Castlerock Farming Company Ltd

Resource Consent Application to Environment Southland

For consent to install bores and take and use groundwater

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Application for Resource Consent (PART A)

environment SOUTHLAND REGIONAL COUNCIL
Te Taiao Tonga

This application is made under Section 88 of the Resource Management Act 1991

The purpose of this Part A form and the relevant Part B form(s) is to provide applications with guidance on information that is required under the Resource Management Act 1991. Please note that these forms are to act as a guide only, and Environment Southland reserves the right to request additional information.

To: Environment Southland
Private Bag 90116
Invercargill 9840

Full name, address and contact details of applicant *(in whose name consent is to be issued)*

Name: Castlerock Farming Company Ltd

Address: 72 Castlerock Rd

RD2, Lumsden 9792

Email: castlerock@ts.co.nz

Phone: 021 432 899 *Preferred* _____ *Additional* Fax: _____

Consultant contact details *(if different from above)*

Contact name/agent: Tim Muller

Address: Landpro

13 Pinot Noir Dr, Cromwell 9342

Email: tim@landpro.co.nz

Phone: 027 2468 795 *Preferred* _____ *Additional* Fax: _____

Please tick the box for the consent(s) you are applying for and complete the relevant Part B form(s) where available:

Land Use

- [X] Bore/well
- [ ] New or expanded dairy farming
- [ ] Effluent storage
- [ ] Cultivation
- [ ] Tree planting
- [ ] Gravel extraction
- [ ] Feed-pad, wintering pad, calving pad or silage pad
- [ ] Riverbed activity
- [ ] Bridges and culverts

Discharge

- [ ] To air
- [ ] To water
- [ ] To land

Water

- [ ] Take and use surface water
- [X] Take and use groundwater
- [ ] Dam water
- [ ] Divert water

Coastal

- [ ] Whitebait stand
- [ ] Structures/occupation of space
- [ ] Removal of natural materials
- [ ] Disturb foreshore/seabed
- [ ] Discharge/deposit substances
- [ ] Commercial surface water activity
- [ ] Reclaim/drain foreshore/seabed
- [ ] Marine farming
- [ ] Other coastal activities

1 Are there any **current** or **expired** consents relating to this proposal? [X] Yes [ ] No

If yes, please provide consent number(s) and description:

See AEE, Section 1.1

2 Are any other consents required from Environment Southland or **other authorities**? [ ] Yes [X] No

If yes, please state the relevant authority and the type of consent(s) required:

3 For what **purpose** is this consent(s) required: (e.g. discharge of effluent, gravel extraction etc.)

To drill one or more wells and take groundwater for irrigation.

4 **Location** of proposed activity

Address: 72 Castlerock Rd and neighbouring properties (See AEE, Table 1).

Legal Description: See Table 1 of AEE.

Map Reference (NZTM 2000): 1242000 E 4926000 N

5 The name and address of the **owner /occupier**: (if other than the applicant)

Name: Phone:

Address:

6 **Please attach a map or a coloured aerial photograph, showing at a minimum, the location of the proposed activities.**

See Map 18180-2 (attached to AEE)

7 Assessment of effects on the environment (AEE)

Please complete the applicable Part B form(s) for the proposed activities. For those activities where no Part B form is available, please attach a written statement that assesses the effects that your activities may have on the environment. An assessment of effects **must** include the following information:

(a) if it likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity;

(b) an assessment of the actual or potential effect on the environment of the activity;

(c) if the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment that are likely to arise from such use;

(d) if the activity includes the discharge of any contaminant, a description of—

(i) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(ii) any possible alternative methods of discharge, including discharge into any other receiving environment;

(e) a description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help or prevent or reduce the actual or potential effect;

(f) identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any persons consulted;

(g) if the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved;

(h) if the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).

You should also include:

(a) an assessment of the activity against any relevant provisions of any relevant objectives, policies, or rules;

(b) any information specified to be included in the application in accordance with the relevant regional plan;

(c) for an application to replace an existing consent, an assessment of the value of the investment of the existing consent holder:

An assessment of effects **must** address the following matters:

(a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects;

(b) any physical effect on the locality, including any landscape and visual effects;

(c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity;

(d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations;

(e) any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants;

(f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

8 Affected Parties

Please attach written approval from parties who may be affected by your activity. *Written Approval of an Affected Party* forms are available on the Environment Southland website. During the processing of your application, Council may determine that additional approvals are required.

9 Correspondence from Council when using a consultant

It is standard practice that both you and your consultant are copied into all correspondence relating to the consent process. This is so that you know what is going on with your application. Please let us know below if you would like us to only contact your consultant. This means you will only hear from us when your application is/is not accepted, when a decision is made or if we feel that you need to be contacted.

I want all correspondence about my application to go to my consultant only ☐ Yes ☒ No

10 Site visit from the Consents Team

Consents staff are able to meet with you, visit your site and see what you are proposing to do. We find that this is beneficial to everyone involved. The cost of the visit will be included in the total cost of processing your consent. However, we find that applications that have an on-site visit are processed with less congestion and at a similar or lesser overall cost. Please let us know below if you would like us to come and see your site.

I would like a member of the Consents Team to visit my site ☐ Yes ☒ No

11 How much will it cost to process my application?

The cost of a consent depends on the complexity of the activities. Staff time is charged out at a rate of $145/hr and vehicle use for site visits is charged at $0.73/km (inclusive of GST).

The fees shown below under section two are **deposits to be paid at the time of application**. Due to the complexity of these activities, this deposit will not usually cover the full cost of processing the application. **Further costs may be incurred** relating to staff time, disbursements, legal charges, consultation fees, and hearing commissioner fees. Environment Southland's User Charges and Fees document is available at:

www.es.govt.nz/fees-and-charges

When the consent has been processed you will receive an invoice for an additional fee, or for a refund.

The Council's user charges are fixed under Section 36 of the Resource Management Act 1991. Our fee schedule is:

1. Fixed fee:	
Bores and wells	**$290**
Whitebait stand	**$220**
2. Deposit:	
All other non-notified applications including: • Certificates of compliance • Changes to consent conditions (variations) • Change of lapse date	**$1,500**
Applications that require notification or limited notification	**$2,000**

How to pay

Environment Southland accepts payment in the forms of cash, Eftpos, cheque, or electronic transfer. All electronic transfers must include the applicant's name and "consent application" as a reference. Please make electronic payments to: Environment Southland, 01-0961-0018998-00.

User Charges

Please note that additional Annual User Charges will apply to all consents. These are payable in advance on the first day of July each year. Tables 4, 5 and 6 of the Environment Southland User Charges and Fees Schedule outlines the fees associated with Annual Administration Charges and Annual Consent Monitoring and Inspection Charges. Table 7: Annual Research and Monitoring Charges applies only to surface and groundwater takes and comprises the following:

- **Surface water takes (per consent, for volumes up to 50,000 m^3/day):**
  - A charge of **$1.89** per year per cubic metre authorised as a maximum daily take.
  - Minimum of **$138**, maximum of **$7,585**.
- **Surface water takes (per consent, for volumes over 50,000 m^3/day):**
  - **$0.0031** per cubic metre authorised as a maximum daily take.
- **Groundwater takes (per consent):**
  - A charge of **$0.89** per year per cubic metre.
  - Minimum of **$162**, maximum of **$1,782**.

Municipal and stock water discount (of 50%) no longer applies.

12 Checklist: Have you included the following?

X	Payment of the required deposit *(see fee schedule)*
-	Written approval from all potentially affected parties *(forms available from the Environment Southland website)*
X	Site plan/location map/sketch of the proposed activity
X	A copy of the Certificate of Incorporation (*where applicant is a company*)
X	Part B form(s) specific to your activity and/or a separate assessment of environmental effects (AEE)

Note:

(a) If your application does not contain the necessary information and the appropriate fee, Environment Southland must return the application.

Signature of applicant

I hereby certify that to the best of my knowledge and belief, the information given in this application is true and correct.

I undertake to pay all actual and reasonable application processing costs incurred by Environment Southland.

Name (block capitals) WILLIAM DAVID BARNHILL THOMAS

Signed WBB Thomas **Date** 10-1-19

(Signature of applicant or person authorised to sign on behalf of applicant)

Job No: 18180 ***Date:*** 11/01/2019

Client Name: Castlerock Farming Company Ltd

1. Information must be specified in sufficient detail

Any information required by this schedule, including an assessment under clause 2(1)(f) or (g), must be specified in sufficient detail to satisfy the purpose for which it is required.

2. Information required in all applications

1. An application for a resource consent for an activity (the activity) must include the following:

	Checklist	Yes	N/A	Report Section	Comments
a)	A description of the activity	☒	☐	1.1	
b)	A description of the site at which the activity is to occur	☒	☐	2.1	
c)	The full name and address of each owner of occupier of the site	☒	☐	1.2	
d)	A description of any other activities that are part of the proposal to which the application relates	☐	☒		
e)	A description of any other resource consents required for the proposal to which the application relates	☐	☒		
f)	An assessment of the activity against the matters set out in Part 2	☒	☐	6.1	
g)	An assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b)	☒	☐	6.2	

2. The assessment under subclause (1)(g) must include an assessment of the activity against:

	Checklist	Yes	N/A	Report Section	Comments
a)	Any relevant objectives, policies, or rules in a document; and	☒	☐	6.2.1 6.2.2 6.2.4	
b)	Any relevant requirements, conditions, or permissions in any rules in a document; and	☒	☐	6.2	
c)	Any other relevant requirements in a document (for example, in a national environmental standard or other regulations).	☒	☐	6.2.3	

3. Additional information required in some applications

An application must also include any of the following that apply:

	Checklist	Yes	N/A	Report Section	Comments
a)	If any permitted activity is part of the proposal to which the application relates, a description of the permitted activity that demonstrates that it complies with the requirements, conditions, and permissions for the permitted activity (so that a resource consent is not required for that activity under section 87A(1):	☒	☐	3.2 3.5	
b)	If the application is affected by section 124 or 165ZH(1)(c) (which relate to existing resource consents), an assessment of the value of the investment of the existing consent holder (for the purposes of section 104(2A)):	☐	☒		
c)	If the activity is to occur in an area within the scope of a planning document prepared by a customary marine title group under section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011, an assessment of the activity against any resource management matters set out in that planning document (for the purposes of section 104(2B)).	☐	☒		

4. Additional information required in an application for subdivision consent

An application for a subdivision consent must also include information that adequately defines the following:

	Checklist	Yes	N/A	Report Section	Comments
a)	The position of all new boundaries	☐	☒		
b)	The areas of all new allotments, unless the subdivision involves a cross lease, company lease, or unit plan:	☐	☒		
c)	The locations and areas of new reserves to be created, including any esplanade reserves and esplanade strips:	☐	☒		
d)	The locations and areas of any existing esplanade reserves, esplanade strips, and access strips:	☐	☒		
e)	The locations and areas of any part of the bed of a river or lake to be vested in a territorial authority under section 237A:	☐	☒		
f)	The locations and areas of any land within the coastal marine area (which is to become part of the common marine and coastal area under section 237A):	☐	☒		
g)	The locations and areas of land to be set aside as new roads.	☐	☒		

5. Additional information required in application for reclamation

An application for a resource consent for reclamation must also include information to show the area to be reclaimed, including the following:

	Checklist	Yes	N/A	Report Section	Comments
a)	The location of the area:	☐	☒		
b)	If practicable, the position of all new boundaries:	☐	☒		
c)	Any part of the area to be set aside as an esplanade reserve or esplanade strip.	☐	☒		

6. Information required in assessment of environmental effects

1. An assessment of the activity's effects on the environment must include the following information:

	Checklist	Yes	N/A	Report Section	Comments
a)	If it is likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity:	☒	☐	5.1	
b)	An assessment of the actual or potential effect on the environment of the activity:	☒	☐	5	
c)	If the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment that are likely to arise from such use:	☐	☒		
d)	If the activity includes the discharge of any contaminant, a description of -: i. The nature of the discharge and the sensitivity of the receiving environment to adverse effects; and ii. Any possible alternative methods of discharge, including discharge into any other receiving environment:	☐	☒		
e)	A description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect:	☒	☐	1.4.2 1.4.3 3.8	
f)	Identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted:	☒	☐	4	
g)	If the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved:	☒	☐	5.7	.
h)	If the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).	☐	☒		

2. A requirement to include information in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

7. Matters that must be addressed by assessment of environment effects

1. An assessment of the activity's effects on the environment must address the following matters:

	Checklist	Yes	N/A	Report Section	Comments
a)	Any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects:	☒	☐	6.1	
b)	Any physical effect on the locality, including any landscape an visual effects:	☐	☒		
c)	Any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity:	☒	☐	5.3	
d)	Any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations:	☒	☐	5	
e)	Any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants:	☐	☒		
f)	Any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use hazardous substances or hazardous installations.	☐	☒		

2. The requirement to address a matter in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

Prepared For
Castlerock Farming Company Ltd

Prepared By
Landpro Ltd
13 Pinot Noir Drive
PO Box 302
Cromwell

Tel +64 3 445 9905

QUALITY INFORMATION

Reference: L:\18180 - Castlerock Farming Co Ltd - Groundwater Take Investigations\Docs\20190111 18180 AEE FINAL.docx

Date: 11 January 2019

Prepared by: Tim Muller

Reviewed by: Mike Freeman

Client Review: **David Thomas**

Version Number: **FINAL**

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LIST OF ATTACHMENTS

1. INTRODUCTION

1.1 Overview of Proposal

The applicant, Castlerock Farming Company Ltd (CFCL), is seeking to obtain consent to install one or more bores accessing the Lumsden Aquifer at their property at 72 Castlerock Rd, Lumsden, and to take and use water from the bore(s) for aquifer testing and irrigation. The application has been discussed with Environment Southland, including a site meeting on September 6th, 2018 with Lauren Maciaszek and Michael Killick.

As discussed at that meeting, applying for consent for the bore installation and water take simultaneously (rather than sequentially as is typical) is justified because the effects of the water take can be assessed based on existing data on the aquifer properties from other nearby water takes. Because the Lumsden Aquifer is nearing full allocation under Environment Southland's *Proposed Southland Water and Land Plan* (WLP), this approach reduces the risk that the applicant would have to make a significant investment in installing bores and other infrastructure, while potentially ending up unable to use the bores. To mitigate uncertainty regarding the hydrogeological effects of the activity, the applicant has volunteered adaptive management conditions requiring the management of the water take to be reviewed after aquifer testing is complete (see Section 1.4).

The applicant already has a surface water permit to take and use water from the Ōreti River (consent number 301933) which is used for irrigation of the farm. That consent allows the applicant to take up to 14,000 m^3/day as primary allocation, with additional water available as supplementary allocation when river flows are high, up to a total of 1,260,000 m^3/year. However, the consent is subject to minimum flow cut-offs which mean that CFCL is frequently unable to irrigate during the driest part of the season when irrigation is most needed. The proposed groundwater take is to supplement the surface water take, enabling the applicant to provide at least limited irrigation to maintain grass growth when flows in the Ōreti River are low.

The proposed groundwater take volumes are summarised below:

Annual maximum: **122,178 m^3**

Daily maximum: **4,320 m^3**

The daily limit is equivalent to continuous pumping at 50 L/s, while the annual limit proposed is limited to 28 days' supply, primarily to ensure that the take would not result in exceeding the allocation limit for the aquifer under the WLP. The existing aquifer allocation is subject to the outcome of an ongoing consent renewal application (APP 20181689), which includes a slight increase in the water take volume currently consented. We have assumed that this ongoing application will be granted without any change to the volume applied for. Under the outgoing *Regional Water Plan* (RWP) the aquifer is over-allocated (the RWP allocations are based on older hydrogeological data).

The applicant hopes to secure all of the water they need from a single bore, but has proposed seven bore locations (as shown on Map 18180-2 in Attachment A) to provide flexibility in case some locations are

unsuccessful and/or more than one bore is needed to provide the volume of water required. This will also potentially give the applicant flexibility to mitigate any interference or stream depletion effects by splitting their water take between two bores at different distances from relevant receptors.

In addition to the production bore(s), test bores and piezometers may be required. For this reason, the applicant is seeking consent to drill and construct up to 12 bores. The production bore or bores will be drilled within 50 m of the locations marked, while any test bores or piezometers required may be up to 200 m from those positions.

1.2 The Applicant

Applicant Address: Castlerock Farming Company Ltd
72 Castlerock Rd
Lumsden 9792
Attn: David Thomas

Address for Service: C/- Landpro Limited
PO Box 302
Cromwell 9342

1.3 Purpose of Documentation

This report provides an assessment of environmental effects in support of the application for resource consent to install bores and to take and use water in accordance with Section 88 of the *Resource Management Act* (RMA).

1.4 Proposed conditions

The applicant proposes the following conditions, subject to input from Environment Southland.

1. *"Within one year of the consent being granted, and before any water is taken from the Lumsden Aquifer for irrigation purposes, the consent holder shall drill the well(s), carry out aquifer testing, and provide an Aquifer Testing Report undertaken by a suitably qualified person to Environment Southland. This report shall include sufficient information to confirm whether the aquifer properties (including transmissivity and storativity) assumed in the application are consistent with the actual aquifer conditions.*

2. *If the Aquifer Testing Report prepared in accordance with condition 1 shows that aquifer properties are significantly different (greater than ±25%) from those assumed in the application, updated calculations or other assessment shall be provided to either:*
    a. *confirm that the interference effects of the water take will be acceptable in accordance with the definitions specified in Appendix L.3 of the WLP, and stream depletion effects will be low or moderate (as defined in Appendix L of the WLP) without any specific management measures, or*
    b. *propose mitigation measures (such as a reduction in the rate of take) to ensure that interference effects are acceptable and stream depletion effects are moderate or less (as defined in Appendix L of the PSWLP).*

3. *"The rate of groundwater abstraction shall not exceed the lesser of*
    a. *4,320 m^3/day or*
    b. *Any lower rate specified in the Aquifer Testing Report under condition 2b, where this is necessary to avoid adverse effects on other wells or on surface water.*

4. *The total volume of water taken under this consent in any one year shall not exceed 122,178 m^3.*

5. *The total volume of water taken under this consent and AUTH-301933 (or any replacement permit for AUTH-301933) shall not exceed the annual water allocation specified in AUTH-301933 or the replacement permit.*

Note that conditions 2 and 3b are proposed as contingency measures to give ES confidence that significant adverse effects will not occur as a result of the proposed activity, not because any significant adverse effects are expected. As discussed below, all effects of the proposed activity are expected to be less than minor.

We are open to discussion regarding the specific wording of these conditions. In particular, conditions 1-3 are non-routine and there may be alternative mechanisms to achieve the same purpose, which is to ensure that interference and stream depletion effects are acceptable, even if the aquifer properties are different to those expected.

2. DESCRIPTION OF EXISTING ENVIRONMENT

2.1 Location land use, and topography

The farm comprises 6 legal properties owned by CFCL and Okaiterua Ltd (a sister company), with a total area of approx. 730 ha. The details of these properties are given in Table 1, and Attachment B contains the

certificates of title and CFCL's certificate of incorporation. The centre of the site is at approximately 1242000 mE, 4926000 mN (NZTM 2000).

Table 1 - Legal properties making up the site

Address	Legal description	Owner	Area (ha)
59, 72 and 78 Castlerock Rd	Lot 2, DP 3186	CFCL	221.36
-	Lot 1, DP 1804	CFCL	1.21
102 Keown Rd	Lot 1, DP 12829	Okaiterua Ltd	96.32
-	Lot 3, DP 636	CFCL	132.38
24 Frisco Rd	Lot 4, DP 636	CFCL	187.72
-	Lot 5, DP 636	CFCL	90.56
Total			**729.55**

Note that much of the surrounding land to the south and west is owned by an unrelated company with a similar name (Castlerock Dairies Ltd).

The site and most of the surrounding land are used for pastoral farming. The site itself is a dairy farm set in a riverplain landscape with two main terraces. Aside from the terrace feature in the eastern part of the site, the topography at the site is mostly flat, at an elevation of approximately 200 metres above sea level (masl).

The applicant operates a relatively low-input farm system, with irrigation used to grow additional grass in preference to importation of supplementary feed. Significant investment has been made into variable rate irrigation, as well as precision application of fertiliser based on soil types and moisture. These activities are managed based on information from 7 in-ground soil moisture probes across the farm. The applicant also has a 10-year riparian planting plan (begun 2 years ago), and has retired some areas of the farm near Murray Creek from grazing in recent years.

Currently, the irrigation system at the farm comprises two centre pivots in the north-eastern part of the farm, covering a total area of approx. 234 ha. The applicant has plans to install additional irrigation in the future, with 3 smaller pivots to be installed near the existing irrigation system and also in the western part of the farm.

Figure 1 - The site is located on the opposite (western) side of the Ōreti River from the town of Lumsden.

2.2 Heritage

The Castlerock Station Historic Area is located in the south-western part of the site near Frisco Road (within Lot 2, DP 3186). The Historic Area includes a stable building and a former cookhouse. The New Zealand Heritage List number is 7366. Note that proposed bore 4 is close to this heritage area, but no bores will be drilled within 50 m of any protected structure or other heritage item, and any discharge water from pump testing will be directed away from the heritage area.

Based on a search of the New Zealand Heritage List, Archsite, and Map 16 of the Southland District Plan, we are aware of no other sites of historical significance within or near the site.

The farm has been held within the same family for approximately 160 years.

