impervious area such as pathways, roads and housing which would occur with PC69 would decrease the amount of local land-surface recharge which could result in reduced base-flow at the springs. It may also lead to local flow paths from surface recharge to springs (such as via gravel lobes in the confining layer) being cut off from their recharge source.

25. Some of this recharge will be intercepted to become stormwater runoff. Where this runoff is discharged to groundwater (as may occur in the western area of the PC69 site where the groundwater levels are slightly lower), it will recharge groundwater and may include contaminants common from roading and roofs such as heavy metals and hydrocarbons.

26. In my view, having reviewed the monitoring data available, I consider it likely that reticulated service pipes for wastewater will be in direct contact with groundwater in some places due to the high water table/pressures. This poses a high risk of groundwater contamination in the event of a leak from any reticulated network. Faecal contamination of groundwater has consequences for safe drinking water. Coliform bacteria are widely used as indicators of faecal contamination. Any detection of 1 or more *E. coli* bacterium per 100 ml exceeds the New Zealand Drinking-water Standards (MoH, 2018). Once in the aquifer, pathogens can travel large distances due to the high permeability and poor filtration capabilty of the gravel aquifer combined with the presece of preferential flow paths (Pang, 2009, Scott, 2012). For example in a coarse gravel aquifer, to obtain bacterial removal rates from a typical concentration in raw sewage to below the < 1 E.Coli per 100 ml drinking water standard would require just over 2000 m distance between the pathogen source and any drinking water supply (Scott, 2012). Thus, even with reticulated services, the high groundwater table presents challenges for the proposed residential zoning.

Dated this 11th day of November 2021

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Philippa Aitchison-Earl

References

Earl, P (1998) *Pilot study of the springs of the Halswell – LII catchment*. Environment Canterbury Technical Report U98/9.

Scott, L and Hanson, C (2017) *Nutrients from Groundwater in Two Spring-fed Tributaries of Te Waihora/Lake Ellesmere*. Presentation at 2017 New Zealand Hydrological Society Conference.

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