2.3 Climate

Lumsden has a cool temperate climate. According to NIWA (2013), the median annual average temperature in the area is between 9 and 10 °C, with a median summer high of 19-20 °C and a median winter low of 0-1 °C.

The site is located in Northern Southland and experiences less rainfall than many other parts of Southland (911 mm per year, compared with 1149 mm for Invercargill for instance (NIWA, 2013)). Rainfall is relatively consistent throughout the year; on average about 60 mm of rain falls in the driest month (July) and 100 mm in the wettest (December). However, there is significant seasonal variation in monthly evapotranspiration, which ranges from approx. 15 mm in June and July to nearly 150 mm in December.

Figure 2 shows the monthly water balance for an average year. Annual rainfall only slightly exceeds annual evapotranspiration, while evapotranspiration significantly exceeds rainfall during the summer months (by 167 mm, in a typical summer). Obviously, this is true to an even greater extent during droughts. For instance, excess evapotranspiration of approx. 330 mm occurred over only 4 months from October 2017-January 2018.

The above comments and Figure 1 are based on rainfall data from the Lumsden AWS and evapotranspiration data from Five Rivers CWS weather stations, with both datasets sourced from Cliflo (NIWA's climate database). Months with fewer than 28 days of data were omitted. The rainfall record is approximately 40 years long (1977-2018). The evapotranspiration record is only from 2014-2018, but the monthly averages over that period are comparable to other weather stations with longer records (Gore and Manapouri, from NIWA, 2013).

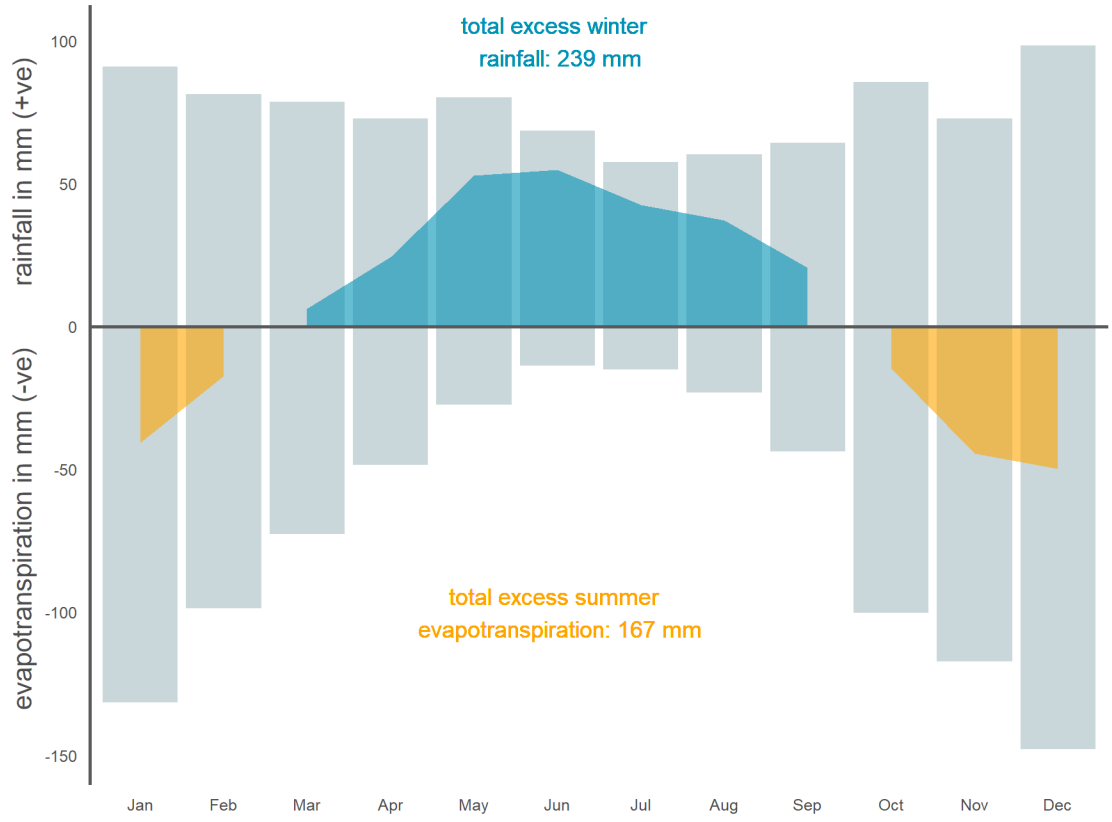


Figure 2 – Rainfall in Lumsden only slightly exceeds evapotranspiration in an average year, and significant excess evapotranspiration occurs during Spring and Summer. Data source: Cliflo (details in text above).

2.4 Hydrology

The site is within the Ōreti River catchment, the third largest in Southland according to Land, Air, Water Aotearoa (LAWA). Based on NIWA's River Maps web app, the Ōreti catchment is approx. 3,513 km^2, of which roughly 1,150 km^2 is upstream of the site. The Ōreti starts in the Thomson Mountains west of Lake Wakatipu, where NZ Topomap shows that numerous peaks 1,500 m or higher are present. From there, it flows generally southwards, discharging into Foveaux Strait via an estuary near Invercargill. Near Lumsden, it flows from west to east across the plains approx. 3 km north of the site, before turning sharply near State Highway 6 and flowing south. The River then passes within 200 m of the eastern site boundary at its closest point, and approx. 2-3 km from most of the proposed bore locations (though some are closer).

Environment Southland maintain flow gauging stations near the site (Ōreti at Lumsden Cableway), and near the downstream end of the River at Wallacetown. The data from these sites is on ES's Environmental Data web portal. The median flow at Lumsden Cableway is 19 m^3/s, while flood flows frequently exceed 100 m^3/s (mean annual flood: 629 m^3/s). The change in flows by the downstream end of the catchment at Wallacetown is modest, with a median of 27 m^3/s and a mean annual flood of 608 m^3/s. At both sites, base

flows are typically lowest in summer and highest in the middle of the year (due to lower evapotranspiration and snow melt).

The applicant's current surface water take consent is subject to conditions restricting the applicant's rate of take based on the flow of the river at Wallacetown. These conditions include a requirement to halve the rate of take when the Ōreti River is flowing at or below 9.2 m^3/s at this site and to cease pumping entirely when the flow drops below 7.93 m^3/s. For the applicant, this means that their ability to irrigate is subject to frequent, unpredictable, and often lengthy interruptions during the driest part of the year when irrigation is most needed. Over the last ~20 years, there have been an average of 38 days per year of minimum flows, with only one year (2004-05) when irrigation could have occurred more or less without interruption. It is not uncommon for more than 60 days of minimum flows to occur in a season, nor for there to be 20 or more consecutive days of minimum flows. Note that these figures do not include additional periods of low flows when irrigation is possible, but at a reduced rate. This is illustrated in Figure 3.

A number of small drains and creeks flow from west to east towards the Ōreti, including Murray Creek, which flows through the site. These are understood to be groundwater-fed, receiving baseflow from shallow groundwater throughflow from the Castlerock Terrace.

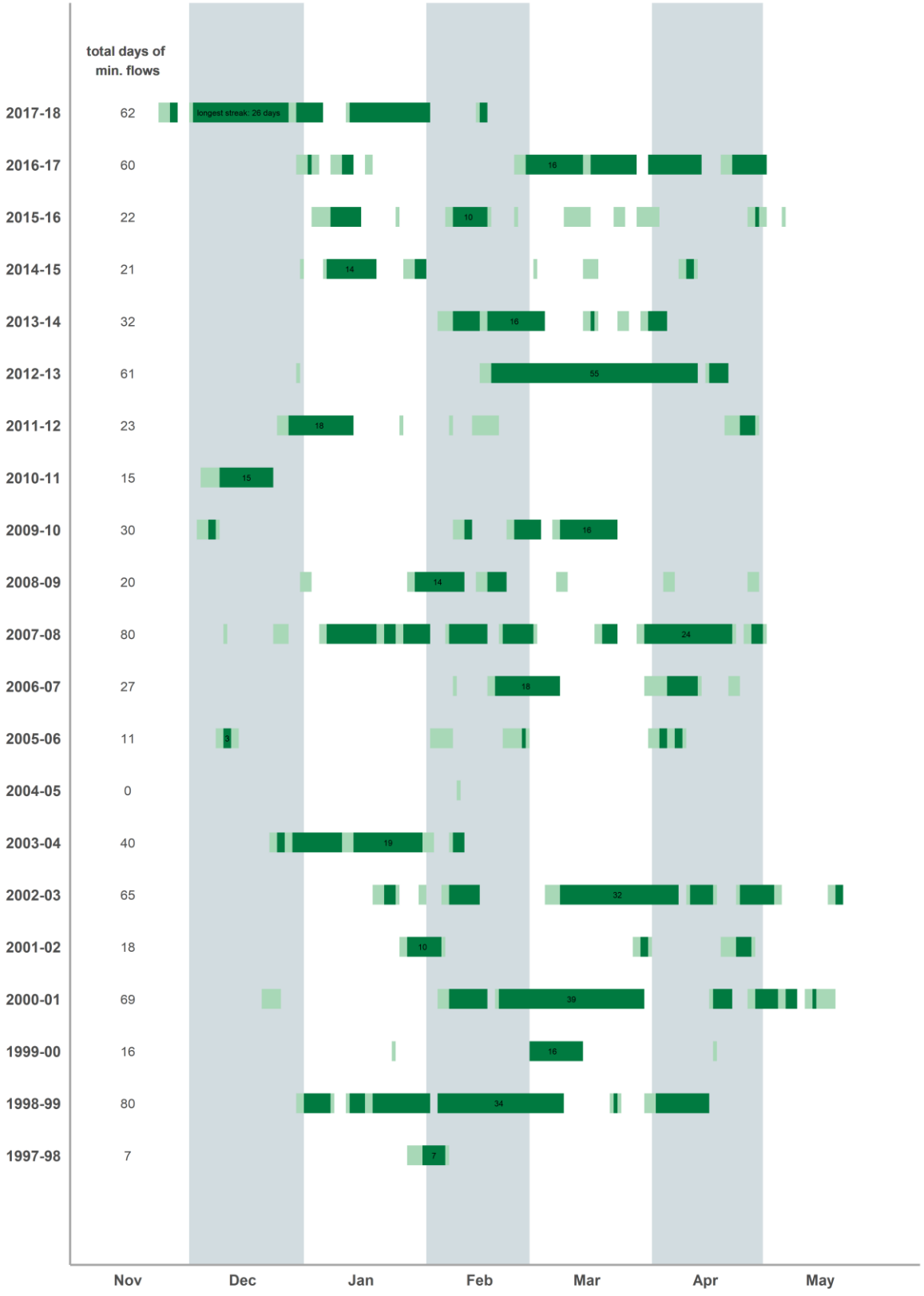


Figure 3 - Periods of minimum flows (dark green, < 7.93 m^3/s) and low flows (light green, < 9.2 m^3/s) in the Ōreti are frequent and unpredictable. Data from the ES Wallacetown monitoring site.

2.5 Soils

SMap (Landcare Research, 2018) indicates that the near-surface soils at the site are predominantly Morven, described as a shallow, well-drained silty loam with an estimated 60 mm of profile available water to 60 cm depth. There are small areas of other soil types, including Eureka (a deep, poorly drained silty loam) in the eastern part of the site near Murray Creek.

2.6 Geology and hydrogeology

The geology and hydrogeology of the area are discussed in detail in the *Hydrogeological Assessment* (Attachment C). In summary, the Institute of Geological and Nuclear Sciences 1:250,000 New Zealand Geology Web Map shows that the geology underlying the site comprises late Pleistocene river deposits. These are described as "sandy greywacke gravel overlain by loess". Boreholes near the site exhibit the following general soil profile:

1. **Topsoil** at the surface, underlain by
2. **Sands and gravels**; underlain by
3. Predominantly **claybound gravels**; underlain by
4. **Gravel and sandy gravel**, underlain by
5. **Variable geology** (insufficient bore logs are available to generalize, other than that the permeability appears to reduce again below this layer).

Layers 2 and 4 above are the water-bearing units for the unconfined Castlerock Groundwater Zone, and the Lumsden Aquifer respectively. Layer 3 forms an aquitard (low permeability layer) between the aquifers.

The site is near the south-eastern end of the Lumsden Aquifer, and the proposed water take is from this source. The Aquifer extends approximately 15 km to the north-west, to the other side of the Ōreti. The Lumsden Aquifer has been extensively studied and used for groundwater extraction over approximately the last 15 years. Ten groundwater take consents permit extraction of a total of 5,637,822 m^3 of groundwater per year from 14 wells screened in the Aquifer. Note that this figure includes the allocation for one consent which currently has a replacement water permit application being processed, with a small increase in the annual volume sought. The total annual consented take is approximately 98 % of the available allocation from the Aquifer under the WLP, with most of the currently consented take occurring north of the Ōreti River.

This is reflected in higher seasonal drawdown in the northern part of the Aquifer compared to the southern part (see Figure 4) although in both long-term monitoring wells the water level recovers to a consistent level each winter. Also, trigger levels which require groundwater extraction to slow or stop based on levels in the well south of the Ōreti have never been reached.

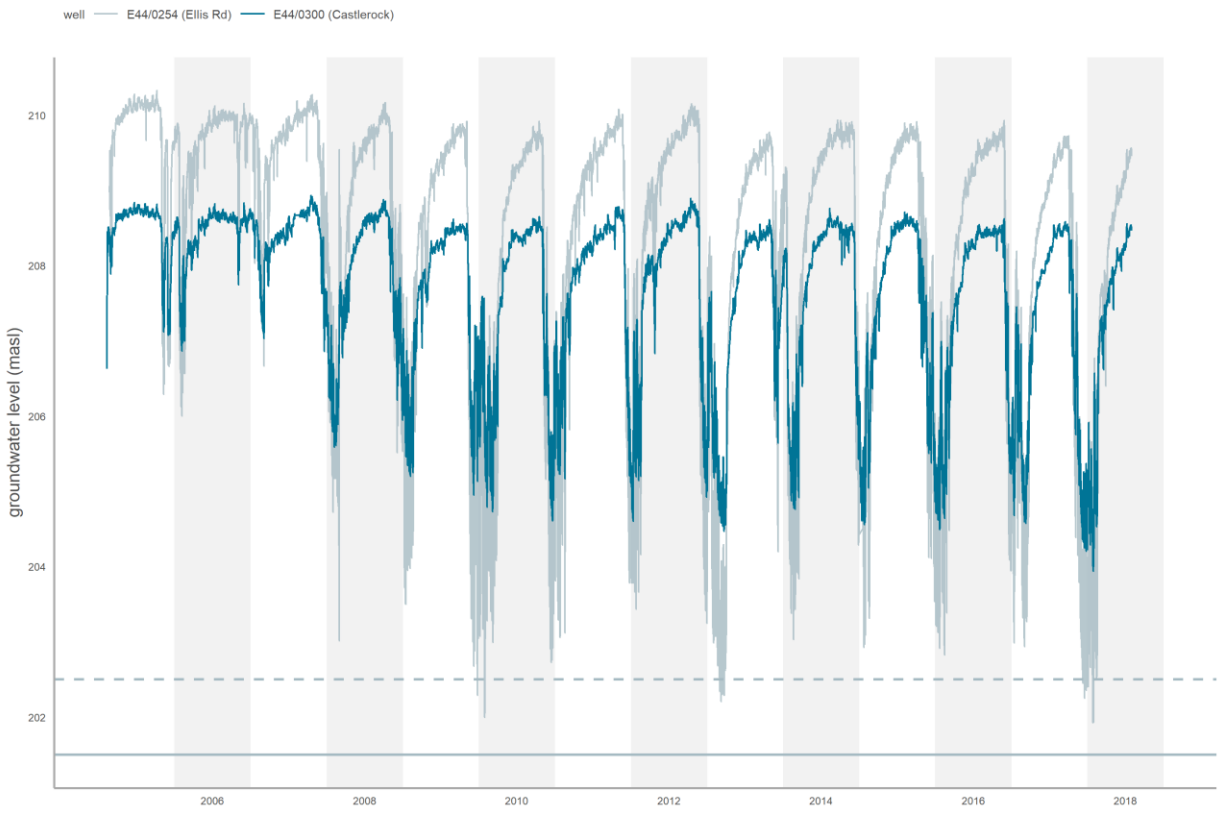


Figure 4 - Maximum seasonal drawdown is typically 7-7.5 m at E44/0254 in the northern part of the aquifer and 4-4.5 m at E44/0300 in the southern part. Since monitoring began, groundwater levels at well E44/0300 (blue line) have remained significantly higher than the trigger levels for water rationing under the WLP (dashed and solid grey horizontal lines – these trigger levels do not apply at well E44/0254).

The Lumsden Aquifer is defined as confined under the WLP, but based on pump test data for two wells near the site, we expect that semi-confined conditions are more likely in this part of the Aquifer (this is discussed in detail in Section 2.4 of Attachment C). The aquifer properties are relatively consistent and well understood, for instance the transmissivity has been estimated to be between 600 and 700 m^2/day in 4 out of 5 wells south of the Ōreti River for which pump tests have been carried out. The exception is the northernmost well in this area (and furthest from the site) which has an estimated transmissivity of approx. 1,400 m^2/day.

3. ACTIVITY CLASSIFICATION

3.1 Plan Status

Environment Southland currently has two Regional Plans relating to bores and groundwater takes:

- The *Regional Water Plan* (RWP), which became operative in 2010, and

- The *Proposed Southland Water and Land Plan* (WLP), the decisions version of which was released in April 2018. The WLP will replace the RWP once all appeals have been resolved.

Under the Resource Management Act, the weighting given to the provisions of two overlapping plans is dependent on a number of factors, but primarily the amount of progress that the newer plan has made towards becoming fully operative (this is explained in detail on the Environment Guide website). In the case of the WLP, the decisions version has been released, and the plan will become fully operative after the resolution of all appeals.

However, as summarised in Table 2, the provisions of the WLP which are of primary relevance to this application are either not under appeal, or are subject to appeals which are of limited relevance to this application. Therefore, in our opinion, the relevant policies of the WLP should be regarded as having very significant weight in this case, while in comparison the relevant provisions of the RWP (while operative) should be considered in the context of their likely replacement in the near future.

In particular, Rule 54 of the WLP, which covers groundwater takes, is not subject to any relevant appeals. One of the appeals on this Rule relates to aquifer testing, seeking the removal or relaxation of a limit that the current application already complies with. The other appeal relates to metering of permitted activity takes and is of no relevance. Importantly, neither appeal relates directly or indirectly to Rule 54(d), which is the Rule under which the applicant's proposed water take for irrigation is applied for. While this rule has effect now, it is useful to understand the context of WLP appeals and the relevant groundwater provisions, particularly the policy context which is outlined in the following table.

Table 2 - Notes on appeals for WLP plans and policies relevant to bores and groundwater

	Appellants	Details of appeal(s)
Policy B7 (on the life-supporting capacity of freshwater)	None	n/a
Policy 20 (management of water resources)	1. Southland Fish & Game (F&G) 2. Alliance Group Ltd 3. Heritage NZ/Pouhere Taonga (HNZPT) 4. Tu Runanga o Ngai Tahu and other (Ngai Tahu) 5. Royal Forest and Bird Protections Society	The Fish & Game appeal relates primarily to technical wording including suggesting the use of 'avoid where practicable' instead of 'avoid' effects in relation to both surface and ground water, and the inclusion of temperature and oxygen content as a measure of water quality. Forest and Bird's appeal seek to remove wording "remedy or mitigate" in relation to effects on ecosystems and significant effects on aquifers, surface flows and water quality. Alliance Group Ltd's appeal relates to reasonable water use for industrial activities. Heritage NZ seek recognition of the potential adverse effects that the use of water and land can have on historical and cultural heritage values. Ngai Tahu request the deletion of "including for primary production" in relation to positive effects of water and land use in section 1A due to not believing specific mention is necessary. Appeals made by Fish & Game and Forest and Bird **have minimal relevance to this application** whilst appeals made by Alliance group Ltd, Heritage NZ and Ngai Tahu **have no relevance to this application**
Policy 21 (allocation of water)	None	n/a
Policy 22 (management of groundwater and surface water use)	None	n/a
Policy 23 (stream depletion effects)	None	n/a
Policy 27 (bore construction)	None	n/a

	Appellants	Details of appeal(s)
Policy 42 (water permit applications)	1. Wilkins Farming Co 2. F&G 3. Alliance Group Ltd	Wilkins Farming Co seek for new water consent applications not to compromise existing consents' rates when there is an over-allocated water body. Fish & Game's appeal relates to replacement water consents from overallocated water bodies always being granted at a reduced rate instead of "generally". Alliance Group Ltd seek for processing facilities to not be subject to minimum flows. **These three appeals hold little to no relevance to this application.**
Rule 16 (discharges from aquifer testing)	None	n/a
Rule 53 (bores and wells)	1. HNZPT	HNZPT seek the addition of an advice note regarding the Heritage NZ/Pouhere Taonga Act 2014 to this and other rules. The outcome of this appeal is **not relevant to this application**.
Rule 54 (abstraction and use of groundwater)	1. Fonterra 2. Wilkins Farming Co	Fonterra's appeal requests that permitted activity water takes under Rule 54(a) should only have to record the volume of water taken weekly, not daily (when metering is required at all). **Fonterra's appeal is of no relevance to this application.** Wilkins Farming Co appeal relates to the maximum rate of take for aquifer testing as a permitted activity under Rule 54(c). They argue that the 75 L/s limit on these takes should be removed, with the volume able to be extracted to be determined on the basis of the volume required for the proposed future take and any environmental risks. The Wilkins appeal relates to a rule relevant to the pump testing for this application, but would have no effect on the outcome (Wilkins seek an increase or relaxation of a condition which the applicant already complies with). We therefore consider that **the outcome of the Wilkins appeal is immaterial to this application.**

	Appellants	Details of appeal(s)
Appendix L (Groundwater Appendix)	1. Wilkins Farming Co 2. Director General of Conservation (DOC)	These appeals relate only to Section 5 of this appendix (allocation). DOC's appeal relates specifically to the Te Anau Groundwater Zone. The Wilkins appeal relates primarily to the Waipounamu groundwater zone, and also requests a more consistent and transparent formula for determining allocation. Overall, these two appeals are considered to have **little to no relevance to this application.**

3.2 Permitted Baseline

Neither the WLP or the RWP allow for installation of bores as a permitted activity.

Groundwater takes are allowed as a permitted activity under both plans, subject to various conditions. In summary:

- The RWP (Rule 23(a)) allows up to 20,000 L/day (20 m^3/day) of groundwater per landholding to be taken as a permitted activity, subject to a maximum flow rate of 2 L/s, and no adverse effects on selected receptors.
- The WLP (Rule 54(a)) allows up to 86 m^3/day of groundwater per landholding to be taken at a maximum rate of 5 L/s. The daily rate of take applies to the sum of the groundwater take and any permitted surface water take, and the water user is required to provide water metering data and other information to ES.
- The WLP (Rule 54(c)) also allows groundwater takes of up to 75 L/s for up to 5 consecutive days for the purposes of pump testing.

Taking the most restrictive conditions of both plans into consideration, a groundwater take of up to 2 L/s and 20 m^3/day could be carried out as a permitted activity (subject to several conditions). The volume and rate of take proposed by the applicant significantly exceeds these limits.

3.3 Bore installation

Rule 53 of the WLP states:

> *(a) The use of land for the drilling or construction of any bore or well is a controlled activity provided the following conditions are met:*
>
> *(i) the bore or well design and headworks prevent:*
>
> *(1) the infiltration of contaminants; and*
>
> *(2) the uncontrolled discharge or leakage of water to the ground surface or between aquifers; and*

(ii) the bore is constructed in accordance with NZS 4411:2001 Environmental Standard for Drilling of Rock and Soil (including the recording and supply of bore logs and other records); and

(iii) for bores to be used for the supply of water from unconfined aquifers, the bore screen fully penetrates the aquifer.

The Southland Regional Council will reserve the exercise of its control to the following matters:

1. the proximity of the bore or well to surface water bodies (including spring-fed streams), potential sources of groundwater contamination and existing bores and wells;

2. the design and depth of the bore or well;

3. the method of drilling or excavation;

4. the design and management of the bore head;

5. the use, maintenance and decommissioning of the bore or well;

6. information and monitoring requirements;

7. adoption and implementation of an Accidental Discovery Protocol.

An application for resource consent under Rule 53(a) will be processed and considered without public or limited notification unless the applicant requests notification or the Southland Regional Council considers special circumstances exist that warrant notification of the application.

The equivalent rule under the RWP (Rule 22(a)) is identical apart from a few minor wording changes and the absence of conditions (ii) and (iii). Neither rule restricts the number of bores which may be installed. The bore(s) are to be installed in accordance with the relevant standard to prevent contaminant infiltration and leakage, and therefore the proposed bore installation will be a **controlled activity** under both plans.

With respect to the appeal by HNZPT in relation to WLP Rule 53 (see Section 3.1), the applicant will not drill any well within 50 m of any of the heritage structures on the site.

3.4 Groundwater take for irrigation

Rule 54(d) of the WLP states:

(d) Other than as provided by Rules 54(a), 54(b), 54(c) and 54(ca) the take and use of groundwater from groundwater management zones listed in Appendix L.5 is a discretionary activity provided the following conditions are met:

(i) the total volume of authorised groundwater abstraction is within the primary allocation limits established in Appendix L.5; and

(ii) if the degree of hydraulic connection, calculated in accordance with Appendix L.2 Table L.2. is Riparian, Direct, High or Moderate the relevant surface water minimum flows and allocation limits specified in Table L.2 are complied with; and

(iii) any interference effects are 'acceptable' in accordance with Appendix L.3; and

(iv) minimum groundwater level cut-offs and seasonal recovery triggers are established in accordance with criteria outlined in Appendix L.6.

The proposed water take will be a **discretionary activity** under this rule of the LWP because the annual water take volume is within the primary allocation limit for the aquifer, and the current evidence strongly indicates that the degree of hydraulic connection is Low (see Section 4 of Attachment C), and the modelled interference effects are acceptable. The proposal will be subject to the minimum groundwater level cut-offs which have been decided by ES and included in Appendix L.5 of the LWP. We presume that these were determined in accordance with the methodology in Appendix L.6. The uncertainty in the hydrogeological effects due to the lack of pump testing data is effectively mitigated by the conditions volunteered (see Section 1.4).

With respect to the RWP, the proposed activity falls under Rule 23(e):

Except as provided for in Rules 23(a) and (b) and the takes authorised by Section 14(3) of the Act, the abstraction and use of groundwater from any of the following sources is a non-complying activity:

…

(iii) a confined aquifer where the total volume of water allocated from the relevant groundwater zone is greater than 75 percent of aquifer throughflow; or

The Lumsden Aquifer is defined as confined (although as noted in the *Hydrogeological Assessment* we expect it will exhibit semi-confined behaviour near the site), and the total volume of groundwater allocated from the aquifer (including the proposed take) exceeds 75 % of the estimated aquifer flow through (5,338,125 m^3/year). Consequently, the proposed water take is a **non-complying activity** under the RWP.

3.5 Aquifer testing

In addition to the groundwater take for irrigation, a smaller, short-term water take will also be required for aquifer testing. This will be a **permitted activity** under Rule 54(c) of the WLP:

c) The take and use of groundwater for hydraulic testing and bore development purposes and any associated discharge of groundwater into water or onto or into land is a permitted activity provided the following conditions are met:

(i) the Southland Regional Council is notified at least three days prior to test commencement; and

(ii) the rate of take does not exceed 75 litres per second; and

(iii) the duration of pumping does not exceed five consecutive days; and

(iv) any discharge of water to water is consistent with the water quality requirements of section 70 of the RMA; and

(v) water discharged onto land must not contribute to flooding on any other landholding; and

(vi) records of all pumping and recovery tests including the rate and duration of pumping, water levels in the pumped well and any water level observation wells and the time measurements are taken and are provided to the Southland Regional Council within one month of the completion of the test.

All of the above conditions will be complied with during aquifer testing. As noted in Section 3.1, the only appeal on Rule 54 which is relevant to Rule 54(c) seeks an increase or relaxation of condition (ii), which the applicant already complies with. As such, this appeal is not relevant to the status of the activity under the WLP, and this Rule may also be regarded as virtually operative.

Nonetheless, we have considered the status under the RWP. Rule 23(a) allows only 20 m^3 of water per day to be taken for aquifer testing as a permitted activity. The applicant's pump test will require taking up to the proposed daily limit required for irrigation (approx. 4,320 m^3/day), and therefore requires consent under Rule 23(e) as a **non-complying activity**, as discussed in Section 3.4 above.

The discharge of water from the pump test will be to ground within the applicant's property and will be a **permitted activity** under Rule 16 of the WLP:

(a) The discharge of water from any bore or well into a lake, river, artificial watercourse, modified watercourse or wetland or onto or into land where it may enter a lake, river, artificial watercourse, modified watercourse or wetland, as a result of aquifer testing, is a permitted activity provided the following conditions are met:

(i) the discharge does not cause flooding of any other person's property, erosion of the bed or banks of the receiving waterbody or land instability; and

(ii) where the discharge is to water, there is no conspicuous change to colour and clarity of the receiving waters at a distance of 20 metres from the point of discharge.

The discharge will also be a **permitted activity** under Rule 13 of the RWP, which is essentially identical to the above.

3.6 Overall status

Considering all of the relevant activities, the proposal is a **discretionary activity** under the WLP and a **non-complying activity** under the RWP. Therefore, overall the proposal is a **non-complying activity.**

We note that the WLP was written with reference to more up to date information on the hydrogeology of the Lumsden Aquifer, which was not available to those writing the RWP. Consideration of this information has resulted in an increase in the allocation limit defined for the aquifer under the WLP compared to the older RWP. That is to say, one of the primary reasons that the proposed activity has non-complying status under the RWP is the outgoing plan relied on data which was the best available at the time, but is not consistent with what is known now.

4. NON-NOTIFICATION & CONSULTATION

A consent authority has the discretion whether to publicly notify an application unless a rule or National Environmental Standard (NES) precludes public notification (in which case the consent authority must not publicly notify) or section 95A(2) applies.

The assessment below of the environmental effects of the proposal strongly concludes that with the proposed conditions the adverse effects will not be significant and therefore they will be no more than minor. The applicants do not request public notification and there are no rules or NES which require the public notification of the application. In addition, there are no special circumstances relating to the application. As such, notification of the application is not necessary.

Clause 6(1)(f) of Schedule 4 of the RMA requires the identification of, and any consultation undertaken with, persons affected by the activity. No persons are considered to be adversely affected by the proposal, as determined by the larger assessment of environmental effects (Section 5 below). Ultimately however, Council must decide that a person is affected pursuant to Section 95E of the RMA.

Overall, it is considered that this application should be processed non-notified and without the need for written approvals.

5. ASSESSMENT OF ENVIRONMENTAL EFFECTS

In addition to the application being made in the prescribed forms and manner, Section 88 of the RMA also requires that every application for consent includes an assessment of the effects of the activity on the environment as set-out in Schedule 4 of the RMA.

5.1 Assessment of Alternatives

The alternative to this groundwater take is the applicant's existing surface water take. While this will remain the applicant's primary source of water, as discussed above it is unreliable and frequently the applicant is unable to take surface water when irrigation is most needed to allow grass growth.

A groundwater take from the (unconfined) Castlerock Aquifer would present a significant risk of causing stream depletion effects, in which case it would likely suffer from the same reliability issues as the current surface water take.

In summary, the Lumsden Aquifer is the best option for the applicant to secure water when the Ōreti River is at minimum flows and exercising their surface water take is not possible.

5.2 Effects on neighbouring wells

Potential effects of the proposed water take on neighbouring wells are discussed in detail in Section 3 of the *Hydrogeological Assessment* (Attachment C). Based on the modelling undertaken, these effects are expected to be 'acceptable' (according to ES's definition) provided that the water take occurs approx. 180 m or more from the closest relevant bore (E44/0623). The proposed well locations are at least 1.1 km from that bore, and interference effects on neighbouring bores will be insignificant and therefore less than minor.

5.3 Effects on surface water

While surface water depletion is not typically of concern for water takes from confined aquifers, the Lumsden Aquifer near the site is expected to be semi-confined. Pumping from a semi-confined aquifer overlain by another aquifer connected to surface water has the potential to indirectly result in stream depletion effects.

Therefore stream depletion was modelled for the proposed water take and discussed in detail in Section 4 of the *Hydrogeological Assessment* (Attachment C). The modelled stream depletion for a stream 50 m away from a well taking 50 L/s is approx. 0.5 L/s (~1 %) after 7 days and 1.3 L/s (~3 %) after 28 days, which is the maximum permissible duration of uninterrupted pumping under the proposed conditions. This corresponds to a low degree of surface water depletion (as defined in the WLP), and therefore we consider that the proposed take is highly unlikely to result in any observable effects on surface water near the proposed take.

Effects on surface water are therefore considered to be less than minor.

5.4 Effects on aquifer sustainability

As discussed in Section 5 of the *Hydrogeological Assessment* (Attachment C), long-term water level monitoring data does not indicate any evidence of over-allocation. This is reflected in the fact that ES has chosen to increase the allocation for the aquifer under the WLP compared to the RWP. The geology and location of the aquifer mean that it has little or no susceptibility to aquifer compaction, subsidence and certainly no risk of salt water intrusion.

The proposed water take represents a small proportion (approx. 2 %) of the water already consented to be taken from the aquifer, and any additional effects are not expected to be discernible. The applicant also acknowledges that the proposed take will be subject to the minimum water level cut-offs in Appendix L.5 of the WLP.

Effects on the sustainability of the aquifer are therefore considered to be insignificant and less than minor.

5.5 Effects on water quality

No direct effects on water quality are expected due to the proposed water take. Any indirect effects of the take on water quality will be negligible as the proposed water take will not result in any intensification of

CFCL's farming system. The total amount of water able to be taken by CFCL will not increase (including their existing surface water take).

Also, during periods when groundwater is used for irrigation, soil conditions will generally be dry (as this will generally occur when the applicant's ability to take surface water is restricted due to low summer rainfall). This means that use of groundwater for irrigation will occur when the risk of nutrient leaching to shallow groundwater or phosphorus runoff is at its lowest.

The effects of the proposed water take on water quality are therefore considered to be insignificant and less than minor.

5.6 Efficiency of water use

As noted above, the proposed water take is to allow some limited irrigation during periods of dry weather when surface water cannot be taken. The consented volume of irrigation for the property as a whole will not increase (see proposed condition 5 in Section 1.4).

The Irricalc online database (http://mycatchment.info/) indicates that the proposed daily limit for this application (4,320 m^3/day) would represent efficient irrigation for approximately 75 ha of pivot-irrigated pasture (assuming PAW = 60 mm, i.e. for Morven soils). The applicant has a significantly greater area under pivot, and therefore the proposed water take is considered to be efficient and reasonable use of water.

5.7 Monitoring

The water take will be metered and reported in accordance with Environment Southland's standard requirements for groundwater takes.

5.8 Uncertainty

The applicant acknowledges that the approach of applying for the bore permit and groundwater take permit simultaneously means there is less certainty about the extent of the effects discussed above than would be the case if pump test data was already available. This uncertainty is mitigated by:

- The large number of other water takes already present in the aquifer (including five south of the Ōreti River). These provide a significant quantity of generally consistent data on the aquifer properties, and enable the geology and hydrogeology near the site to be predicted with relative confidence even before drilling.
- The availability of long-term groundwater level records at two locations within the aquifer. These give an accurate and consistent record of actual seasonal drawdown in the aquifer both north and south of the Ōreti, and have also allowed us to assess our modelling of existing drawdown in the aquifer, which is conservative relative to what has actually been measured at these wells.

- The applicant's decision to propose well locations significantly further from neighbouring wells potentially susceptible to drawdown than the distance that is likely to be necessary to avoid adverse effects, based on modelling.
- The availability of multiple well locations, which would allow the applicant to spread the water take over two or more wells at varying distances from potentially affected wells or surface water bodies if this is necessary to minimize any effects which are significantly greater than those modelled.
- The conditions volunteered by the applicant, which require the applicant to carry out pump testing after consent is granted and before taking water for irrigation. If the pump test results indicate aquifer properties significantly different from those expected, and that this may result in the take having effects significantly greater than modelled. As noted above, several mitigation options are available, including reducing the instantaneous rate of take as a last resort.

Considering all of the above, we consider that there is a high degree of confidence that the assessment of the various potential effects outlined in the previous sub-sections will hold true, even if the aquifer properties are somewhat different to those assumed.

6. STATUTORY CONSIDERATIONS

Schedule 4 of the RMA requires that an assessment of the activity against the matters set out in Part 2 and any relevant provisions of a document referred to in Section 104 of the RMA is provided when applying for a resource consent for any activity. These matters are assessed as follows.

6.1 Part 2 of the RMA

A decision on a discretionary or non-complying resource consent application must be made in accordance with the purpose and principles of the RMA (Part 2) and must have regard to the matters set out in Section 104 of the RMA.

Part 2 of the RMA sets out the purpose and principles of the RMA. The purpose of the RMA is the sustainable management of natural and physical resources. Sustainable management is defined in Section 5 as:

> *'Managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while:*
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
> *(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
> *(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.'*

Section 5 of the RMA must be read in conjunction with Sections 6 to 8 of the RMA.

Taking into account the above, the taking and use of the water as proposed is consistent with Section 5 of the RMA as the use of water will benefit the applicant and their community socially, culturally and economically, while having a less than minor effect on the long-term sustainability of the Lumsden Aquifer, potentially connected surface waterbodies and their ability to provide for the reasonably foreseeable needs of future generations.

There are no matters of national importance under Section 6 of the RMA that will be affected by the proposal. The activity is also consistent with the requirements of Section 7 of the RMA, with particular regard given to the efficient use and development of natural and physical resources, the maintenance and enhancement of amenity values and the quality of the environment, the finite characteristics of natural and physical resources, the protection of habitat of trout and salmon and the effects of climate change.

Regarding Section 8, the proposed activity is not inconsistent with the principles of the Treaty of Waitangi.

Overall, the activity is considered to be consistent with Part 2 of the RMA.

6.2 Section 104(1)(b) of the RMA

In accordance with Schedule 4 of the RMA, an assessment of the activity against the relevant provisions of a document referred to in 104(1)(b) of the RMA must be included in an application for resource consent. Documentation in this section are noted as being:

(i) a National Environmental Standard;
(ii) other regulations;
(iii) a National Policy Statement;
(iv) a New Zealand Coastal Policy Statement;
(v) a Regional Policy Statement or Proposed Regional Policy Statement;
(vi) a plan or proposed plan.

Under the RMA, regional plans need to give effect to NPSs, NESs and RPSs. For an application of this scale, an assessment of the application against the regional plans is adequate as these plans ultimately give effect to the higher order statutory instruments. The following discussion therefore focusses on the relevant plans, with brief discussion of other particularly relevant documents.

6.2.1 Proposed Southland Water and Land Plan (2018)

The following policies, which give effect to the plan's objectives, are relevant to this application for resource consent: Policies B7, 2, 6, 10, 15A, 20, 21, 22, 23, 27, 40, 41 and 42. The most relevant of these policies are copied below:

Policy B7 of the National Policy Statement for Freshwater Management 2014 (as amended in 2017)

1. When considering any application the consent authority must have regard to the following matters:

(a) the extent to which the change would adversely affect safeguarding the life-supporting capacity of freshwater and of any associated ecosystem; and

(b) the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of freshwater and of any associated ecosystem resulting from the change would be avoided.

2. This policy applies to:

(a) any new activity; and

(b) any change in the character, intensity or scale of any established activity;

that involves any taking, using, damming or diverting of freshwater or draining of any wetland, which is likely to result in any more than minor adverse change in the natural variability of flows or level of any freshwater, compared to that which immediately preceded the commencement of the new activity or the change in the established activity (or in the case of a change in an intermittent or seasonal activity, compared to that on the last occasion on which the activity was carried out).

3. This policy does not apply to any application for consent first lodged before the National Policy Statement for Freshwater Management 2011 took effect on 1 July 2011.

Policy 20 – Management of water resources

Manage the taking, abstraction, use, damming or diversion of surface water and groundwater so as to:

1A. recognise that the use and development of Southland's land and water resources, including for primary production, can have positive effects including enabling people and communities to provide for their social, economic and cultural wellbeing;

1. avoid, remedy or mitigate adverse effects from the use and development of surface water resources on:

(a) the quality and quantity of aquatic habitat, including the life supporting capacity and ecosystem health and processes of waterbodies;

(b) natural character values, natural features, and amenity, aesthetic and landscape values;

(c) areas of significant indigenous vegetation and significant habitats of indigenous fauna;

(d) recreational values;

(e) the spiritual and cultural values and beliefs of tangata whenua;

(f) water quality, including temperature and oxygen content;

(g) the reliability of supply for lawful existing surface water users, including those with existing, but not yet implemented, resource consents;

(h) groundwater quality and quantity;

(j) mātaitai, taiāpure and nohoanga;

2. avoid, remedy or mitigate significant adverse effects from the use and development of groundwater resources on:

(a) long-term aquifer storage volumes;

(b) the reliability of supply for lawful existing groundwater users, including those with existing, but not yet implemented, resource consents;

(c) surface water flows and levels, particularly in spring-fed streams, natural wetlands, lakes, aquatic ecosystems and habitats (including life supporting capacity and ecosystem health and processes of waterbodies) and their natural character; and

(d) water quality;

3. ensure water is used efficiently and reasonably by requiring that the rate and volume of abstraction specified on water permits to take and use water are no more than reasonable for the intended end use following the criteria established in Appendix O and Appendix L.4.

Policy 21 – Allocation of water

Manage the allocation of surface water and groundwater by:

1. determining the primary allocation for confined aquifers not identified in Appendix L.5, following the methodology established in Appendix L.6;

2. determining that a waterbody is fully allocated when the total volume of water allocated through current resource consents and permitted activities is equal to either:

(a) the maximum amount that may be allocated under the rules of this Plan, or

(b) the provisions of any water conservation order;

3. enabling secondary allocation of surface water and groundwater subject to appropriate surface water environmental flow regimes, minimum lake and wetland water levels, minimum groundwater level cutoffs or seasonal recovery triggers, to ensure:

(a) long-term aquifer storage volumes are maintained; and

(b) the reliability of supply for existing groundwater users (including those with existing resource consents for groundwater takes that have not yet been implemented) is not adversely affected;

4. when considering levels of abstraction, recognise the need to exclude takes for non-consumptive uses that return the same amount (or more) water to the same aquifer or a hydraulically connected lake, river, modified watercourse or natural wetland.

Policy 22 – Management of the effects of groundwater and surface water use

Manage the effects of surface and groundwater abstractions by:

1. avoiding allocating water to the extent that the effects on surface water flow would not safeguard the mauri of that waterway and mahinga kai, taonga species or the habitat of trout and salmon;

2. ensuring interference effects are acceptable, in accordance with Appendix L.3;

3. utilising the methodology established in Appendix L.2 to:

(a) manage the effects of consented groundwater abstractions on surface waterbodies; and

(b) assess and manage the effects of consented groundwater abstractions in groundwater management zones other than those specified in Appendix L.5.

Policy 23 – Stream depletion effects

Manage stream depletion effects resulting from groundwater takes which are classified as having a Riparian, Direct, High or Moderate hydraulic connection, as set out in Appendix L.2 Table L.2, to ensure the cumulative effect of those takes does not:
1. exceed any relevant surface water allocation regime (including those established under any water conservation order) for groundwater takes classified as Riparian, Direct, High or Moderate hydraulic connection; or
2. result in abstraction occurring when surface water flows or levels are less than prescribed minimum flows

Policy 27 – Bore construction and management

Require minimum standards for the construction, operation and maintenance of bores and wells.

Policy 42 – Consideration of water permit applications

When considering resource consent applications for water permits to take and use water:
1. except for non-consumptive uses, consent will not be granted if a water body is over allocated or fully allocated; or to grant consent would result in a water body becoming over allocated or would not allow an allocation target for a water body to be achieved within a time period defined in this Plan; and
2. except for non-consumptive uses, consents replacing an expiring resource consent for an abstraction from an over-allocated water body will generally only be granted at a reduced rate, the reduction being proportional to the amount of over-allocation and previous use, using the method set out in Appendix O; and
3. installation of water measuring devices will be required on all new permits to take and use water and on existing permits in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010; and
4. where appropriate, minimum level or flow cut-offs and seasonal recovery triggers on resource consents for groundwater abstraction will be imposed; and
5. conditions will be specified relating to a minimum flow or level, or environmental flow or level regime (which may include flow sharing), in accordance with Appendix K, for all new or replacement resource consents (except for water permits for non-consumptive uses, community water supplies and water bodies subject to minimum flow and level regimes established under any water conservation order) for:
(a) surface water abstraction, damming, diversion and use; and
(b) groundwater abstraction in accordance with Policy 23.

In our opinion, the application is consistent with all of these policies. In particular, Attachment C confirms that the proposal is consistent with Policy 20, managing water resources so that the significant adverse effects on the long-term aquifer sustainability, reliability of supply for existing water users, surface water

levels and water quality are avoided, mitigated or remedied. The proposal will provide benefits to the applicant and the local community, and the use of the resource is considered an efficient use. Water allocation is managed in accordance with Policy 21 and this proposal does not seek to over-allocate the existing water resources. Interference effects of the proposal have been determined to be acceptable, and therefore the proposal is consistent with Policy 22. In terms of policy 23, the proposed abstraction will have low hydraulic connectivity to Murray Creek and its tributaries. The proposal is also consistent with Policy 42, and consideration of the consent duration proposed is given in Section 7 below.

With regards to the other policies listed at the start of this section, which are not in relation to groundwater takes or bores but still generally relevant:

- The application has considered the relevant iwi management plan (*Te Tangi a Tauira*) and is therefore consistent with Policy 2 of the PSWLP.
- With respect to Policies 6, 10 and 15A, we have considered the effects of the groundwater abstraction including the use of the water for irrigation purposes, and we conclude that irrigation will have a negligible effect on water quality.

6.2.2 Regional Water Plan for Southland

The following policies, which give effect to the plan's objectives, are relevant to this application: Policies 1A, B7, 14, 14A, 21, 22, 23, 25 ,26, 28, 29, 30, 31.

The content of these policies is largely consistent with that of the relevant WLP policies, and therefore the comments in the preceding section are generally applicable to the RWP policies. The proposal is not contrary to any of the relevant polices as specified in the RWP for reasons as discussed in Section 5 of this report and Attachment C. Due to this consistency with the Regional Water Plan policies, the objectives in relation to the regional direction for the management of water quantity and use are also met. Further consideration of the proposed 25-year consent duration is given in Section 7.1 below.

6.2.3 National Environmental Standards

Clauses 6, 7 and 8 of the *Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations* 2007 (NES) apply to water and discharge permits issued by regional councils.

There are no Drinking Water Protection Zones defined for the Lumsden or Castlerock Aquifers in Appendix J of the WLP. Therefore, this proposal does not have the potential to affect registered drinking water supplies that provide 501 or more people with drinking water for 60 or more calendar days each year. Furthermore, the emergency provisions of the NES need not apply as the effects of the proposed activity will not be significantly adverse (Regulations 11 and 12).

6.2.4 Iwi Management Plans

The Ngāi Tahu ki Murikiku Natural Resource and Environmental Iwi Management Plan, 2008 (NREM, a.k.a. *Te Tangi a Tauira*) is the iwi management plan relevant to the Southland Region. The following policies are considered relevant to this application:

- Require scientifically sound, understandable, and culturally relevant information with resource consent applications;
- Preference to take water from bores as opposed to surface water abstractions;
- Recommend as a condition of consent, that any application for irrigation puts in on-farm rainwater holding facilities, to help with dairy washdown and irrigation;
- Encourage best practice and efficient use of water, particularly in terms of sustainable irrigation design, delivery and management, making best use of available water before water levels get too low and reducing the amount of water lost through evaporation by avoiding irrigating on hot windy days;
- Applications for water abstraction should determine where the water came from and its age;
- Applications should justify the quantities of water requested;
- Encourage the installation of appropriate measuring devices (e.g. water meters) to accurately measure, report and monitor volumes of water being abstracted;
- Advocate for durations not exceeding 25 years on resource consents related to water abstractions; and,
- Require, where necessary, a consent condition providing for the review of the volumes able to be abstracted from bores based on the observed seasonal recovery of groundwater levels between individual irrigation seasons and on longer-term water level recovery.

The proposal is generally consistent with the policies of the NREM and it is noted that a broad judgement of the proposal should be made taking into account all aspects of sustainable use and development of the water resource.

6.3 Section 104D of the RMA

Because the activity is a non-complying activity an assessment of Section 104D must be undertaken. This section states:

> *(1) Despite any decision made for the purpose of section 95A(2)(a) in relation to adverse effects, a consent authority may grant a resource consent for a non-complying activity only if it is satisfied that either—*
> *(a) the adverse effects of the activity on the environment (other than any effect to which section 104(3)(a)(ii) applies) will be minor; or*
> *(b) the application is for an activity that will not be contrary to the objectives and policies of—*
>
> > *(i) the relevant plan, if there is a plan but no proposed plan in respect of the activity; or*

(ii) the relevant proposed plan, if there is a proposed plan but no relevant plan in respect of the activity; or

(iii) both the relevant plan and the relevant proposed plan, if there is both a plan and a proposed plan in respect of the activity.

(2) To avoid doubt, section 104(2) applies to the determination of an application for a non-complying activity.

The information provided in this report strongly supports the conclusion that the application passes both 'gateway' tests in that the adverse effects will be less than minor and the activity is not contrary to the objectives and policies of either the RWP or the WLP.

7. CONSENT DURATION, REVIEW AND LAPSE

7.1 Duration and review

Other consents for groundwater abstraction in the part of the Lumsden Aquifer near the site have typically been granted with a term of between 10 and 25 years. In this case a term of 25 years is sought. This term recognises the significant investment that the applicant will have to make to exercise this consent (drilling, aquifer testing, infrastructure and consenting costs), and the on-going investment that will be made in irrigation infrastructure maintenance and monitoring.

Section 123 of the RMA specifies that where a term of consent is not specified by way of condition the default term is 5 years, and where a term is specified, the maximum term that may be applied is 35 years. A consent term of 25 years is significantly shorter than the 35-year duration the applicant is by default entitled to seek.

Councils are required to assess each application for consent on its merits applying effects-based methodology to determine firstly whether consent shall be granted and secondly what term of consent is appropriate for the activity taking into account the following:

- The knowledge of the resource and any anticipated effects on the resource as a result of the activity;
- The level of certainty about the effects; and
- The long-term acceptability of the effects.

The Lumsden Aquifer resource is well understood and the modelled effects of the proposed take are small, in proportion to the scale of the proposed activity. While there is some uncertainty regarding the aquifer properties, the applicant has proposed adaptive management conditions to ensure that the effects will be within the acceptable range even if the hydrogeological characteristics are significantly different to the many other Lumsden Aquifer takes.

The source zone is not over-allocated under the WLP, and the applicant seeks only a small portion of primary allocation from this zone (albeit the last remaining share of this allocation).

It is anticipated that the resulting permit will contain adequate monitoring and review conditions to ensure that over-abstraction does not occur. Should adverse effects result from the exercise of the permit, Council has the ability to review the conditions of the consent pursuant to S.128 of the RMA. Under S.128(1)(a)(iii), Council may also wish to specify other appropriate purposes for review on the consent.

With regards to a desirability for granting a common expiry date, the applicant's existing water permit and is due to expire in 2025, and a ~6 year consent term is not appropriate for the application in question given the small scale, low level of risk and the level of economic investment. Furthermore, Council have adequate facility to review the conditions of the consent under S.128(1)(b) of the RMA should further management methods be introduced in the future.

The proposed consent conditions are considered adequate to monitor any potential environmental impact of the activity. A 25-year consent duration is sufficient and reasonable in the circumstances and consistent with the Iwi Management Plan and balances the applicants' level of investment with the low level of risk. In summary, a robust reason for granting a shorter consent term has not been identified, but there are many good reasons why a 25-year consent term should be granted.

7.2 Lapse period

Under Section 125 of the RMA, resource consents lapse if they are not given effect to within a reasonable timeframe. For any activity other than aquaculture, the lapse period is 5 years from the date the consent was granted, unless another date is specified in the consent and/or an application for an extension has been made and approved.

In this case, a lapse period of 5 years is considered appropriate, as the proposed abstraction may not occur every year if flows in the Ōreti are high, and it would be unreasonable if the applicant lost access to their groundwater supply in the event that a few consecutive wet summers made it temporarily unnecessary.

Note that we have assumed that drilling the well and carrying out pump testing would not be considered to be giving effect to the consent to take water for irrigation. As per the volunteered conditions, aquifer testing will be carried out within 1 year. If this was considered to be exercising the water take permit, the applicant would be agreeable to a shorted lapse period.

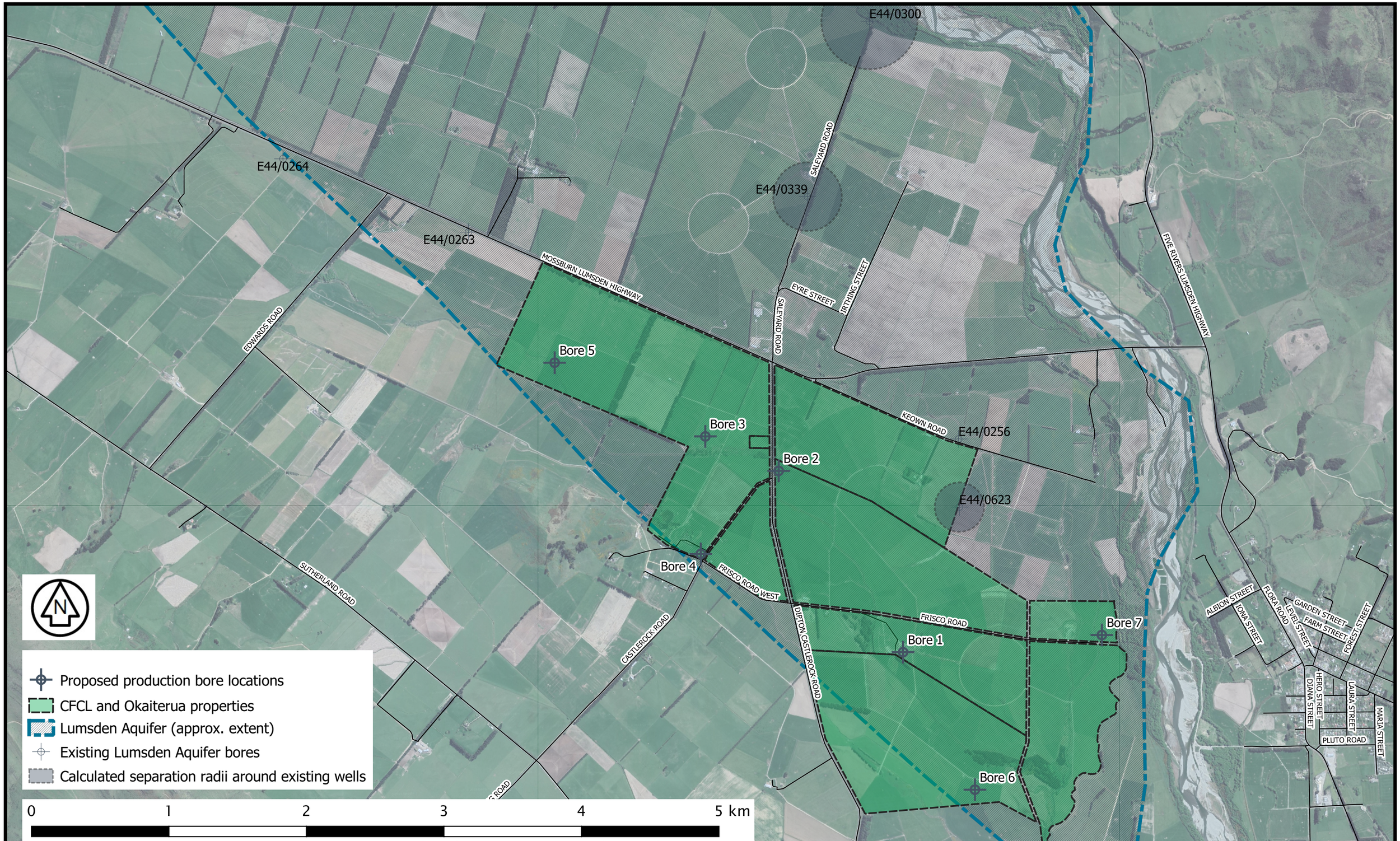
8. CONCLUSION

A decision to grant consent under Section 104D of the RMA can be made on the basis that:

a) The adverse effects on the environment will be minor or less;
b) The proposal meets the non-notification requirements of Section 95A of the RMA; and
c) The proposal is consistent with the requirements of the RMA, the policies of both relevant ES plans, and other relevant matters.

Granting of the consents will be consistent with the purpose of the RMA for the reasons explained within this report. The proposed activities are not expected to result in adverse effects on other water users or surface water bodies, and potential adverse effects will be appropriately avoided or mitigated.

Attachment A: Site Map



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Client:

CASTLEROCK FARMING COMPANY LTD.

WELL LOCATION PLAN

Sources & Notes

- Satellite photograph from Google.
- Farm properties from Quickmap.
- Bore locations and aquifer extent from Environment Southland.
- Separation radii calculated as discussed in Hydrogeological Assessment (see Section 3.2). Only shown if >50 m.

Mapped 11/12/2018 by TM. Revised 13/12/2018. Proposed bores added 20/12/2018. Finalised with separation radii 11/01/2019.

Job No.	Map No.
18180	2

Scale: 1:25000 at A3

Datum	Rev.
NZTM 2000	4

Attachment B: Certificates of title and other legal documents

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD
Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**SL6A/101**
Land Registration District	**Southland**
Date Issued	16 May 1979

Estate	Fee Simple
Area	1.2141 hectares more or less
Legal Description	Lot 1 Deposited Plan 1804

Registered Owners
Castlerock Farming Company Limited

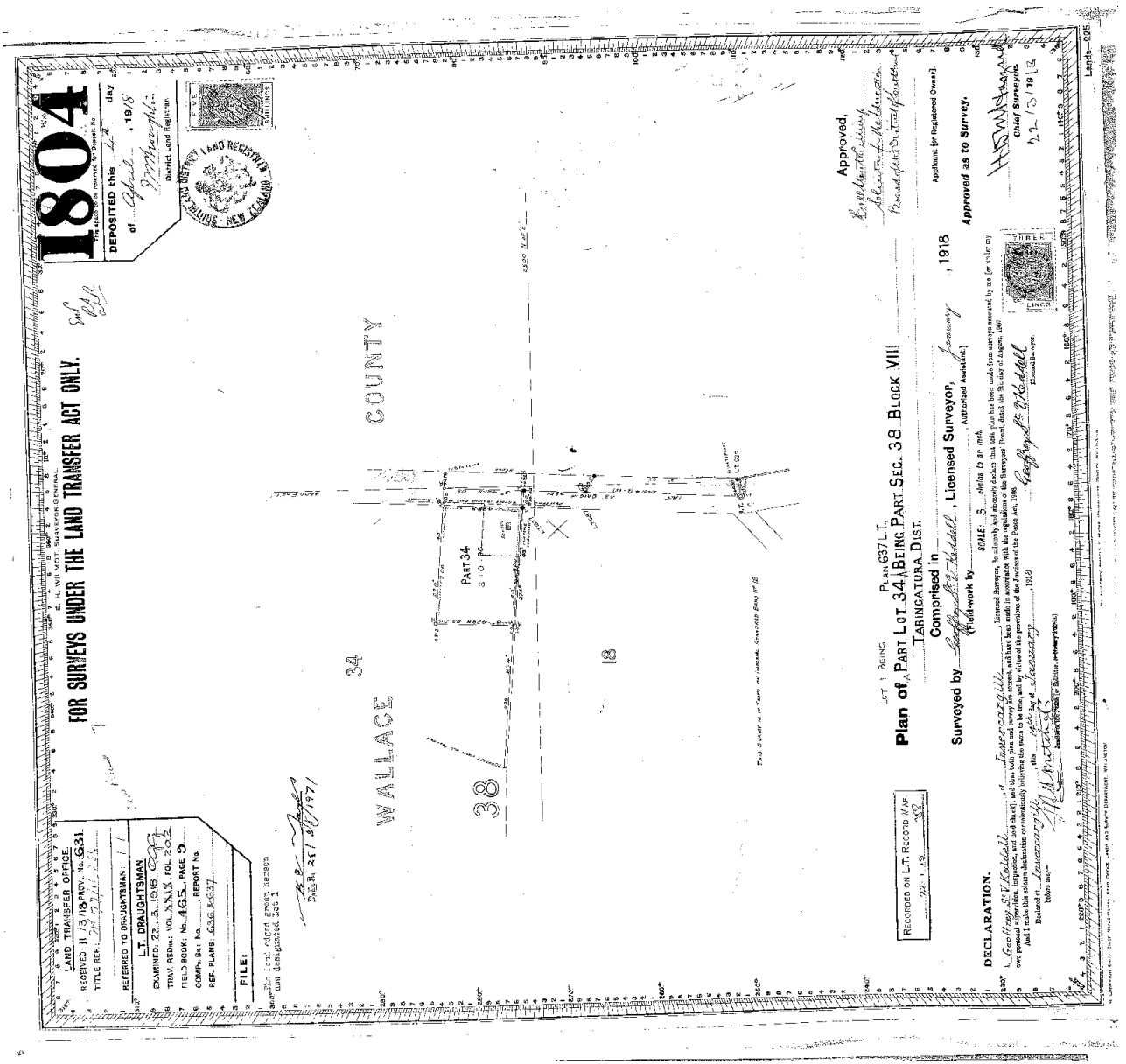
Interests

Subject to Section 8 Coal Mines Amendment Act 1950

Subject to Section 168A Coal Mines Act 1925

9446216.3 Mortgage to Rabobank New Zealand Limited - 12.7.2013 at 3:25 pm

Identifier **SL6A/101**



RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD
Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**SLA1/782**
Land Registration District	**Southland**
Date Issued	06 November 1962

Prior References
SL162/294

Estate	Fee Simple
Area	632.0279 hectares more or less
Legal Description	Lot 3-5 Deposited Plan 636 and Lot 2 Deposited Plan 3186

Registered Owners
Castlerock Farming Company Limited

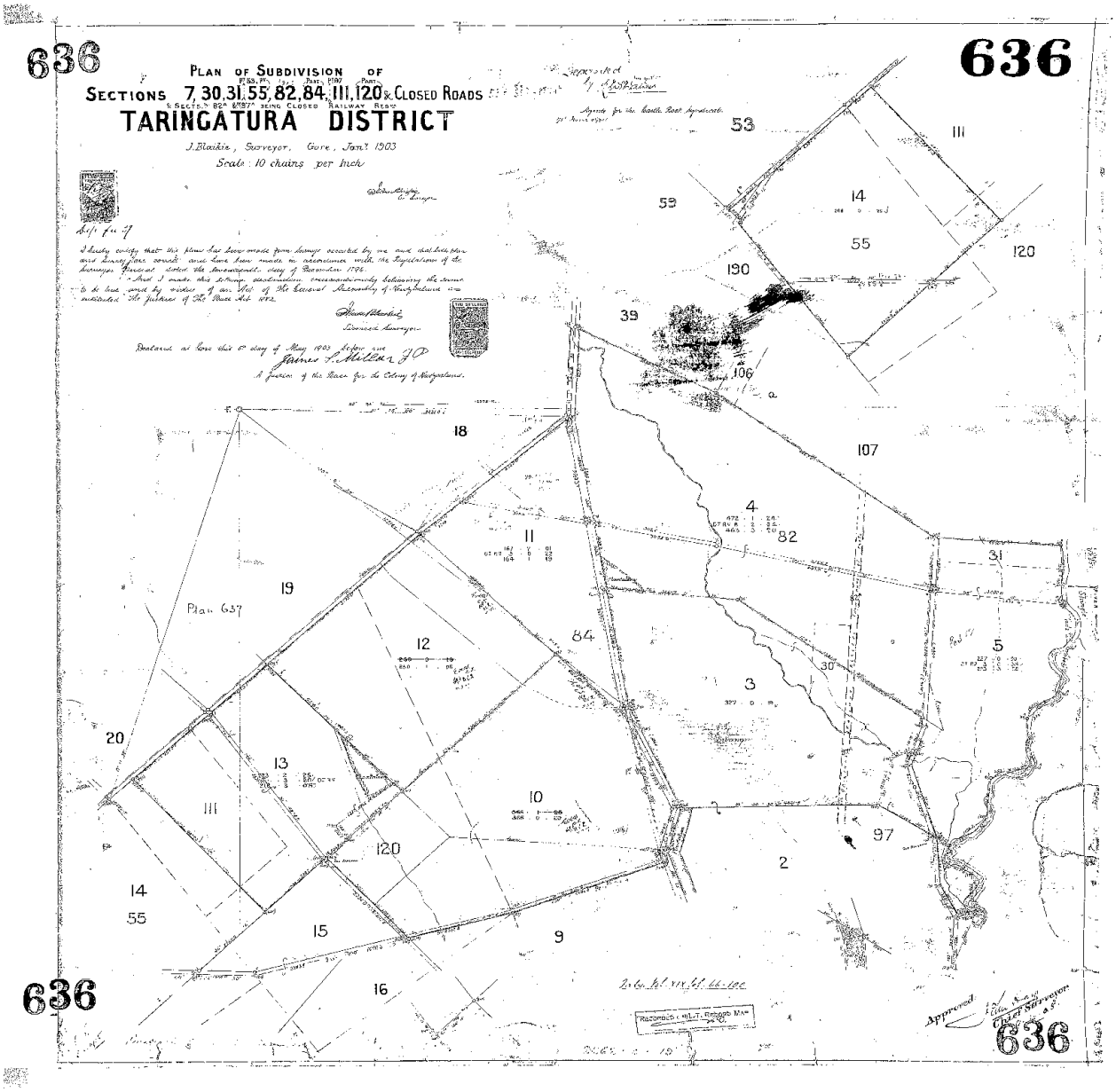
Interests

8450062.8 Notice pursuant to Section 195(2) Climate Change Response Act 2002 - 24.3.2010 at 9:00 am (affects Lot 3 and Lot 5 DP 636 and Lot 2 DP 3186)

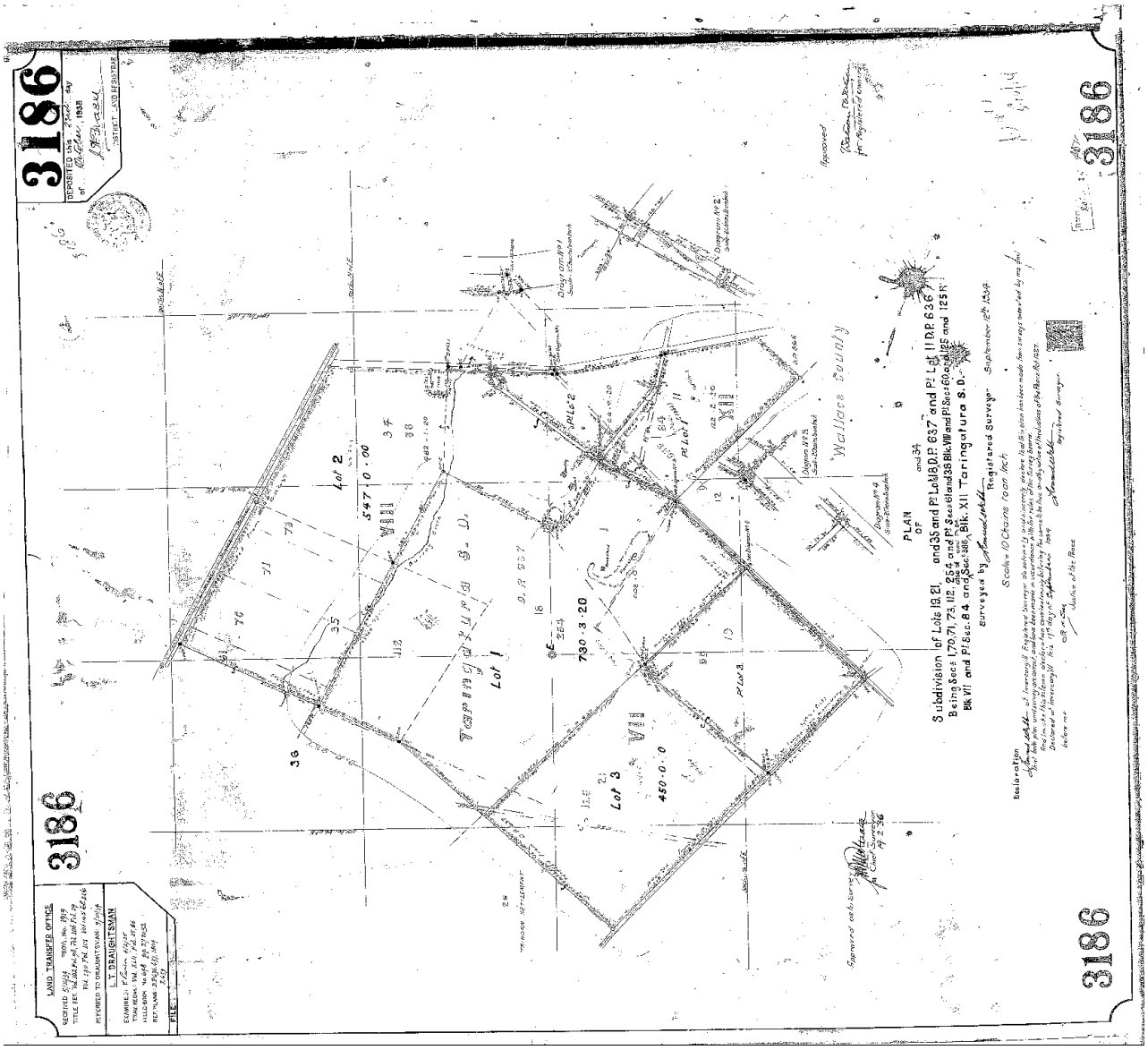
9111245.1 Notice pursuant to Section 195(2) Climate Change Response Act 2002 - 29.6.2012 at 1:34 pm (affects Lot 2 DP 3186)

9446216.3 Mortgage to Rabobank New Zealand Limited - 12.7.2013 at 3:25 pm

Identifier **SLA1/782**



Identifier **SLA1/782**



RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD
Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**SL10B/161**
Land Registration District	**Southland**
Date Issued	26 March 1992

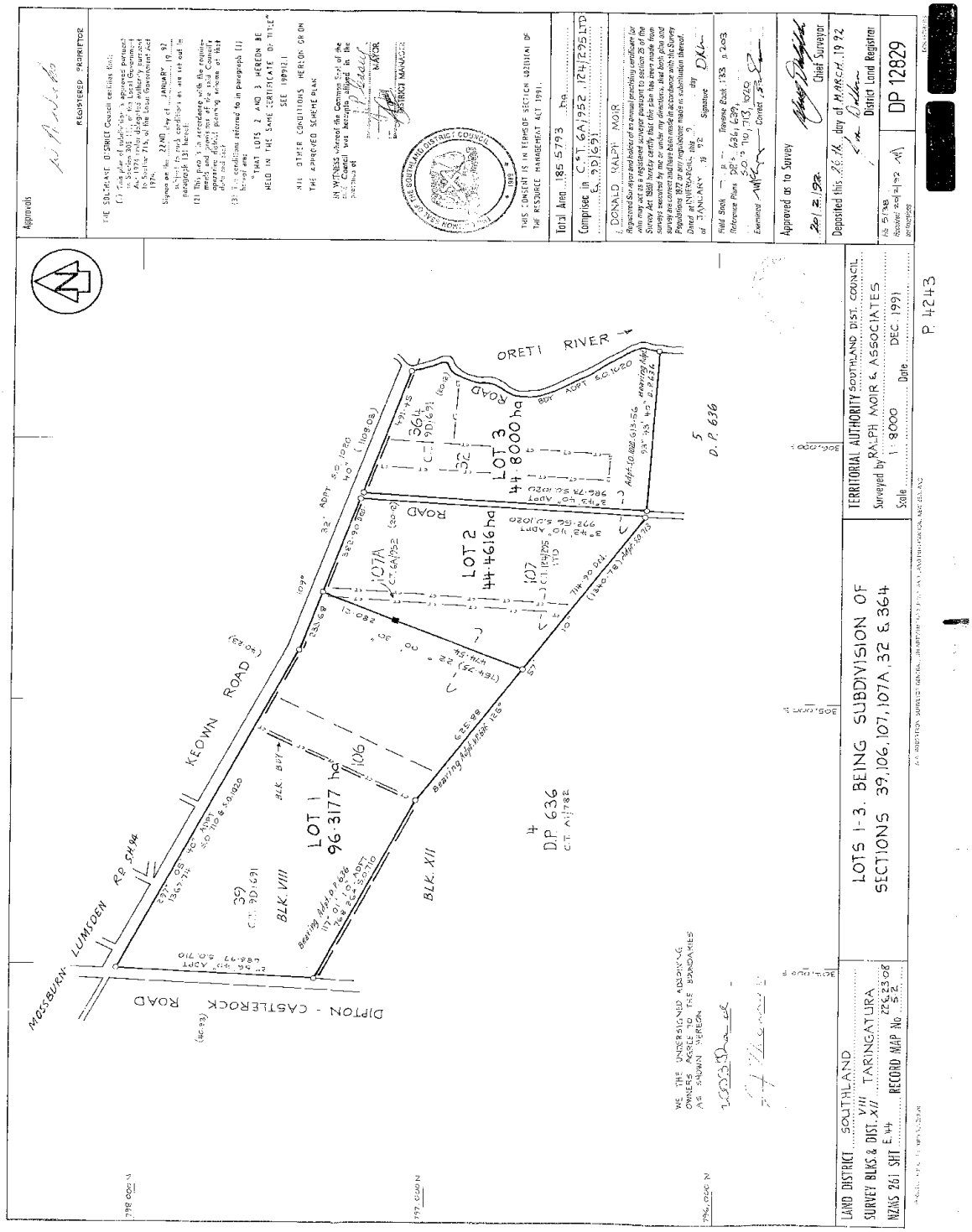
Prior References
SL124/295 SL6A/952 SL9D/691

Estate	Fee Simple
Area	96.3177 hectares more or less
Legal Description	Lot 1 Deposited Plan 12829

Registered Owners
Okaiterua Limited

Interests
10376506.3 Mortgage to ASB Bank Limited - 30.3.2016 at 4:14 pm

Identifier **SL10B/161**



NEW ZEALAND COMPANIES OFFICE

COMPANIES REGISTER

Certificate of Incorporation

CASTLEROCK FARMING COMPANY LIMITED

1961485

NZBN: 9429033275345

This is to certify that CASTLEROCK FARMING COMPANY LIMITED was incorporated under the Companies Act 1993 on the 29th day of June 2007.

Registrar of Companies
10th day of January 2019

REGISTRAR OF COMPANIES NEW ZEALAND

Certificate generated 10 January 2019 03:28 PM NZDT

Attachment C: Hydrogeological Assessment

TECHNICAL COMMENT

Date: 21/12/2018 Our Ref: 18180

Written by: Tim Muller

Reviewed by: Brydon Hughes (Liquid Earth)

Subject: Hydrogeological assessment, Frisco Rd, Lumsden

---

1 Introduction

Castlerock Farming Company Ltd (CFCL) is applying for resource consent to drill one or more bores on their farm at Castlerock, near Lumsden, and to take groundwater from the bore(s). The applicant already has a surface water take consent from the Ōreti River which is used for irrigation of the farm, however this is subject to minimum flow cut-offs which mean they are frequently unable to irrigate during the driest part of the season when irrigation is most needed. The proposed groundwater take is to supplement the surface water take, enabling the applicant to provide at least limited irrigation to maintain grass growth when flows in the Ōreti are low.

The groundwater is to be taken from the Lumsden Aquifer, which is already used under 10 unrelated groundwater take permits. Consequently, the aquifer properties are relatively well understood, and it is nearing the primary allocation of 5.76 million m^3 per year defined for the aquifer under Environment Southland's *Proposed Southland Water and Land Plan* (WLP).

For these reasons, and to avoid the risk of installing bores that may not be able to be used, the applicant has opted to apply for the consents to drill bores and to take water simultaneously, rather than sequentially as would be more typical. This approach was discussed in a site meeting on September 6th with Lauren Maciaszek and Michael Killick of Environment Southland, who were comfortable with this approach provided that a robust assessment of the hydrogeological effects was provided. The proposed groundwater take volumes are summarised below:

Annual maximum:	**122,178 m^3**
Daily maximum:	**4,320 m^3**

The daily limit is equivalent to continuous pumping at 50 L/s, while the annual limit proposed represents all of the remaining allocation in the aquifer under the WLP (subject to the outcome of an ongoing consent renewal application which includes a slight increase in the water take volume under that consent).

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The purpose of this report is to:

- Summarise the relevant information already known about the hydrogeology of the area.
- Provide details of the existing water takes in the aquifer, including an assessment of the potentiometric head and existing drawdown for wells near the site.
- Assess the likely drawdown and stream depletion effects of the proposed groundwater take, and provide a summary of the conditions under which those effects are expected to be acceptable (including expected aquifer properties, well location(s) and rates of take).

Although the hydrogeology of the area is well understood, the properties of the aquifer at the proposed well locations cannot be precisely known before drilling. For this reason, the consent limits stated above will also be subject to an additional condition or conditions requiring that the applicant provide a *Hydraulic Testing Report* or equivalent after the wells have been drilled. This report will either confirm that the pump test results are generally consistent with the aquifer properties assumed in this report and that the effects on neighbouring water users and on surface water will be acceptable, or it will propose mitigation measures (such as a reduction in the instantaneous rate of take) to ensure that effects are within the acceptable range. This adaptive management approach is considered a robust means of ensuring that significant adverse effects do not occur, given the volume of information already available about the Aquifer.

This assessment has included assessment of pump test reports and other related information for several other wells in the Lumsden Aquifer. Due to the volume of information reviewed, it would have been impractical to attach all of this information to the report. However, all of the data reviewed is available on request.

2 Setting

2.1 Site and surrounds

The farm comprises 6 legal properties owned by CFCL and Okaiterua Ltd (a sister company), with a total area of approx. 730 ha. The details of these properties are given in the *Assessment of Environmental Effects* (AEE) for this application. The centre of the site is at approximately 1242000 mE, 4926000 mN (NZTM 2000). The site is currently operated as a dairy farm, as detailed in the AEE. Most of the surrounding land is also used for pastoral farming.

Figure 1 - The site is located on the opposite (western) side of the Ōreti River from the town of Lumsden.

2.2 Climate and surface water

As discussed in more detail in the AEE, the site is located in Northern Southland and experiences less rainfall than many other parts of Southland (911 mm per year, compared with 1149 mm for Invercargill for instance (NIWA, 2013)). As shown in Figure 2, significant moisture deficits typically occur in summer.

The Ōreti River flows from west to east across the plains approx. 3 km north of the site, before turning and flowing south. The River then passes within 200 m of the eastern site boundary at its closest point, and approx. 2-3 km from most of the proposed bore locations. Environment Southland maintain a flow gauging station near the site (Ōreti at Lumsden Cableway), and provide the data from this on their Environmental Data web portal. The median flow at this location is 19 m^3/s, while flood flows frequently exceed 100 m^3/s (mean annual flood: 629 m^3/s). Base flows are typically lowest in summer and highest in the middle of the year.

A number of small drains and creeks flow from west to east towards the Ōreti, including Murray Creek, which flows through the site. These are understood to be groundwater-fed, receiving baseflow from shallow groundwater throughflow from the Castlerock Terrace.

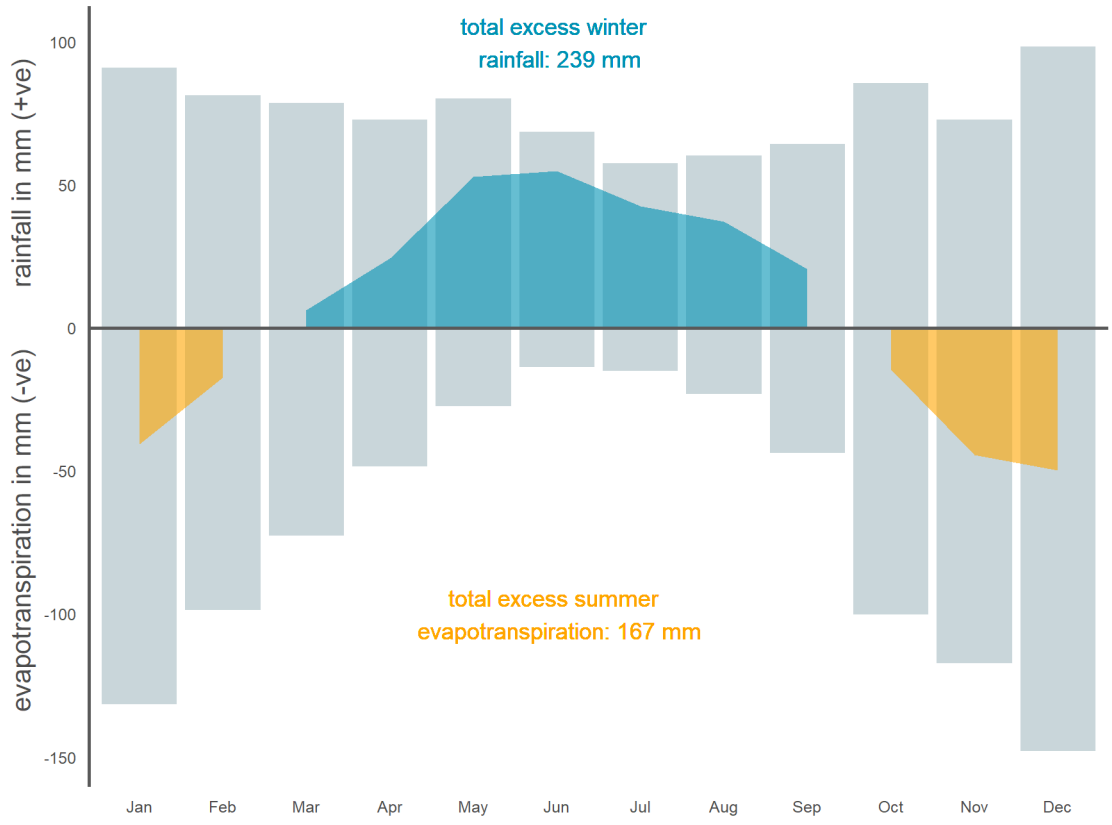


Figure 2 –Rainfall in Lumsden only slightly exceeds evapotranspiration in an average year, and significant excess evapotranspiration occurs during Spring and Summer. Data source: Cliflo. Rainfall from Lumsden AWS, 1977-2018, evapotranspiration from Five Rivers CWS, 2014-2018 (but comparable to other nearby weather stations with longer records). Months with fewer than 28 days of data excluded.

2.3 Soils and geology

SMap (Landcare Research, 2018) indicates that the near-surface soils at the site are dominantly Morven, described as a shallow, well-drained silty loam. There are small areas of other soil types, including Eureka (a deep, poorly drained silty loam) in the eastern part of the site near Murray Creek.

According to the Institute of Geological and Nuclear Sciences 1:250,000 New Zealand Geology Web Map, the geology underlying the site comprises late Pleistocene river deposits, described as "sandy greywacke gravel overlain by loess".

The three closest bores which penetrate into the Lumsden aquifer are E44/0256, E44/0623 (both to the east) and E44/0263 (to the west). The locations of these bores are shown on Drawing 18180-2 (attached to the AEE), and the logs for these bores (see Attachment A) show the following typical soil profile:

- **Topsoil** at the surface;
- **Sands and gravels** to between 4.5 and 6.8 metres below ground level (mbgl);
- Predominantly **claybound gravels**, forming a confining layer to varying depths (approx. 63.5 mbgl in E44/0263, 27 mbgl in E44/0256 and 15.5 mbgl in E44/0623);
- **Gravel and sandy gravel**, forming the water-bearing layer (inferred to represent the 'Lumsden Aquifer'), typically 10-15 m thick;

- **Variable geology below this layer**, with further claybound gravel in E44/0623, and sandstone in E44/0256. Well E44/0263 did not extend below the water-bearing gravel layer.

2.4 Hydrogeology

The hydrogeology of the area has been extensively studied, with the most comprehensive example being *Hydrogeology of the Ōreti Basin* (SKM, 2005; note that this was written by the reviewer of this report). The area contains a shallow groundwater resource, which ES has divided into three zones for management purposes (the Castlerock, Ōreti and Five Rivers aquifers). There are also two confined aquifers separated by a geological boundary: the North Range and Lumsden Aquifers, of which the Lumsden is the largest. The site is located within the Castlerock Groundwater Zone (CGZ), and over the Lumsden Aquifer.

The CGZ extends from Mossburn in the west almost as far as the Ōreti to the east. It is fed both by rainfall infiltration and by a number of streams which lose flow to groundwater in the western part of the aquifer. In the eastern part of the CGZ (closer to the site), the aquifer feeds a series of springs which drain to Murray Creek (ES, n.d.) Based on piezometric contours, the flow in the aquifer generally follows the surface topography (SKM, 2005).

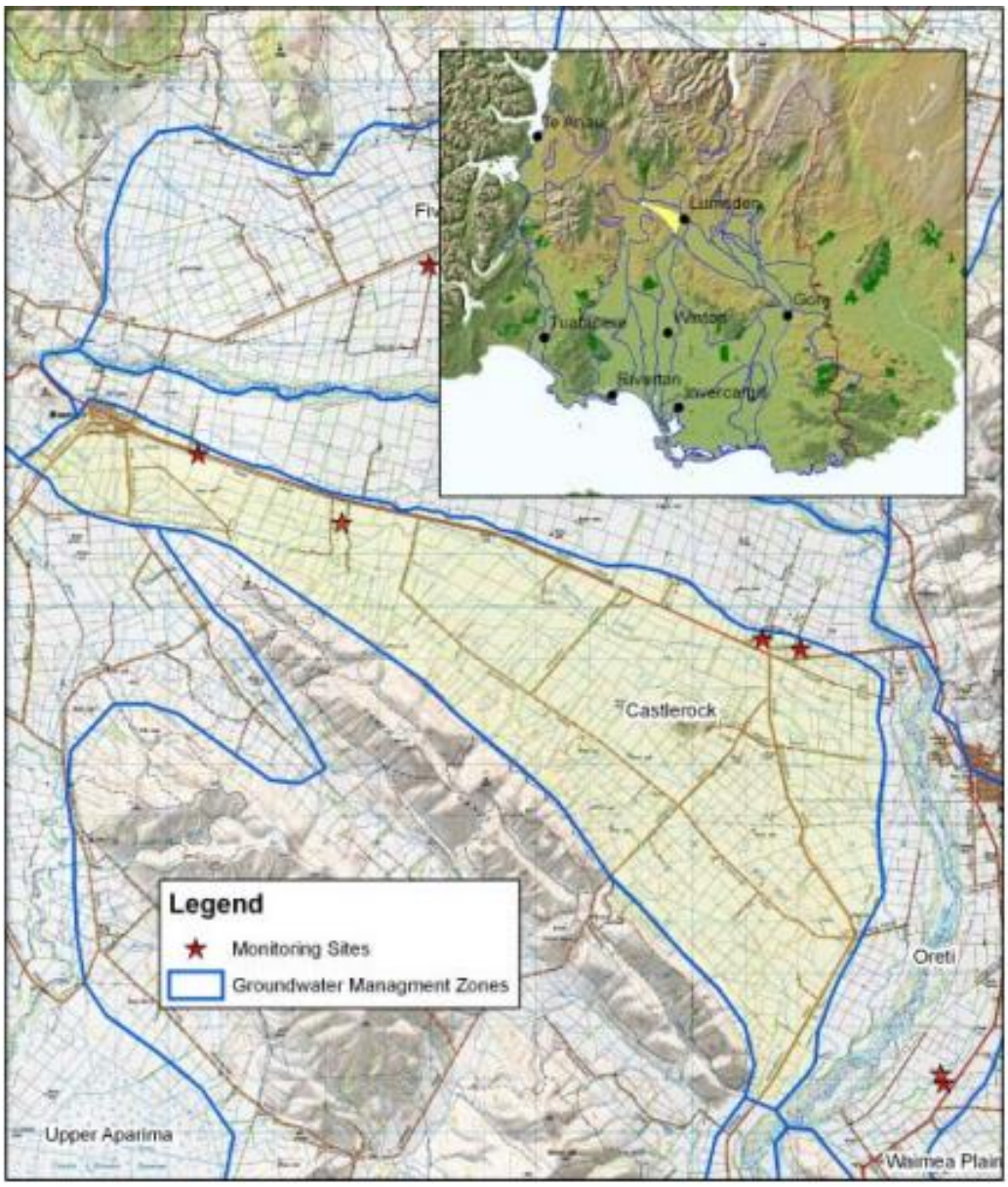


Figure 3 - Extent of the Castlerock Aquifer. (Extracted from Figure 1 of the ES Groundwater Zone Information Sheet)

The proposed groundwater take will be from the deeper Lumsden Aquifer, which is defined by ES as a confined aquifer. However, both the thickness of the confining layer and the relative head difference between the confined and unconfined aquifers (SKM, 2005) appear to decrease towards the south-east, and in our opinion it is likely that the aquifer is in fact semi-confined near the site. This is supported by information provided in support of the consent applications for the two wells closest to the proposed well locations:

- The *Hydraulic Testing Report* for the water take from well E44/0623 (Landpro, 2016) showed that pump test results fit leaky/semi-confined aquifer models as well or better than those for confined aquifers. The recovery data also indicated the presence of a recharge source (which would be consistent with leakage from the overlying aquifer).
- The original consent application for the water take from well E44/0256 (MWH, 2005) noted that the pump test data was "found not to conform with the Theis curve, indicating that either leaky

aquifer conditions or a recharge boundary is present." MWH inferred a high transmissivity zone running through the middle of the aquifer based on the results of their own and several other pump tests, however in our opinion leaky aquifer conditions in the south-eastern part of the aquifer are a more likely explanation.

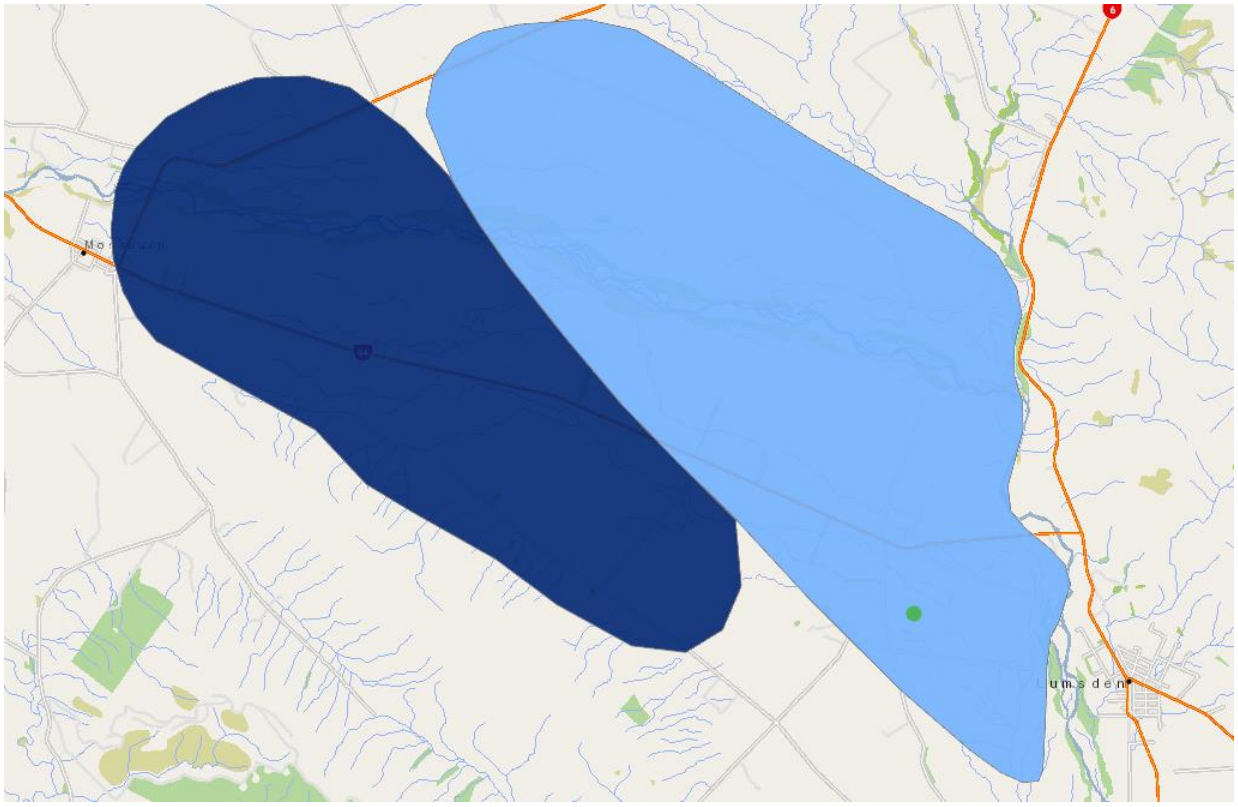


Figure 4 - The site (green dot shows approx. centre point) is located towards the south-eastern end of the Lumsden Aquifer (light blue), the larger of two confined aquifers in the Ōreti Basin (the other being the North Range Aquifer, shown in dark blue). Source: ES Beacon GIS viewer.

SKM's 2005 investigation included a summary of aquifer properties calculated from pump tests carried out in the Lumsden Aquifer before that time. This information (from Table 6 of their report) is reproduced below.

Table 1 - Hydrogeological properties for wells in the Lumsden Aquifer (reproduced from Table 6 of SKM, 2005)

Well Number	Hydraulic Conductivity (m/day)	Transmissivity (m2/day)	Storativity
E44/0200	70	600	0.00007
E44/0225	100	2330	0.0008
E44/0251	125	1850	0.003
E44/0252	100	2300	0.003
E44/0263	24	670	0.001
E44/0264	80	640	0.00001
E44/0269	335	3700	0.001
Average (arithmetic mean)	**119**	**1727**	**0.0013**

The transmissivity of the aquifer south of the Ōreti appears to decrease slightly, with wells E44/0256, E44/0263, E44/0264 and E44/0623 all having a transmissivity of 600-700 m^2/day (E44/0256 and E44/0623 were not included in the SKM report; transmissivity at those wells was calculated at 700 and 670 m^2/day, respectively). Of the wells south of the Ōreti with measured transmissivity values, only well E44/0339 (the closest production well in the Lumsden Aquifer to the River in this area) had a greater transmissivity: 1434 m^2/day.

According to data provided by Environment Southland, there are 10 groundwater take consents authorising extraction of a total of 5,637,822 m^3 of groundwater from 14 wells. This volume includes one consent which is currently subject to a renewal application involving a slight increase in the volume – we have assumed that this application will be granted without any change to the volume applied for. The current consented volume amounts to approx. 98 % of the allocation available from the aquifer under the WLP (5.76 million m^3). Most of the currently consented groundwater take (approx. 3.5 million m^3) is from wells north of the Ōreti.

This is reflected in the continuous water level records kept by ES for the aquifer, which show that seasonal drawdown is much greater in their monitoring well north of the Ōreti (E44/00254) than in the well to the south E44/0300 (Figure 5). Regardless, the seasonal pattern in both wells is similar, with several metres of drawdown occurring during the irrigation season, and recovery in the off-season to a generally consistent seasonal peak.

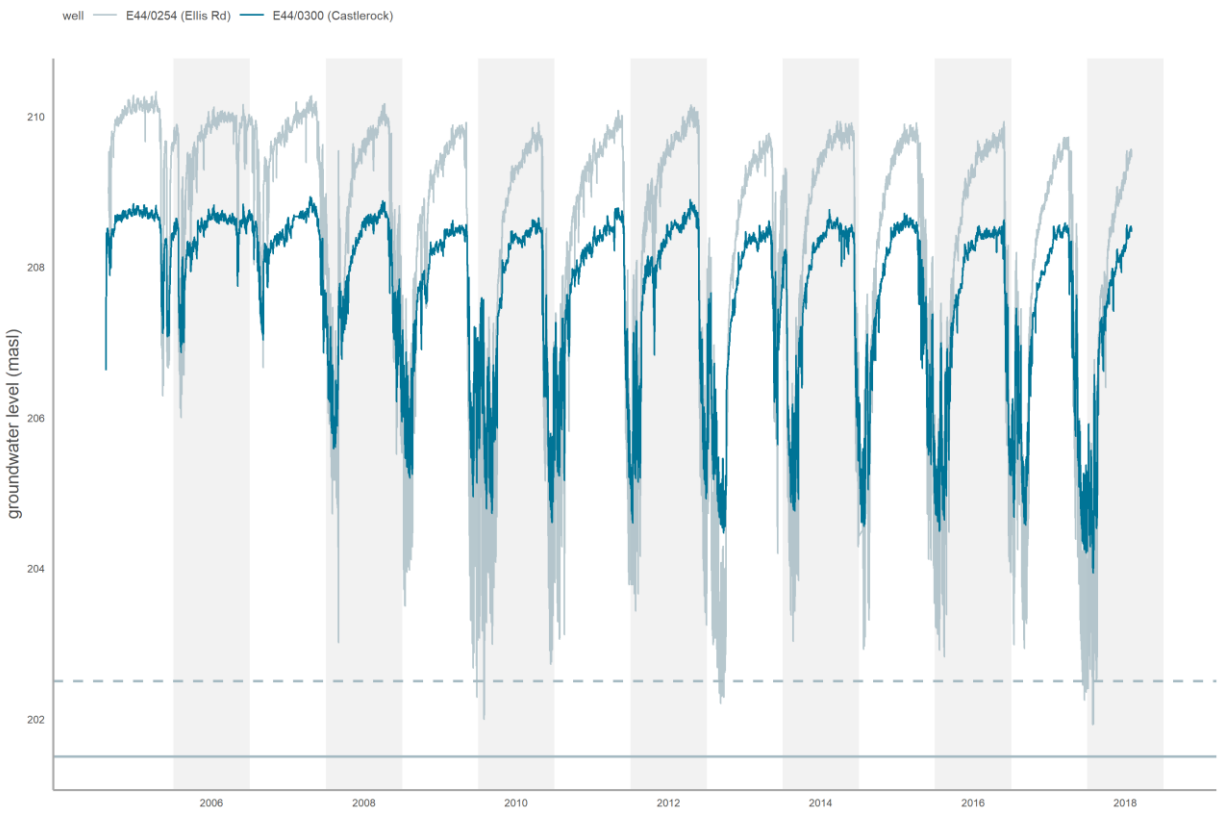


Figure 5 - Maximum seasonal drawdown is typically 7-7.5 m at E44/0254 in the northern part of the aquifer and 4-4.5 m at E44/0300 in the southern part. Since monitoring began, groundwater levels at well E44/0300 (blue line) have remained significantly higher than the trigger levels for water rationing under the PWLP (dashed and solid grey horizontal lines – these trigger levels do not apply at well E44/0254).

3 Well interference

3.1 Existing interference

In Appendix L.3 of the Proposed Southland Water and Land Plan, acceptable interference effects are defined as:

> *The cumulative interference effect of any new groundwater abstraction (in conjunction with other lawfully established groundwater takes) is considered* ***"acceptable" if the drawdown does not exceed any of the following limits*** *in properly constructed and operated bores:*
>
> *(ii)* ***50 percent of the potentiometric head*** *in any existing bore screened in a* ***confined aquifer*** *that is* ***not utilised for long-term monitoring of water levels****; or*
>
> *(iv)* ***no more than 20 percent of the available potentiometric head*** *in a* ***confined aquifer*** *that exists 50 percent of the time during natural conditions when no pumping is occurring from the aquifer,* ***for bores utilised for long-term monitoring of water levels****; or*

> *(v) in any situation where the **drawdown interference exceeds any of the limits in sub-clauses (i)-(iv) the new groundwater abstraction will be considered acceptable if it can be demonstrated that the drawdown interference will not have an impact upon the yield of the bore that is any more than minor or the effect is mitigated**.*
>
> *[emphasis added; points (i) and (iii) omitted as they relate to unconfined aquifers]*

In order to assess the activity against these standards, it is necessary to understand not only the direct effects of the proposed take, but also the potentiometric head in the existing wells near the site that may be affected by the proposed take, as well as the drawdown already occurring in the aquifer due to existing water takes.

For this application, we have only assessed interference effects observed/modelled to occur in wells south of the Ōreti as the effects of the proposed take on wells 3+ km to the north are expected to be negligible. However, our assessment of existing drawdown effects in the aquifer includes effects caused by all wells, including those north of the River. Existing drawdown on well E44/0254 (the ES water level monitoring well north of the Ōreti) was also modelled to allow comparison of modelled vs actual drawdown and assess the accuracy of the results.

3.1.1 Potentiometric head

Potentiometric head is the difference between the groundwater level in a well penetrating a confined aquifer, and the base of the aquitard above the aquifer. ES's definition of potentiometric head is based on the mean annual maximum groundwater level, as shown in Figure 6. For most of the wells considered, only a single groundwater level measurement is available from the data held by ES. In most cases, this single value will be lower than the mean annual maximum, and therefore the estimated potentiometric heads below are considered conservative.

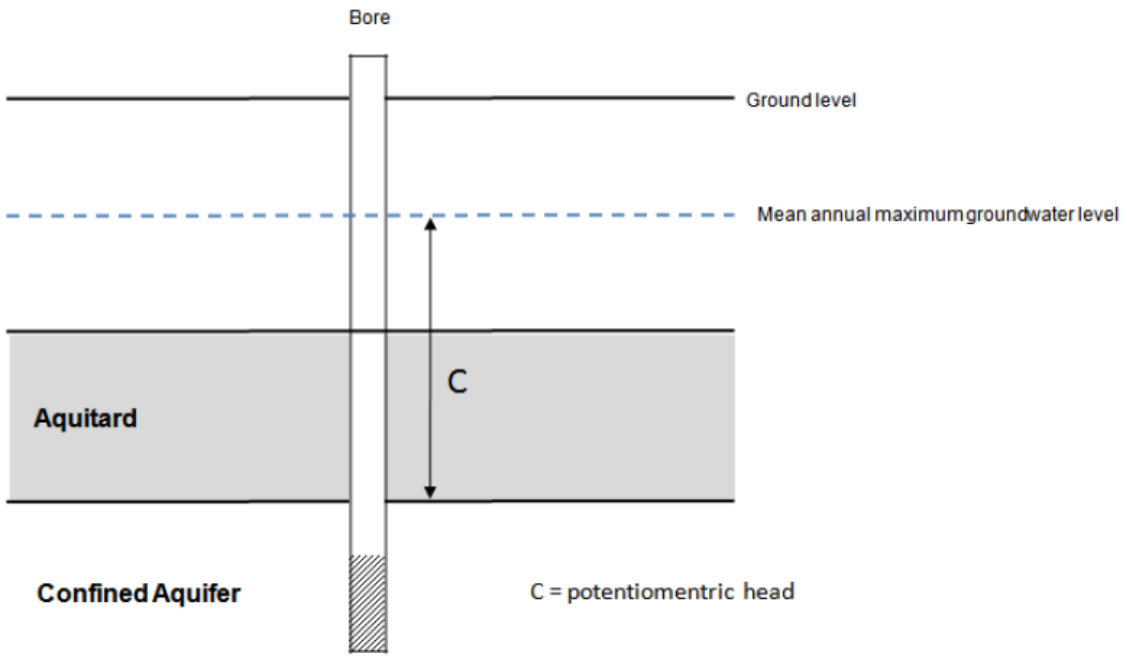


Figure 6 - Diagram showing ES's definition of potentiometric head for a confined aquifer (from Appendix L.3 of the PWLP)

The potentiometric head has been calculated for the wells associated with water takes from the Lumsden aquifer south of the Ōreti, plus the two ES groundwater monitoring wells in the aquifer. The relevant data are summarised in Table 2. Note that the base of the confining layer was taken from interpretive comments in the relevant consent application where possible. Otherwise, this is based on our interpretation of the relevant bore logs.

Table 2 - Available drawdown and other key details of relevant nearby wells

Well	Date drilled	Static water depth (mbgl)	Base of aquitard (mbgl)	Poten-tiometric head (m)	Notes/sources
E44/0300	10/2/2005	5.5 *	34	28.5	Beacon/ ES Enviro Data/ SKM (2005)
E44/0256	July 2004	4.12	27	22.9	ES data
E44/0263	5/2/2004	18.84	63.5	44.7	Aqualinc bore log
E44/0264	-	-	-	-	No bore log – assumed same as closest well (0263).
E44/0339	3/12/2014	7.1	19.6	12.5	Southdrill bore log
E44/0623	18/4/2016	4.68	15.5	10.8	McNeill bore log

** Note: E44/0300 surface RL of 213.97 m, and static water level of ~ 208 5 m.*

3.1.2 Existing drawdown

As noted above, actual drawdown in the Lumsden Aquifer is monitored by Environment Southland at two groundwater level monitoring wells:

- E44/0254, north of the Ōreti (referred to by ES as "Lumsden Aquifer at Ellis Rd"), where maximum seasonal drawdown is typically 7-7.5 m; and
- E44/0300, south of the Ōreti near Saleyard Rd (referred to as "Lumsden Aquifer at Castlerock"), where maximum seasonal drawdown is typically 4-4.5 m.

To assess the drawdown in the aquifer as a whole away from those two points, we have carried out modelling based on the existing consented takes in the aquifer. This was based on information on these takes provided by ES, including the location of the wells and the volume and rate of water take allowed under the consent. The Hunt and Scott (2007) model was selected, using the "Two aquifer system" calculation spreadsheet available on Environment Canterbury's website. Spatial variation in aquifer confinement was accounted for by assuming semi-confined conditions south of the Ōreti River and more well-confined conditions to the north. The input parameters were as follows:

Table 3 - Input values for existing drawdown calculations

	Value	Notes/source
T (pumped aquifer transmissivity, m^2/day)	**1,725**	SKM, 2005 (mean of all values for the Lumsden Aquifer from Table 6, n=7)
S (pumped aquifer storativity, dimensionless)	**0.0013**	As above
K'/B' (representing the movement of water through the aquitard, day^{-1}). K' is the hydraulic conductivity of the aquitard, and B' the thickness.	**0.0015** **0.000015**	Used for all takes south of the Ōreti, from Landpro (2015) *Hydraulic Testing Report* for well E44/0339 on Saleyard Rd. This well had a confining layer approx. 6.3 m thick, which implies a hydraulic conductivity of 0.009 m/day for the aquitard. Used for all takes north of the Ōreti. A value two orders of magnitude below the above was selected on the basis that the aquifer becomes more confined towards the north (see Section 2.4), and the Hunt and Scott (2007) solution approximates the Theis solution more closely as K'/B' decreases.
T_0 (shallow aquifer transmissivity, m^2/day)	**1,000**	Landpro, 2015
Sigma (shallow aquifer specific yield, dimensionless)	**0.035**	Landpro, 2015
Q (pumping rate, m^3/day)	**130 - 18,780**	Maximum daily rate of take allowed under each consent, based on data provided by ES. In the case of consent 300056, it was assumed that the current application to slightly increase the volume taken would be approved unchanged.
t (duration of pumping, days)	**68-365**	Ratio of maximum annual volume and maximum daily rate of take under each consent (again, assuming increased limits for consent 300056). Source as above.

The existing drawdown in any given well was taken as the sum of the modelled drawdowns caused by every other well in the aquifer (but not including the effect of a water take on the pumped well itself). The scenario modelled therefore assumes that all water users in the catchment will stagger the start date of pumping based on the value of **t** above, and pump continuously at the maximum allowable rate before all finishing on the same date (with the modelled drawdown values representing the seasonal peak drawdown that might be measured in the aquifer immediately before pumping ceased in all water takes). This is obviously a very conservative assumption as a review of actual water use data indicates water use is typically intermittent and seldom, if ever, occurs continuously at the maximum authorised rate for individual consents.

Two of the takes (consent 20158481 near Ellis Rd north of the Ōreti and 20171076 near Saleyard Rd south of the Ōreti) allow pumping from multiple wells. This was modelled as follows:

- The three wells covered by consent 20158481 were modelled as a single hypothetical well located at the midpoint of the three. The hypothetical well is located within 600 m of all of the real wells and within 200 m of the well from which the largest volume of water was taken in the 2017-18 irrigation season (E44/0407, based on data provided by Environment Southland). The nearest part of the site of interest is approx. 4 km to the south.
- The 4 wells covered by consent 20171076 were modelled as two wells: E44/0623 located south of Keown Road, and a hypothetical well representing the remaining three (E44/0338-9 and E44/0354). The hypothetical well is located approx. 50 m or less from the 3 wells it represents, 2.5 km from well E44/0623, and 1.3 km from the nearest part of the site of interest. The daily water allocation for this consent was divided between E44/0623 and the hypothetical well based on the instantaneous pumping rates (3,600 m^3/day for well E44/0623 and 13,680 m^3/day for the other wells). The data provided by ES shows that no water was actually taken from well E44/0623 in the 17/18 season, but allowing for the proposed future abstraction from this well is conservative as it is closer to the site (within a few metres of the eastern boundary) than the other wells.

These slight simplifications are not expected to significantly affect the modelling results. The existing drawdown calculations are in Attachment B, and summarised in Table 4. The modelled drawdown for the two ES monitoring wells exceeded actual measured drawdown by between 20 % and 70 %, indicating that the model results are conservative:

- E44/0254 (north of the Ōreti): 9.1 m modelled drawdown vs 7-7.5 m measured.
- E44/0300 (south of the Ōreti): 6.9 m modelled drawdown vs 4-4.5 m measured.

Table 4 - Acceptable vs actual/modelled drawdown in relevant nearby wells

Well	Purpose	Poten-tiometric head (m)	Acceptable drawdown (m)	Existing drawdown (m)	Basis for ex. drawdown estimate	Remaining available drawdown (m)
E44/0300	Monitoring	28.5	5.7	4.5	ES level data	**1.2**
E44/0256	Irrigation	22.9	11.5	4.1	Calculated	**7.4**
E44/0263	Irrigation	44.7	22.4	4.4	Calculated	**18.0**
E44/0264	Irrigation	-	22.4	3.9	Calculated	**18.5**
E44/0339	Irrigation	12.5	6.3	4.7	Calculated	**1.6**
E44/0623	Irrigation	10.8	5.4	3.5	Calculated	**1.9**

Note: potentiometric head taken from Table 2. Acceptable drawdown calculated from this, based on 20 % of potentiometric head for E44/0300 (a water level monitoring well), and 50 % for all other wells. Existing drawdown based on actual measurements where available (E44/0300 only), otherwise model outputs.

The three wells with the least remaining available drawdown are E44/0300 (the ES monitoring well approx. 2.6 km north of the site), E44/0339 (representing a group of production wells approx. 1.3 km north of the site), and E44/0623 (a production well which immediately neighbours the site boundary). All of these have a remaining available drawdown between 1 and 2 m, and the latter two are owned by the same water user (although on different properties) and operated under consent 20171076.

3.2 Interference from proposed new water take

The existing drawdown measurements and modelling results summarised in Table 4 indicate that the proposed groundwater take will need to be managed to ensure that the drawdown caused is no more than 1.2 m at well E44/0300, 1.6 m at E44/0339, and 1.9 m at E44/0623. The likely drawdown effects of the proposed take have been modelled using the Hunt and Scott (2007) solution with the parameters listed in Table 5. These are similar to those in Table 3, but the aquifer properties have been selected based only on wells south of the Ōreti, and the pumping rate and duration are specific to this application.

Table 5 - Input values for proposed take drawdown calculations

	Value	Notes/source
T (pumped aquifer transmissivity, m^2/day)	**600**	Conservative estimate based on values for wells near the site (rather than average for the whole aquifer, as for the existing drawdown calculations).
S (pumped aquifer storativity, dimensionless)	**0.0001**	
K'/B' (representing the movement of water through the aquitard, day^{-1})	**0.0015**	From Landpro (2015) *Hydraulic Test Report* for well E44/0339 on Saleyard Rd, as per existing drawdown calcs for wells south of the Ōreti.
T_0 (shallow aquifer transmissivity, m^2/day)	**1,000**	As per existing drawdown calculations.
Sigma (shallow aquifer specific yield, dimensionless)	**0.035**	
Q (pumping rate, m^3/day)	**4,320**	Maximum proposed daily rate of take.
t (duration of pumping, days)	**28**	Ratio of maximum proposed annual rate of take to maximum proposed daily take.

The results (Attachment B and Figure 7) indicate that the interference effects of the proposed well will be acceptable, provided that it is at least 350 m from well E44/0300, 250 m from E44/0339, and 180 m from well E44/0623. This is based on points (ii) and (iv) of ES's definition of 'acceptable' interference effects, and ignores point (v) of the definition, which acknowledges that drawdown at slightly greater than the numerical limits may still be 'acceptable' where adverse effects are no more than minor. Regardless, the calculated minimum distances are less than the actual distance from the well to the site for all but E44/0623.

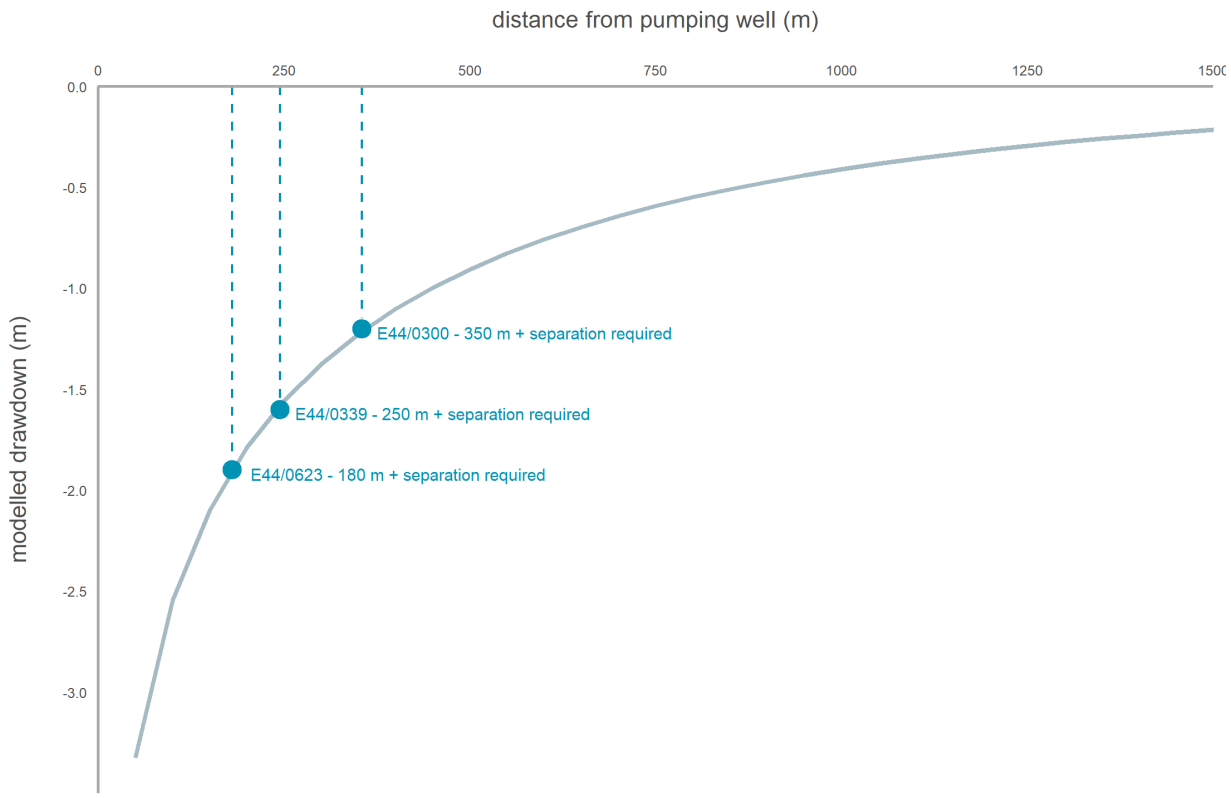


Figure 7 - Drawdown modelling using the Hunt and Scott (2007) solution indicates that interference effects on nearby wells with relatively low remaining available drawdown will be acceptable, provided the pumping well is at least a few hundred metres from those wells.

Drawdown in the overlying (Castlerock) aquifer is also not expected to be significant, with modelled drawdown of no more than 0.5 m (not shown in Figure, but included in Attachment B).

Nonetheless, as a conservative measure to minimise the chance that the rate of take will have to be reduced to maintain acceptable drawdown effects if the aquifer properties are somewhat different to what is expected, it would be preferable to install wells no less than 1 km from well E44/0623 and 1.5 km from E44/0339.

4 Stream depletion

Pumping water from a well has the potential to reduce the flow of nearby streams which are connected to groundwater. This is not of concern for confined aquifers, but given our expectation that the part of the Lumsden Aquifer beneath the site is semi-confined, stream depletion requires consideration in this case. Ward and Lough (2011) developed a mathematical model for the stream depletion effects of pumping groundwater from a semi-confined aquifer underlying an unconfined aquifer which is connected to surface water. Potential stream depletion effects of the proposed water take were calculated in accordance with Ward and Lough's solution, using the 'function.xls' spreadsheet (Hunt, 2012) which can be found from Environment Canterbury's website. The input parameters used are the same as those used for the drawdown assessment, with the addition of:

- **L** (distance from well to stream): **50 m** was arbitrarily selected as a distance from any of the streams/drains on site which is easily achievable.

- **λ** (streambed conductance): **0.1** was selected as the streams in the eastern part of the Castlerock Aquifer where the wells are to be located, and where the connectivity between groundwater and surface water is expected to be lower than closer to the centre of the aquifer, where significant groundwater discharge to surface water occurs. λ is defined as:

$$\lambda = \frac{K" \, b}{B"}$$

  Where K" is the hydraulic conductivity of the streambed, b is the stream width, and B" is the thickness of the streambed. For a stream which is 3 m wide and has a 1 m thick bed, a λ value of 0.1 implies a hydraulic conductivity of 0.033 m/day (approx. three times the hydraulic conductivity calculated for the confining layer at E44/0339 – see Table 3).

The calculations are in Attachment B, and the results are plotted in Figure 8. They show that after 28 days, approximately 2.5 % of the proposed water take would be drawn from a stream 50 m from the well. This would equate to approx. 1.3 L/s of stream depletion. This indicates a **low** degree of stream depletion, as defined by ES in Appendix L.2 of the WLP. This is consistent with the relatively low hydraulic conductivity of the aquitard (compared to the water-bearing layers) and the large storage volume available in the unconfined aquifer.

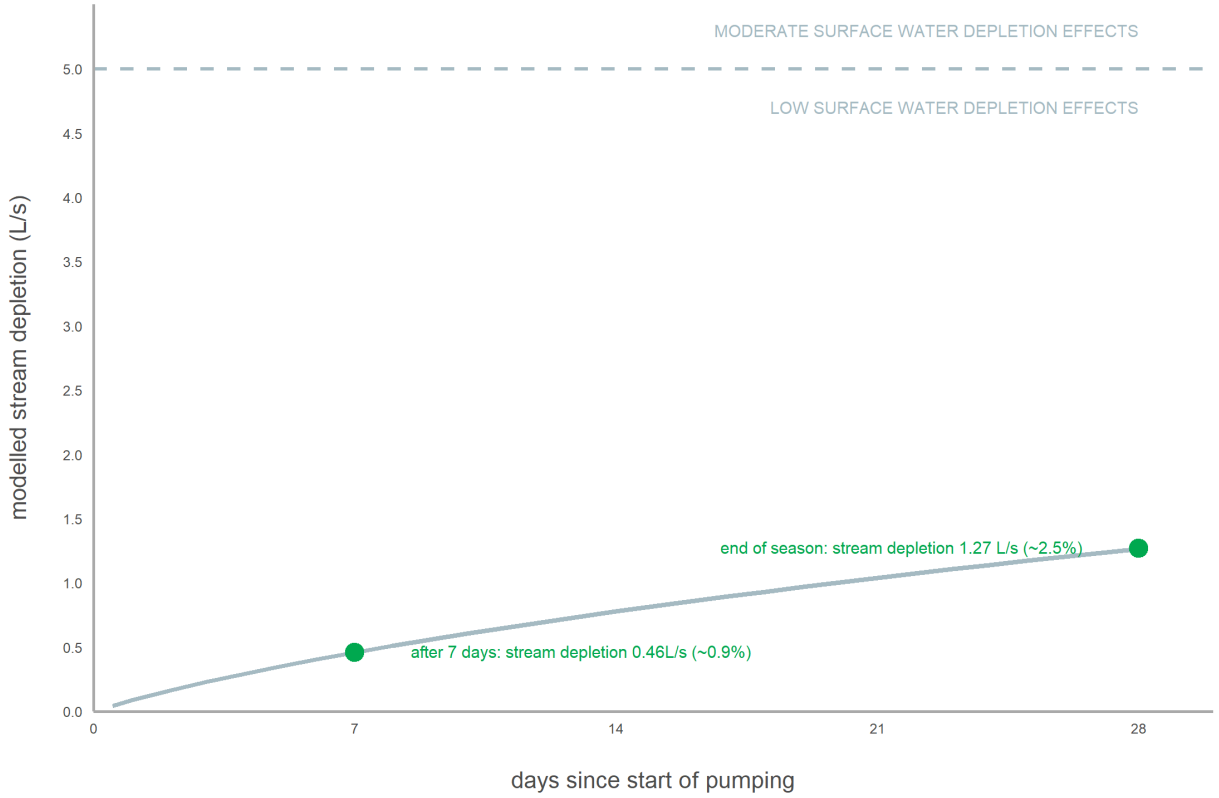


Figure 8 - Stream depletion effects on a stream 50 m from the proposed well will be no more than a few litres per second, based on modelling using the Ward and Lough (2011) solution.

5 Aquifer sustainability

The Lumsden Aquifer is already heavily used and studied, and ES's groundwater level record does not show evidence of any significant change in off-season groundwater levels over time. The proposed groundwater take represents approx. 2 % of the currently consented take (and the primary allocation) and is to occur in the less-used (southern) part of the aquifer. It is therefore reasonable to assume the proposed abstraction is unlikely to result in discernible effects on aquifer sustainability.

The aquifer is not coastal, and therefore not susceptible to salt-water intrusion.

Pumping of groundwater can also result in aquifer compaction or subsidence. This typically occurs in aquifers where significant long-term drawdown of groundwater levels occurs in fine-grained geological materials. This has not been occurring in the Lumsden Aquifer to date, and the proposed water take will make only a minor and localised contribution to drawdown in the aquifer. The predominantly gravel geology beneath the site also presents a relatively low risk of aquifer compaction or subsidence.

6 Conclusions

As discussed in this report, we consider that there is sufficient information from existing bores in the Lumsden Aquifer to adequately assess the likely effects of the proposed water take. Based on this information and the calculations presented above, the proposed water take is not expected to have significant adverse effects in terms of interference with other bores, stream depletion, or aquifer sustainability.

These conclusions will need to be reassessed based on the results of pump testing of the new bore or bores. However, even if pump testing shows that the aquifer properties are different to those expected, it will be possible to avoid adverse effects by altering the management of the proposed water take (for instance, installing two wells with a lower rate of take per well).

The effects of aquifer testing have not been explicitly calculated, but are expected to be insignificant, given the short duration of testing that will be required.

7 References and acknowledgements

Environment Southland, no date, *Castlerock Groundwater Zone Information Sheet*. Accessed December 2018 from http://gis.es.govt.nz/apps/groundwater/zones/Castlerock.pdf

Hunt, 2012, *Groundwater analysis using Function.xls* (self-published). Accessed November 2018 from https://sites.google.com/site/brucehuntsgroundwaterwebsite/

Hunt and Scott, 2007, 'Flow to a Well in a Two-Aquifer System', *Journal of Hydraulic Engineering 12:2*, 146-155

Landpro, 2015, *Hydraulic Testing Report* for Holmesdale Trust (ref: S14176)

Landpro, 2016, *Hydraulic Testing Report* for HM and KA English (ref: S15326)

Manaaki Whenua/Landcare Research, 2018, *S-Map Online: The digital soil map for New Zealand*. Accessed December 2018 from https://smap.landcareresearch.co.nz/

MWH, 2005, *Application for Resource Consent: Groundwater Take and Irrigation, Castlerock*, for W Menlove.

SKM, 2005, *Hydrogeology of the Oreti Basin*, report prepared for Environment Southland.

Ward and Lough, 2011 (November), 'Stream Depletion from Pumping a Semiconfined Aquifer in a Two-Layer Leaky Aquifer System', *Journal of Hydrologic Engineering*, 955-959.

Geo-spatial data analysis and mapping used QGIS (version 3.2.3)

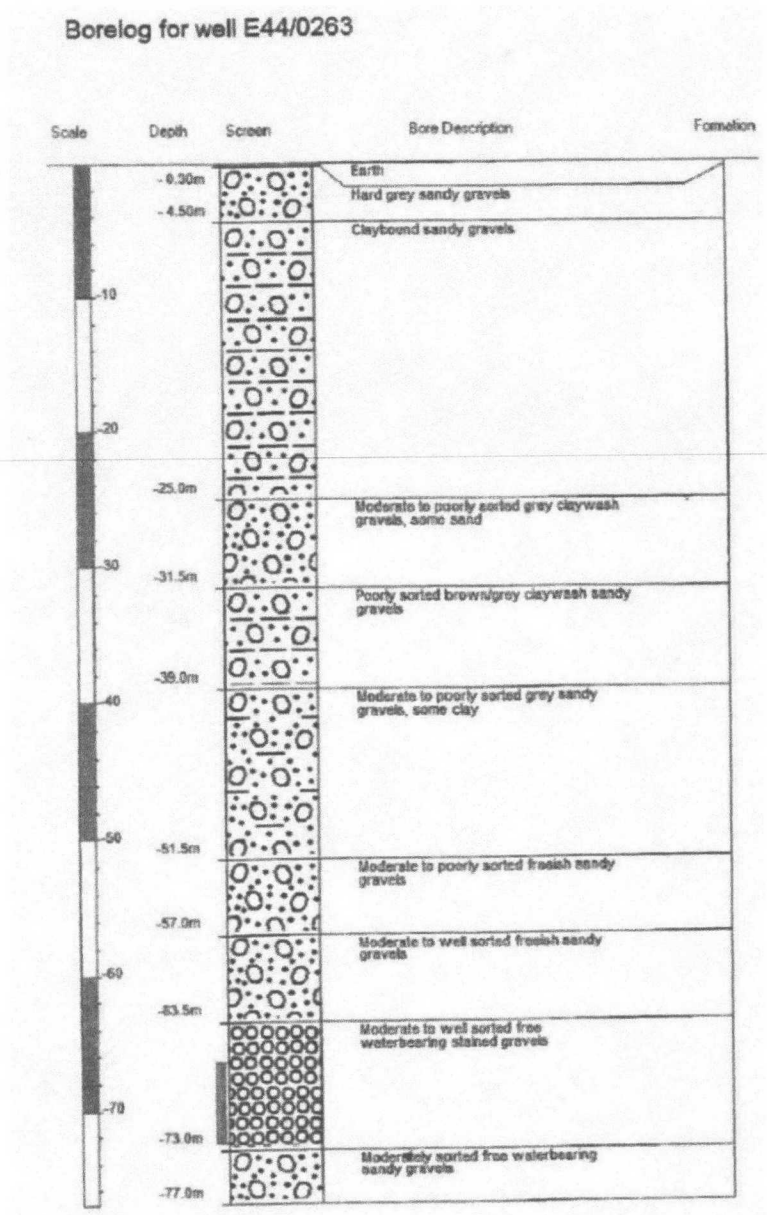
Other numerical data analysis and visualisation used R/RStudio (versions 3.5.1 and 1.1.463, respectively). The following packages were used: clifro, expint, lubridate, rdist, readxl, tidyverse.

Attachment A: Bore logs

Note: no formal log is available for well E44/0256, but the relevant data was provided by ES:

DEPTH	LITHOLOGY_CODE	DESCRIPTION	STRATA_DESCRIPT
-8	GRCL	Gravel & clay	Heavy clay bound gravels
-8.8	CL	Clay	Clay
-31	GRCL	Gravel & clay	Heavy clay bound gravels
-36.6	GRCL	Gravel & clay	Light clay bound gravels
-2	GR	Gravel	Gravels - dry
-7	GRCL	Gravel & clay	Claybound gravels - wet
-17	GRCL	Gravel & clay	Claybound gravels
-30	GR	Gravel	Gravels - wet
-0.3	SOIL	Soil	Earth
-2	GRSA	Gravel & sand	Sandy gravels
-4.5	GRSA	Gravel & sand	Grey sandy gravels
-18	GRCL	Gravel & clay	Claybound waterbearing gravels
-27	GRCLSA	Gravel clay & sand	Moderate to poorly sorted claywash sandy gravels
-31	GRSA	Gravel & sand	Moderate to poorly sorted freeish sandy gravels, some stained
-37.5	GRSA	Gravel & sand	Poorly sorted gravels and coarse sand
-50	SASOMGR	Sand with some gravel	Grey/blue sandstone and some gravels
-56	GR	Gravel	Small grey gravels
-71	FGR	Fine gravel	Small red/brown angular rock

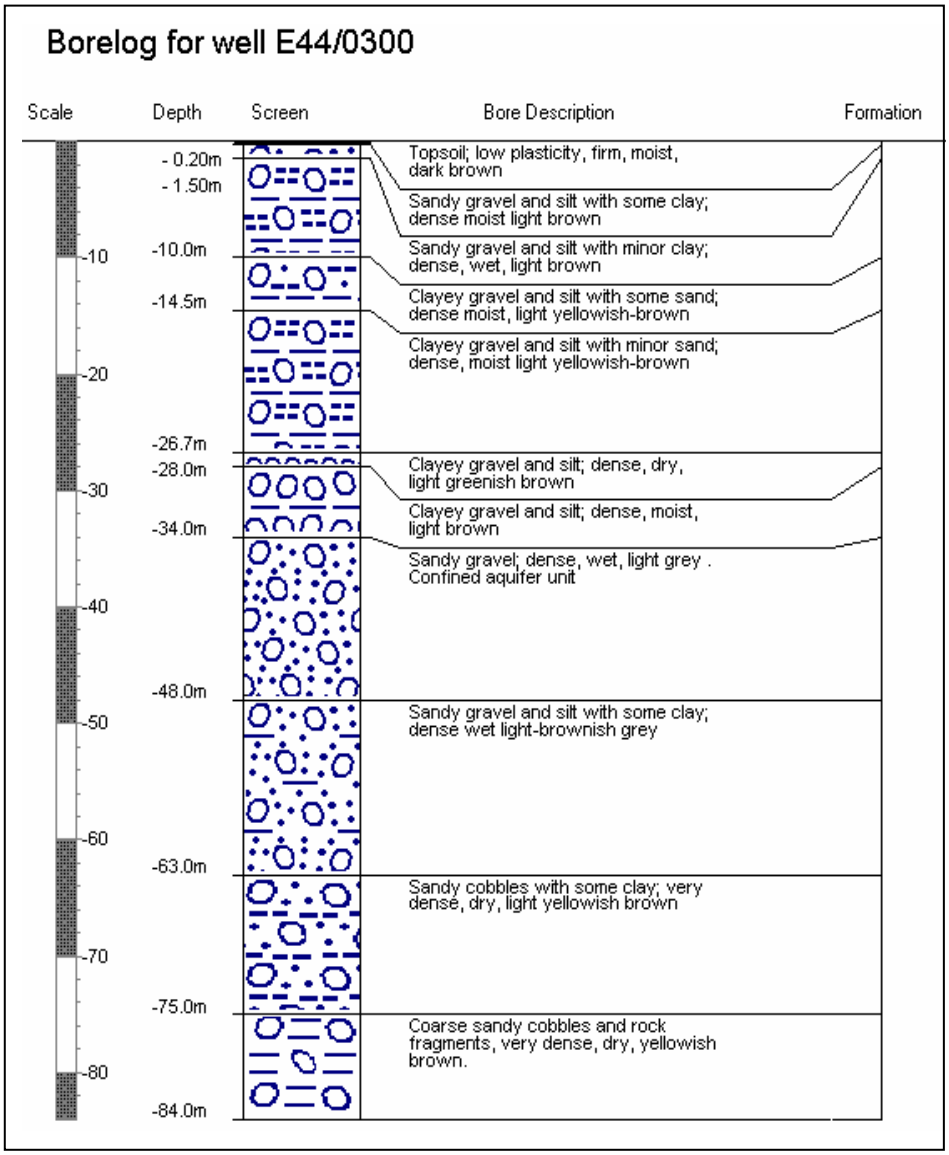
Appendix D: Bore Log for Bore E44/0263



ll number	Well depth	Initial water level	diameter	casing material	Aquifer type	Aquifer Name	Transmissivity
44/0267	35	2	450	steel	confined	North Range	630
44/0266	83	-3.25	450	steel	confined	North Range	700
44/0268	38	DRY ALL CASING REMOVED	450	steel	confined	North Range	
44/0263	77	-18.8	450	steel	confined	Lumsden	670

E44/0623 bore log, from Aqualinc Assessment of Environmental Effects (2015)

- **Figure 4. Drillers log from E44/0300 in the central Oreti basin**



A similar pattern of subsurface geology is observed across the area from Ellis Road as far south as the Mossburn-Lumsden Highway. North of Ellis Road the thickness of the confined aquifer unit diminishes and the subsurface geology becomes a thick, relatively undifferentiated sequence of claybound gravel. An investigation bore (E44/0183) drilled by Environment Southland adjacent to the Mossburn-Five Rivers Highway near the Cromel Stream showed a sequence of relatively undifferentiated claybound gravels extending to a depth of over 50 m.

South of the Lumsden-Mossburn Highway, a similar pattern of Quaternary gravels is observed but which is offset vertically from those to the north by approximately 25 m. In this area the gravels

E44/0300 bore log from SKM, 2005

SOUTHDRILL
WATER EXPLORATION

BORE LOG DATA SHEET

CLIENTS NAMES:	Longreach Trust C/- Hamish English
FULL ADDRESS:	160 Breakneck Road RD 1 Dipton
RESOURCE CONSENT NO:	20147066
BORE SIZE:	300mm
START DATE:	3 December 2014
FINISH DATE:	6 December 2014
MACHINE:	Schramm T555
RAPID NO:	
GRID REFERENCE:	E2151517 - N5490139
DRILLER:	Shaun Crosland
MEASURED FROM:	T.O.C.
300mm UPSTAND:	Yes
TOTAL DEPTH BORE:	42m
TOP LEADER:	38.5m
STATIC WATER LEVEL:	7.1m
SCREEN - SLOT:	4ml
- TYPE:	Stainless Steel
PVC SLOTTED:	
SCREEN:	3m
LEADER:	.5m
SUMP:	
TOTAL CASING USED:	39m
AT TIME OF PUMPING-BORE DID:	40LPS
TEST PUMP PERIOD:	
DRAWDOWN FROM SWL:	35m
AIR/PUMP INTAKE:	37.5m
BACTERIAL WATER TEST:	
CHEMICAL WATER TEST:	
IMPERVIOUS SEAL AT GROUND LEVEL AROUND CASING	Yes
CASING TOP SEALED TO PREVENT CONTAMINATION	Yes

COMMENTS:

BORE LOG:

0 - 6.1m	Dry sandy gravles
6.1 - 13.3	Wet gravel
13.3 - 19.6	Clay Bd gravels
19.6 - 39m	Wet gravels

E44/0339 bore log, from Landpro Hydraulic testing report (2015)

mcneill

DRILLING ■ DISTRIBUTION ■ PUMPING

SINCE 1918

Client Name:	Hamish English	Home No.	
		Cell No.	
Address	Keown Rd Castle rock	Consent No.	
Grid Reference	E- 1242882 N- 4926130		
Driller	Neil Simmons		
Machine/Rig:	DR24	Fleet No. 232	
Drill Method:	Dual rotary		
Bore diameter mm	300mm		
Start date:	18/4/16	Finish Date: 20/4/16	
Development Hours:	7.0 hrs	Development Method: air surge	
Screen Slot:	2.5 mm	ID 256 mm	OD 273 mm
PVC slotted	Top m	Bottom m	
Total casing used:	26.50 m	Total Depth: 29.27 m	
Sump length:	N/A m	Sump Diameter: mm	
Test Pumping	Air lifted	Pumped	Rate: LPS
Test Pump period	Hrs	Pump intake: m	
Bacterial Water test	Yes	No	
Chemical Water test	Yes	No	
Casing top sealed	Yes ✓	No	
Impervious seal at ground	Yes ✓	No	
Over Drilled	Yes	No ✓	m

Comments:

wl at 5.0m 2.38m

wl at 23m 4.68m

Bore log

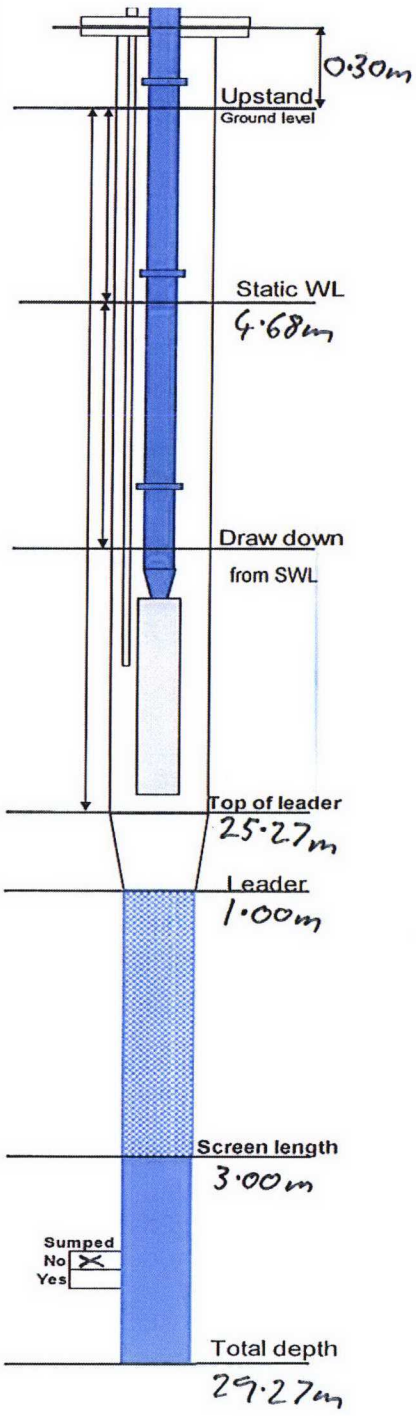
0 – 0.2 Soil

0.2 – 6.8 Gravel

6.8 – 15.5 Heavy clay Bound Gravel

15.5 – 28.8 Gravel Some Sand

28.8 – 29.3 Clay Bound Gravel



Version: 1, Created 16 October 2014

E44/0623 bore log, from Landpro Hydraulic Testing Report (2016)

Attachment B: Calculations

Existing drawdown calculations using Hunt and Scott (2007)

Parameters		
T	1725	(m2/d)
S	0.0013	(-)
K'	0.036	(m/d)
B'	24	(m)
K'/B' (sth)	0.0015	(d-1)
K'/B'(nth)	0.000015	
T0	1000	(m2/d)
sigma	0.035	(-)
Q	various	(L/s)
Q	various	(m3/d)
radius	various	(m)

Notes
This spreadsheet illustrates the use of Bruce Hunt's macro solutions for leaky aquifers.
Input parameters are:
T - pumped aquifer transmissivity
S - pumped aquifer storativity
K' - aquitard vertical hydraulic conductivity
B' - aquitard thickness
T_0 - Water table aquifer transmissivty
sigma - water table specific yield
Q - pumping rate
radius - distance from pumped bore
t - time
Outputs are:
Eta_Volume - the cumulative volume drained from the water table aquifer (m^3)
Drainage rate - instantaneous drainage rate (derived from incremental change in Eta_Volume (L/s)
W_11 - drawdown in pumped aquifer at distance = radius & time = t (m)
Eta_11 - drawdown in water-table at distance = radius & time = t (m)

					E44/0300			E44/0254			E44/0256			E44/0263			E44/0264			E44/0623			Saleyard		
Well	K'/B'	Q (m3/d)	Q(m3/yr)	t (days)	r(m from 0300)	Eta_11	W_11	r(m from 0254)	Eta_11	W_11	r(m from 0256	Eta_11	W_11	r(m from 0263)	Eta_11	W_11	r(m from 0264)	Eta_11	W_11	r(m from 0623)	Eta_11	W_11	r(m from Saleyard)	Eta_11	W_11
E44/0391	0.000015	190	56,880	300	2,112	0.00	0.03	1,026	0.00	0.04	5,222	0.00	0.02	4,366	0.00	0.02	4,899	0.00	0.02	5,709	0.00	0.02	3,289	0.00	0.02
E44/0252	0.000015	6,000	495,125	83	1,283	0.03	1.18	2,278	0.02	0.88	4,241	0.01	0.56	4,348	0.01	0.55	5,220	0.01	0.46	4,737	0.01	0.51	2,586	0.02	0.81
E44/0269	0.000015	8,497	699,000	82	4,013	0.02	0.83	1,187	0.04	1.73	6,985	0.01	0.48	4,874	0.02	0.70	4,734	0.02	0.72	7,440	0.01	0.44	4,883	0.02	0.70
E44/0263	0.0015	2,300	188,662	82	3,298	0.04	0.05	4,483	0.02	0.03	3,872	0.03	0.04	-			1,454	0.12	0.15	4,096	0.00	0.00	2,494	0.00	0.00
E44/0225	0.000015	7,500	737,750	98	3,457	0.03	0.85	842	0.05	1.79	6,398	0.01	0.49	4,327	0.02	0.71	4,290	0.02	0.72	6,850	0.01	0.45	4,291	0.02	0.72
E44/0256	0.0015	2,155	190,000	88	3,109	0.05	0.06	6,008	0.01	0.01	-			3,872	0.03	0.04	5,326	0.01	0.02	496	0.18	0.31	2,120	0.08	0.09
E44/0264	0.0015	1,871	127,480	68	4,387	0.01	0.02	4,704	0.01	0.02	5,326	0.01	0.01	1,454	0.09	0.11	-			5,540	0.01	0.01	3,833	0.02	0.03
Comp Ellis Rd	0.000015	18,780	1,710,875	91	2,184	0.08	2.84	865	0.11	4.41	5,289	0.04	1.46	4,289	0.05	1.77	4,776	0.05	1.61	5,773	0.04	1.34	3,321	0.06	2.17
Comp Saleyard Rd	0.0015	13,680	1,133,706	83	1,303	0.77	0.97	3,960	0.18	0.21	2,120	0.50	0.58	2,494	0.40	0.47	3,833	0.19	0.23	2,560	0.39	0.45	-		
E44/0623	0.0015	3,600	298,344	83	3,597	0.06	0.07	6,481	0.01	0.01	496	0.30	0.51	4,096	0.04	0.05	5,540	0.02	0.02	-			2,560	0.10	0.12
E44/0300	0.0015	0	0	0	-	0.00	0.00	2,944	0.00	0.00	3,109	0.00	0.00	3,298	0.00	0.00	4,387	0.00	0.00	3,597	0.00	0.00	1,303	0.00	0.00
E44/0254	0.000015	0	0	0	2,944	0.00	0.00	-	0.00	0.00	6,008	0.00	0.00	4,483	0.00	0.00	4,704	0.00	0.00	6,481	0.00	0.00	3,960	0.00	0.00
Total						**1.10**	**6.90**		**0.45**	**9.13**		**0.92**	**4.14**		**0.67**	**4.42**		**0.44**	**3.94**		**0.65**	**3.52**		**0.33**	**4.65**

LANDPRO
Make the most of your land

Proposed take drawdown calculations using Hunt and Scott (2007)

Parameters		
T	600	(m^2/d)
S	0.0001	(-)
K'	0.036	(m/d)
B'	24	(m)
K'/B'	0.0015	(d-1)
T0	1000	(m^2/d)
sigma	0.035	(-)
Q	50.0	(L/s)
Q	4320	(m^3/d)
time	28	days

Notes
This spreadsheet illustrates the use of Bruce Hunt's macro solutions for leaky aquifers.
Input parameters are:
T - pumped aquifer transmissivity
S - pumped aquifer storativity
K' - aquitard vertical hydraulic conductivity
B' - aquitard thickness
T_0 - Water table aquifer transmissivty
sigma - water table specific yield
Q - pumping rate
radius - distance from pumped bore
t - time
Outputs are:
Eta_Volume - the cumulative volume drained from the water table aquifer (m^3)
Drainage rate - instantaneous drainage rate (derived from incremental change in Eta_Volume (L/s)
W_11 - drawdown in pumped aquifer at distance = radius & time = t (m)
Eta_11 - drawdown in water-table at distance = radius & time = t (m)

distance (m)	Eta_11	W_11
50	0.49	3.32
100	0.48	2.54
150	0.47	2.10
200	0.46	1.79
250	0.45	1.56
300	0.43	1.38
350	0.42	1.23
400	0.40	1.10
450	0.39	1.00
500	0.37	0.91
550	0.36	0.83
600	0.34	0.76
650	0.33	0.70
700	0.32	0.64
750	0.30	0.59
800	0.29	0.55
850	0.27	0.51
900	0.26	0.47
950	0.25	0.44
1000	0.24	0.41
1050	0.23	0.38
1100	0.21	0.36
1150	0.20	0.34
1200	0.19	0.31
1250	0.18	0.29
1300	0.17	0.28
1350	0.17	0.26
1400	0.16	0.24
1450	0.15	0.23
1500	0.14	0.22
1550	0.13	0.20
1600	0.13	0.19
1650	0.12	0.18
1700	0.11	0.17
1750	0.11	0.16
1800	0.10	0.15
1850	0.09	0.14
1900	0.09	0.13
1950	0.08	0.13
2000	0.08	0.12
2050	0.07	0.11
2100	0.07	0.11
2150	0.07	0.10
2200	0.06	0.09
2250	0.06	0.09
2300	0.06	0.08
2350	0.05	0.08
2400	0.05	0.07
2450	0.05	0.07
2500	0.04	0.07

LANDPRO
Make the most of your land

Stream depletion calculations using Ward and Lough (2011)

Inputs		
Q	50	L/s
Q	4320	m^3/day
Duration	30	days
T_1	600	m^2/day
T_2	1000	m^2/day
S_1	0.0001	
S_2	0.035	
L	50	m (from well to steam)
K'	0.036	m/day
B'	24	m
gamma	0.1	(K' * stream width)/B'
Stream width	1	m

Equation parameters		
T_2/S_2L^2	11.42857143	(1st input parameter without time)
T_1/T_2	0.6	
S_1/S_2	0.002857143	
$(K'/B/)*L^2/T_2$	0.00375	
gamma*L/T_2	0.005	

The solutions can be calculated with the following programs:

$$\frac{\Delta Q}{Q} = Q\_16\left(\frac{tT_2}{S_2L^2}, \frac{T_1}{T_2}, \frac{S_1}{S_2}, \frac{(K'/B')L^2}{T_2}, \frac{\lambda L}{T_2}\right) \qquad (207)$$

Days	$tT_2(S_2L^2)$	Stream depletion factor	Stream depletion L/s
0.5	5.7	0.001	0.04
1	11.4	0.002	0.08
2	22.9	0.003	0.16
3	34.3	0.005	0.23
4	45.7	0.006	0.29
5	57.1	0.007	0.35
6	68.6	0.008	0.40
7	80.0	0.009	0.46
8	91.4	0.010	0.51
9	102.9	0.011	0.56
10	114.3	0.012	0.60
11	125.7	0.013	0.65
12	137.1	0.014	0.69
13	148.6	0.015	0.74
14	160.0	0.016	0.78
15	171.4	0.016	0.82
16	182.9	0.017	0.86
17	194.3	0.018	0.89
18	205.7	0.019	0.93
19	217.1	0.019	0.97
20	228.6	0.020	1.00
21	240.0	0.021	1.04
22	251.4	0.021	1.07
23	262.9	0.022	1.11
24	274.3	0.023	1.14
25	285.7	0.023	1.17
26	297.1	0.024	1.20
27	308.6	0.025	1.23
28	320.0	0.025	1.27